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JOINT VENTURE

EDITHVALE AND BONBEACH LEVEL CROSSING REMOVAL PROJECTS

ENVIRONMENT EFFECTS STATEMENT

EES TECHNICAL REPORT C
Acid Sulfate Soils and Contamination

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Executive Summary

The Victorian Government is removing 50 of Melbourne's most dangerous and congested level crossings. The Edithvale Road, Edithvale and Station Street/Bondi Road, Bonbeach level crossing removal projects were referred to the Minister for Planning who decided an Environment Effects Statement (EES) was required.

This report addresses the Scoping Requirements of the EES in relation to potential impacts of acid sulfate soils (ASS) and contamination resulting from construction and operational activity as a result of removing the level crossings.

Contamination and spoil management context

ASS are naturally occurring soils containing iron sulphides that when exposed to air, have the potential to generate and mobilise acid, which can liberate contaminants. Anthropogenic contamination of land and groundwater is primarily the result of human activity both historical and in current practice, such as poor storage, handling and disposal of substances.

Understanding ASS and contamination for construction projects is important for protecting human health with respect to nearby residents, land uses and the environment within and adjacent to the construction footprint. It is also important to understand the characteristics of ASS and the presence of potential contamination of the land to assist in the effective management of spoil produced during construction.

Existing conditions

An assessment of acid sulfate soil and contamination existing conditions was undertaken to assess the potential effects of acid sulfate soils and contaminated soils on the environment and human health as a result of the projects. The assessment included a limited indicative soil and groundwater intrusive investigation to gain a general understanding of the soil and groundwater conditions of the project areas.

The Edithvale and Bonbeach project areas are located within a modified, urban environment. The project areas are underlain by Quaternary age aeolian and swamp deposits, which in turn overlie the Pliocene age Baxter Sandstone or Brighton Group sediments. A variable thickness of anthropogenic fill material overlies the natural geological materials associated with the construction of the local transport and residential/commercial infrastructure.

Edithvale

A review of available information and data collected during this investigation has indicated the nature and extent of Coastal Acid Sulfate Soils (CASS) and contamination at Edithvale and can be summarised as follows:

- The Stage A investigation identified a 'high risk' of CASS being present in the project area
- The Stage B investigation identified Potential Acid Sulfate Soils (PASS) ranging from four metres below ground surface (mbgs) to15 mbgs that requires management if disturbed as per Victorian EPA guidelines
- The Stage C investigation indicated the standing water level (SWL) of the groundwater for shallow '*Quaternary Aquife*r' ranged between 0.68 metres Australian Height Datum (mAHD) and 1.30 mAHD, which equates to as shallow as 1.03 mbgs and deep as 5.73 mbgs. The SWL for deeper '*Upper Tertiary Aquifer'* was measured ranging between 0.56 mAHD and 1.07 mAHD, which equates to 1.31 mbgs to 5.85 mbgs respectively.

- The groundwater chemistry was different for both the aquifers with the shallow groundwater being slightly acidic to neutral (pH ranging from 5.01 to 7.36) and fresh (Electrical conductivity values ranging from 307 micro Sieverts per centimetre (µS/cm) to 731 µS/cm) as compared to the higher alkalinity (pH ranging from 7 to 8.52) and higher salinity (Electrical conductivity values ranging from 2544 µS/cm to 21,653 µS/cm) noted in the deeper aquifer.
- Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS, were noted for the shallow aquifer. The chloride to sulfate ratio did not indicate presence of actual acidity for the deeper aquifer. The pH of the samples (greater than five) and the measured buffering capacity (greater than 60 milligrams per litre (mg/L)) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.
- The Stage D hazard assessment as per Best Practice Management Guidelines (BPMG) (DSE, 2010) indicates that the hazard associated with disturbance of CASS at Edithvale is 'High'. This requires that an Acid Sulfate Soils Management Plan (ASSMP) be developed in accordance with the BPMG (DSE 2010) prior to construction.

Potential land uses identified during the desktop investigation that may be sources of contamination are summarised in Table 1.

Table 1 Edithvale – Potential sources of contamination

Location	Potential source of contamination	Potential contaminants of concern
Within project area	Uncontrolled Fill, Rail corridor	Metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, fertilisers, pesticides, herbicides, asbestos, illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard) and aesthetics such as building rubble.
	Quaternary Sands – naturally occurring disseminated pyrite	Acidity, metals, salinity
Outside project area	Service station, Dry cleaners, Commercial/industrial areas, Boat storage, Former car dealer, upholsterer, mechanics, Audit Statements [redacted]	Aliphatic hydrocarbons, heavy metals, total recoverable hydrocarbons, BTEX, PAH, phenols, Per- and Polyfluoroalkyl substances (PFAS), cyanides, polychlorinated byphenyls, bactericides, bleaches, brighteners, detergents, enzymes, fungicides, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), surfactants, turpentine, ammonia, waterproofing, alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
	Fire station – leaks and spills from use and storage of PFAS and/or oils and fuels	PFAS, Aliphatic hydrocarbons, BTEX, PAH, phenols, lead.

The intrusive soil investigation confirmed:

- the presence of fill material, ranging from surface to 0.7 mbgs. The fill material included silt, sand, gravel, clay and asphalt.
- detectable concentrations of Perfluorohexane sulfonic acid (PFHxS), Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonic acid (PFOS) were reported in three soil samples obtained in the vicinity for the former Edithvale fire station located at [redacted].
- results from two soil samples collected from anthropogenic fill material exceeded the maximum concentrations allowed for lead and benzo(a)pyrene to be disposed of as Fill Material and has the potential to classify as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.

The groundwater investigation confirmed:

- concentrations of selected metals (aluminium, arsenic, chromium (III + IV), iron, manganese, nickel, and zinc), total dissolved solids, ammonia as N, nitrogen, phosphorous (total) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens beneficial uses in the Quaternary aquifer
- concentrations of selected metals (aluminium, boron, iron, nickel and zinc), total dissolved solids, ammonia as N, sulphate, sulphate as S, phosphorous (total), fluoride exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens and stock watering beneficial uses in the Upper Tertiary aquifer
- concentrations of PFHxS+PFOS and PFOS were reported above the PFAS NEMP 2017 freshwater ecosystem or the PFAS NEMP 2017 Drinking water (health) in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at 206 Station Street, Edithvale.
- detectable concentrations of PFHxS, 6:2 FTS, PFOA and PFHxA were reported in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at [redacted].
- detectable concentrations of 3&4 methylphenol and phenol were reported in one groundwater sample obtained in the vicinity for the former boat storage facility located at [redacted]

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Edithvale level crossing removal construction footprint may be contaminated to some degree with metals, polycyclic aromatic hydrocarbons (PAH) and PFAS. Further detailed testing to understand soil and groundwater contamination is required during detailed design as per the Environmental Performance Requirements detailed in Section 10.

Bonbeach

The review of the available information and the data collected during this investigation has indicated the nature and extent of CASS and contamination at Bonbeach can be summarised as follows:

- The Stage A investigation identified a 'high risk' of CASS being present in the project area
- The Stage B investigation identified PASS ranging from 3.5 mbgs to16 mbgs that requires management if disturbed as per Victorian EPA guidelines

- The Stage C investigation indicated the SWL of the groundwater for shallow '*Quaternary Aquife*r' ranged between 0.05 mAHD and 0.91 mAHD which equates to as shallow as 3.08 mbgs and as deep as 5.92 mbgs. The SWL for deeper '*Upper Tertiary Aquifer'* was measured ranging between below sea level -0.23m AHD and 1.06 mAHD which are similar to 1.64 mbgs to 5.47 mbgs respectively.
- The groundwater chemistry for the shallow aquifer was observed to be neutral to alkaline (pH ranging from 7.61 to 9.67) and fresh water (EC values ranging from 521 to 883 µS/cm). Comparatively the deeper groundwater was observed to be neutral to highly alkaline (pH ranging from 7.21 to 12.74) and fresh to saline (EC values ranging from 543 to 9447 µS/cm) in nature.
- Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS were noted for both the shallow and the deeper aquifer. However the pH of the samples (greater than 5) and the measured buffering capacity (greater than 60 mg/L) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.
- The Stage D hazard assessment as per BPMG (DSE 2010) indicates that the hazard associated with disturbance of CASS at Bonbeach is 'High'. This implies that an ASSMP be developed in accordance with the BPMG (DSE, 2010) prior to construction.

The identified potential land uses identified during the desktop investigation that may be sources of contamination are summarised in Table 2.

Table 2 Bonbeach - Potential contamination sources

Location	Potential source of contamination	Potential contaminants of concern
Within project area	Fill material, Rail corridor, Electrical sub-station	Metals, PAHs, petroleum hydrocarbons, chlorinated naphthalenes, chlorodiphenyls, polychlorinated biphenyls fertilisers, pesticides, herbicides, asbestos, illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard) and aesthetics such as building rubble.
	Quaternary Sands	Disseminated pyrite
Outside project area	Panel beaters, Telstra exchange, Furniture manufacturer, Mower sales/service centre, Commercial/industrial areas, Service station, Laundromat, Audit Statements [redacted]	Metals, PAHs, petroleum hydrocarbons, fertilisers, pesticides, herbicides, polychlorinated biphenyls, asbestos volatile organic compounds, acids, alkalis, glycols, Acids, alkalis, solvents, metals, total recoverable hydrocarbons, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol)

The intrusive soil investigation confirmed:

- the presence of fill material, ranging from surface to 0.3 mbgs. The fill material included silt, silty sand, sand, gravel and sandy gravel.
- results from five soil samples collected from anthropogenic fill material exceeded the maximum concentrations allowed to be disposed of as fill material and therefore has the potential to classify as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.

The groundwater investigation confirmed:

- concentrations of selected metals (aluminium, arsenic, chromium (III + IV), copper, iron, molybdenum, nickel and zinc) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens beneficial uses in the Quaternary aquifer
- concentrations of selected metals (aluminium, arsenic, chromium (III + IV), copper, iron, lead, nickel, selenium and zinc) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens beneficial uses in the Upper Tertiary aquifer
- detectable concentrations of phenol were reported in a groundwater sample obtained from one borehole located in the vicinity of a Groundwater Restricted Use Zone at [redacted].
- detectable concentrations of TRH fraction C6-C10, TPH C6-C9, toluene, 3-&4-methylphenol, phenols, total phenolics, and acetone were reported in a groundwater sample obtained from one borehole located in the vicinity of a commercial/industrial area (including a furniture manufacturer).
- detectable concentrations of phenols, acetone and idomethane were reported in a groundwater sample obtained from one borehole located in the vicinity of the rail corridor.
- detectable concentrations of phenols were reported in a groundwater sample obtained from one borehole located in the vicinity of the rail corridor.
- detectable concentrations of acetone and idomethane were reported in a groundwater sample obtained from one borehole located in the vicinity of the rail corridor.

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Bonbeach level crossing removal construction footprint may be contaminated to some degree with metals, phenols, total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOCs). Further detailed testing to understand soil and groundwater contamination is required during detailed design as per the Environmental Performance Requirements detailed in Section 10.

Spoil assessment and management

The estimated ex-situ spoil volumes based on the desktop and indicative soil contamination investigations are summarised below:

- Fill Material – 120,341 cubic metres (m^3) and 145,639 m^3 for Edithvale and Bonbeach respectively
- Category A and B – assumed only at Bonbeach, approximately 100m^3
- Category C – 11,440 m^3 and 28,704 m^3 for Edithvale and Bonbeach respectively

- Waste acid sulfate soils – 43,355 m^3 and 8,515 m^3 for Edithvale and Bonbeach respectively. It is noted that waste ASS requiring management would not be generated during excavation of the trench at Bonbeach

The cumulative spoil disposal assessment summarised the following key findings:

- The disposal of excess spoil to landfill and the capacity of the existing landfills to accept the spoil generated during the Edithvale and Bonbeach level crossing removals may be impacted by other major concurrent infrastructure projects (e.g. the Melbourne Metro Rail Tunnel Project and the Westgate Tunnel Project). It is noted that the estimated quantity of spoil requiring management during the Edithvale and Bonbeach level crossing removals only makes up six percent of the total spoil estimated to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail Tunnel and West Gate Tunnel infrastructure projects.
- For the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects, 73% of spoil is estimated to be categorised as Fill material. As the use of Fill material off-site is not regulated and is not required to be disposed to an EPA licenced landfill, it is considered that there is sufficient capacity to reuse or dispose to landfill the combined estimated volume of Fill expected to be generated.
- There is considered to be sufficient capacity within EPA licenced landfills to accommodate the combined total of approximately 361,764 m^3 (ex-situ) of Category C contaminated soils to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects. This could be further reduced by application of treatment technologies to reduce contaminant concentrations and/or leachability to allow for Category C soils to be reclassified as Fill material post treatment. Further, Category A and B soils can also potentially be reclassified as Category C soil post treatment. Reclassification of material would require additional testing and application to EPA Victoria. Treatment is required to be undertaken at a facility licensed to receive and treat the particular material.
- Offsite disposal of waste acid sulfate soil can only occur to a premise that is either licenced to accept waste acid sulfate soil in accordance with the EPA 1970, or has an Environment Management Plan (EMP) approved by EPA Victoria. There is considered to be sufficient capacity within EPA licenced and/or approved facilities to accommodate the combined total of approximately 878,670 cubic metres (ex-situ) of waste acid sulfate soil to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects.

Risk and impact assessment

An assessment of risks to Beneficial Uses of land and groundwater (as specified in the SEPP *Prevention and Management of Contamination of Land* and the SEPP *Groundwaters of Victoria)* posed by the projects was undertaken in accordance with AS/NZS ISO 31000:2009 Risk Management Process. Based on the desktop and field assessments undertaken, the key risks related to CASS and contamination and their risk rating with respect to the construction and operation of the projects are listed below, after implementation of the Environmental Performance Requirements:

Edithvale and Bonbeach

- Disturbance, handling, storage or disposal of CASS/contaminated (including asbestos) soil resulting in adverse health and environmental impacts was assessed as a **Negligible** risk level
- Disturbance, handling, storage or disposal of CASS/contaminated soil leads to the generation of odorous material and results in a loss of amenity was assessed as a **Negligible** risk level
- Disturbance, handling, storage or disposal of acidic and/or contaminated groundwater results in adverse health and environmental impacts was assessed as a **Negligible** risk level
- Unknown contamination encountered during construction results in environmental, health or amenity impacts was assessed as a **Negligible** risk level
- Fuel/chemical spill results in adverse health or environmental impact was assessed as a **Negligible** risk level
- Management of other waste (solid inert, liquid, organic, packaging and food scraps) results in environmental impact was assessed as a **Negligible** risk level
- Transport or disposal of CASS and/or contaminated soil is not in compliance with EPA Victoria permit/licence and results in an environmental impact was assessed as a **Negligible** risk level
- Intersection of contaminated soil and/or groundwater resulting in vapour impacts on human health was assessed as a **Negligible** risk level

Edithvale

Risks associated with changes to groundwater flow paths during construction and ongoing operation of the Edithvale level crossing removal, taking into consideration the implementation of the Environmental Performance Requirements developed to mitigate the associated impacts, are:

- Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses. This risk was assessed to have **Negligible** residual risk
- Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses. This risk was assessed to have **Minor** residual risk

Bonbeach

Risks associated with changes to groundwater flow paths during construction and ongoing operation of the Bonbeach level crossing removal, taking into consideration the implementation of the Environmental Performance Requirements developed to mitigate the associated impacts, are:

- Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses. This risk was assessed to have **Minor** residual risk
- Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses. This risk was assessed to have **Negligible** residual risk

Environmental Performance Requirements (EPRs)

Nine EPRs were developed to achieve the acceptable environmental outcomes that are required for the projects. The EPRs are applicable to the final design, construction and operation approach and provide certainty regarding the environmental performance of the projects.

The management of known or unexpected PASS and/or contamination during the construction and operation phases would be controlled by developing and implementing the following:

- a Spoil Management Plan(s) in accordance with relevant regulations, standards or best practice guidelines to the satisfaction of EPA
- an Acid Sulfate Soil Management Plan prior to construction of the project 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 to the satisfaction of EPA
- a Construction Environmental Management Plan including procedures to manage waste
- measures to manage acidic and/or contaminated groundwater
- rail trenches designed within the limits defined in the incorporated document
- the tanked rail trench design at Edithvale that does not result in:
  - groundwater mounding that increases water logging at ground level
  - adverse impact to structures (subsidence, foundations)
  - not result in degradation to groundwater quality that would preclude beneficial use of groundwater (salinity, contaminants, acid sulfate soils)
- a Groundwater Management Plan to the satisfaction of the EPA and relevant water authorities
- a groundwater monitoring plan that details sufficient monitoring of groundwater level and quality in areas of potential mounding/drawdown to verify that no significant impacts occur
- a Community and Stakeholder Engagement Management Plan in consultation with the City of Kingston.

The effectiveness of the implemented control measures requires frequent monitoring and adjustment given that construction sites constantly change.

Abbreviations

Term	Definition
%S	percentage sulfur
AASS	actual acid sulfate soils
ADWG	Australian drinking water guidelines
AHD	Australian height datum
AMG	Austrlian map grid
ANC	acid neutralising capacity
ANZECC	Australian and New Zeland Environment and Conservation Council
ASCS	Australian Soil Classification System
ASRIS	Australian Soil Resource Information System
ASS	acid sulfate soil
ASSMP	Acid sulfate soil management plan
bgl	Below ground level
BPMG	Best practice management guidelines
BTEX	benzene, toluene, ethylbenzene and xylene
CASS	coastal acid sulfate soils
CRS	chromium reducible sulfur
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DER	Department of Environment Regulation
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EC	Electrical conductivity
EES	Environment effect statement
EMP	Environmental management plan
EP Act	*Environment Protection Act 1970*
EPA	Environment Protection Authority Victoria
EPR	Environmental performance requirement

Term	Definition
GoV	Groundwaters of Victoria
GRZ	General Residential Zone
IWRG	Industrial Waste Resource Guidelines
JSA	Job Safety Analysis
JV	AECOM-GHD Joint Venture
kg	kilogram
LXRA	Level Crossing Removal Authority
LXRP	Level Crossing Removal Program
m	metres
M	Molar
mbgs	metres below ground surface
mg/L	milligrams per litre
mm	millimetre
MMBW	Melbourne and Metropolitan Board of Works
MTM	Metro Trains Melbourne
NATA	National Association of Testing Authorities
NEMP	National environmental management plan
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NHMRC	National Heatlh and Medical Research Council
NV	Neutralising value
OCP	organochlorine pesticides
PAH	polycyclic aromatic hydrocarbons
PASS	potential acid sulfate soil
PFAS	per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic acid
PUZ	Public Use Zone
QA	Quaternary aquifer
RDZ1	Road Zone Category 1
RDZ2	Road Zone Category 2
RL	relative level

Term	Definition
Scr	Chromium reducible sulfide
SEPP	State Environment Protection Policy
SPOCAS	suspension peroxide combined acidity and sulfur
TAA	Titratable Actual Acidity
TDS	Total dissolved solids
UMTD	Fyansford Formation
UPSS	underground petroleum storage system
UTAF	Upper Tertiary Aquifer
VAF	Victorian Aquifer Framework
VOC	Volatile organic compound
w/v	Weight/volume

Glossary

Term	Description
%S	A measure of reduced inorganic sulfur (using the SCR or SPOS methods) expressed as a percentage of the weight of dry soil analysed. Can also be used as an 'equivalent sulfur unit' when comparing the results of tests expressed in other units, or when doing acid base accounting.
Acid sulfate soil	Naturally occurring soils, sediments or organic substrates (e.g. peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. When oxidised they can generate acidic (aggressive) groundwater.
Acid Neutralising Capacity	ANC is the measure of a soil's inherent ability to buffer acidity and resist the lowering of the soil pH. This may be provided by dissolution of calcium and/or magnesium carbonates (e.g. shell), cation exchange reactions, and by reaction with the organic and clay fractions. The efficiency of these buffering constituents and activities is further dependent on the type, amount and particle size of these minerals.
Actual acid sulfate soil	Acid sulfate soils that has been disturbed and oxygenated and where some or all of the sulphides originally present have been oxidised. Resulting in a pH of <4.
Actual Acidity	*Actual acidity* represents soluble and exchangeable acidity already present in the soil and is the acidity often formed as a consequence of previous oxidation of sulphides. This acidity will be mobilised and discharged following a rainfall event and measured by Titratable Actual Acidity (TAA).
Action Criteria	The measured level of potential plus existing acidity beyond which management action is required if a soil or sediment is to be disturbed. The trigger levels vary for texture categories and the amount of disturbance. The extent of management required will vary with the level of acidity and the volume of the disturbance, among other factors.
Alluvium	An unconsolidated accumulation of stream-deposited sediments, including sands, silts, clays or gravels.
Aquifer system	A body of permeable or relatively permeable materials that functions regionally as a water yielding unit. It comprises two or more permeable units separated by, at least locally, confining units that impede groundwater movement.
Aquitard	A saturated, poorly permeable bed that impedes groundwater movement and does not yield water freely to wells, but which may transmit appreciable water to or from adjacent aquifers.
Australian Height Datum (AHD)	The datum used for the determination of elevations in Australia. The determination uses a national network of benchmarks and tide gauges, and sets mean sea level as zero elevation.
Beneficial use	A use of the environment or any element of the environment which is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits.
Buffering Capacity	See Acid Neutralising Capacity

Term	Description
Bulk Density	With regard to soils, the mass of an oven-dry sample per unit of soil as found in the field. In an ASS risk assessment context, planned disturbance volumes can be converted to tonnage using the bulk density (volume x BD = tonnage). Expressed in units of g/cm^3 or t/m^3 , which are numerically equivalent – i.e.,1.5 g/cm^3 is the same as 1.5 t/m^3
Certificate of Environmental Audit	Issued for a property where, following an audit, an environmental auditor believes the environmental condition of the land is suitable for any beneficial use.
Chromium Suite	In acid sulfate soils analysis, a suite of tests used to characterise the net acidity of a soil. The suite centres on the use of the chromium-reducible sulfur measure for potential acidity, along with a number of tests for other forms of acidity depending on the soil pH (TAA for actual acidity, S_{NAS} for retained acidity, and a choice of several ANC methods for acid neutralising capacity
Coastal acid sulfate soil (CASS)	Acid sulphate soils can occur in coastal and inland settings. Where ASS occurs in coastal settings they are commonly referred to as Coastal Acid Sulfate Soil .
Confined aquifer	A formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations. Confined groundwater is generally subject to pressure greater than atmosphere.
Contaminated land	Land used for industry, mining or the storage of chemicals, gas, wastes or liquefied fuels (if not ancillary to another use of land).
Contaminated soil	Soil or a mixture of soils that can be classified as Category A, B or C Contaminated Soil as provided for under the Regulations and defined in the Industrial Waste Guidelines (published in Special Gazette No. S177 on 9 June 2009).
Discharge	The volume of water pumped or flowing from a well per unit of time, expressed in litres per second.
Ex situ	A Latin phrase that means 'out of place'. The Ex-situ investigation refers to soil testing and spoil characterisation once soil is excavated. The Ex situ spoil volume refers to volume of excavated soils and includes a bulking factor depending on the soil texture.
Fineness factor	It is a numerical value to account for non-homogeneous mixing, and variation in reactivity associated with the particle size of acid neutralising material (e.g. agricultural lime) and insoluble surface coating.
Fractured rock aquifer	An aquifer in which water is stored and transmitted by fractures, joints and other discontinuities within the rock mass.
Geomorphic	The branch of geology that studies the characteristics and configuration and evolution of rocks and land forms.
Holocene	Of, relating to or denoting the present epoch, which is the second epoch in the Quaternary period, beginning approximately 10,000 years ago.
Hydraulic conductivity	The rate at which water at the prevailing kinematic viscosity would move under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow, expressed in metres per day.

Term	Description
Hydrogeologic	Those factors that deal with subsurface waters and related geologic aspects of surface waters.
Hydrogen Sulfilde	A gas with the formula H2S. Commonly known as 'rotten egg gas' due to its smell, H2S is released from anaerobic systems as a metabolic by-product. The gas is heavier than air and potentially fatally toxic if allowed to accumulate in confined spaces.
Impact pathway	The consequence of an action or hazardous event that results in a change in conditions.
In situ	A Latin phrase that means ‘on-site’ or ‘in place’. The in-situ investigation refers to intrusive investigation of soils in place, prior to being excavated. The In situ spoil volume refers to volume of undisturbed soils prior to disturbance.
Jarosite	An acidic, pale yellow (straw- or butter-coloured) iron hydroxysulfate mineral: KFe3(SO4)2(OH)6. Jarosite is a by-product of the acid sulfate soil oxidation process, forms at pH
Leachate	The liquid that has percolated through solid waste and dissolved soluble components.
Liming Rate	Liming rate is defined as the dose of neutralising agent needed to neutralise the calculated net acidity for a select sample. A suitable neutralising material such as fine grained (<0.5 millimetres (mm)) agricultural limestone (aglime) is likely to be required. Depending on the severity and variability of the net acidity, the liming rate is typically calculated based on the maximum net acidity value.
Moles H^+/tonne	A measure of acidity, expressed as the number of moles of hydrogen cations per tonne of oven-dry soil material. A mole is 6.022x1023 atoms of a given substance. The term can also be used as an 'equivalent acidity unit' when comparing the results of tests expressed in other units, such as when doing acid base accounting.
Monitoring bore	Refer to Observation bore.
Net acidity	A calculation summing up the capacity of a given soil to generate acidity under favourable conditions. For ASS, the generalised formula for net acidity is potential acidity plus actual acidity plus retained acidity, minus the acid neutralising capacity, which is divided by the fineness factor
Observation bore	A well drilled in a selected location for the purpose of observing parameters such as water levels and pressure changes.
Oxidation	Describes the loss of electrons or hydrogen and the gain of oxygen by a molecule, atom or ion, or the increase in oxidation state of an element. The most familiar example of chemical oxidation is rusting iron. In an ASS context, the term is commonly used to refer to the process of pyrite or iron sulfides reacting with oxygen and releasing acid and iron products.
Pleistocene	Of, relating to, or denoting the first epoch of the Quaternary period, between the Pliocene and Holocene epochs, from 2.5 million years ago to 10,000 years ago.
Permeability	The property of capacity of a porous rock, sediment or soil for transmitting a fluid, it is a measure of the relative ease of fluid flow under unequal pressure.

Term	Description
pH	A measure of the acidity or alkalinity of a soil of water body on a logarithmic scale of 0 to 14; pH 7 is alkaline. Note that one unit change in pH denotes a ten-fold change in acidity
Potential acid sulfate soil (PASS)	These are soils containing iron sulfides that has not been exposed to air and oxidised but will generate acidity if oxidised.
Potential Acidity	*Potential Acidity* is the 'hidden' acidity that will be released if all of the sulfide minerals contained within a soil (e.g. pyrite) are fully oxidised. In the CRS suite, potential acidity is measured by the chromium reducible sulfide (Scr) concentration.
Priority site	Sites for which EPA Victoria has issued a clean-up notice pursuant to Section 62A, or a pollution abatement notice pursuant to Section 31A or 31B (relevant to land and/or groundwater), of the Environment Protection Act 1970.
Pyrite	Pale-bronze or brass-yellow mineral with the formula FeS2; the most widespread and abundant of the sulfide minerals. In ASS, pyrite usually occurs as very small crystals, often within a framboidal or euhedral structure. The large surface area of these small particles makes them highly reactive; much more so than the larger crystals commonly encountered in mining situations.
Quaternary period	Of or belonging to the geologic time, system of rocks, or sedimentary deposits of the second period of the Cenozoic Era, from the end of the Tertiary Period through the present.
Remediate	To remove, disperse, destroy, dispose of, abate, neutralise or treat any pollutant, waste, substance or environmental hazard in order to restore the environment to a state as close as practicable to the state it was in immediately before contamination.
Retained Acidity	Retained Acidity is another component of existing acidity and represents the acidity stored in largely insoluble compounds such as jarosite and other iron and aluminium minerals. This acidity may be released slowly into the environment by hydrolysis of these relatively insoluble sulfate salts. Retained acidity cannot be measured in the laboratory by TAA only, hence an additional analysis step is performed when measured pHKCl (i.e. pH measured in a 1:40 (w/v) suspension of soil in a solution of 1 molar (M) potassium chloride) is <4.5
Risk rating	A risk rating considers the likelihood and consequence of an event.
Semi-confined (or leaky) aquifer	An aquifer confined by a layer of moderate permeability (aquitard) that allows vertical leakage of water into or out of the aquifer.
Statement of Environmental Audit	Issued where, following an audit, an environmental auditor believes the land is not suitable for all possible beneficial uses, but is suitable for specific uses or developments. It may contain conditions for clean-up or management of contamination.
Static water level or Standing water level	The level of water in a well that is not being affected by the withdrawal of groundwater.
Stratigraphy	The study of rock / soil strata, especially of their distribution, deposition and age.

Term	Description
Tertiary Age	The term for a geologic period from 65 million to 2.6 million years ago, a time span that lies between the superseded Secondary period and the Quaternary period.
Total dissolved solids	The total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water.
Unconfined aquifer	An aquifer where the watertable is exposed to the atmosphere through openings in the overlying materials.
Watertable	The level at which the groundwater pressure is equal to atmospheric pressure. It may be conveniently visualised as the 'surface' of the subsurface materials that are saturated with groundwater in a given vicinity. However, saturated conditions may extend above the watertable as surface tension holds water in some pores below atmospheric pressure.
Weathered	The mechanical and chemical breakdown of rocks by the action of rain, snow, wind, etc.

1 Introduction

1.1 Purpose

The Victorian Government is removing 50 of Melbourne's most dangerous and congested level crossings, inclusive of the level crossings at Edithvale Road, Edithvale (Edithvale) and Station Street/Bondi Road, Bonbeach (Bonbeach).

The level crossing removal projects have three core objectives. To provide:

- improved productivity from more reliable and efficient transport networks
- better connected, liveable and thriving communities
- safer communities.

The Edithvale and Bonbeach level crossing removal projects were referred to the Minister for Planning on 9 March 2017. On 5 April 2017, the Minister issued a decision determining that an Environment Effects Statement (EES) is required for the projects due to the potential for a range of significant environmental effects.

To assess the potential effects of acid sulfate soils and contaminated soils on the environment and human health as a result of the projects, an assessment of potential acid sulfate soil and contamination impacts was undertaken. The assessment included a limited indicative soil and groundwater intrusive investigation to gain a general understanding of the soil and groundwater conditions of the project areas. This report provides an acid sulfate soil and contamination impact assessment for the Edithvale and Bonbeach level crossing removal projects.

1.2 Why understanding ASS and Contamination is important

Impacts to the environment and human health as a result of encountering Acid Sulfate Soils (ASS) and contamination during construction activities can be detrimental and costly to manage or remediate if not well understood prior to works commencing.

ASS is the common name given to soils containing iron sulfides – predominately pyrite. ASS includes Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS).

PASS are soils containing iron sulfides that has not been exposed to air and oxidised but will generate acidity if oxidised. AASS are soils containing iron sulfides that has already been exposed to air and has become acidified (pH ≤ 4.0) as a result of inorganic sulfide oxidation.

ASS can occur in coastal and inland settings. Where ASS occurs in coastal settings they are commonly referred to as Coastal Acid Sulfate Soil (CASS). Since the project locations are within a coastal setting, they are herein referred to as CASS. When these soils are exposed to air either naturally (e.g. during a drought), through soil disturbance (e.g. during excavation) or through a lowered water table (e.g. drain construction), the iron sulfides can react with oxygen and water to produce sulfuric acid (H_2SO_4). The oxidation of CASS can result in the generation, mobilisation and migration of acidity which can liberate contaminants (e.g. nutrients and metals) and potentially cause marked impact to the environment, engineered structures and human health.

Whereas CASS is naturally occurring, anthropogenic contamination of land and groundwater is primarily the result of human activity both historical and current, such as poor storage, handling and disposal of substances.

Understanding CASS and contamination for construction projects is important for protecting human health with respect to nearby residents, land uses and the environment within and adjacent to the construction footprint. It is also important to understand the characteristics of

CASS and the presence of potential contamination of the land to assist in the effective management of spoil produced during construction.

The project area is largely surrounded by residential zones however there are pockets of commercial uses and potential for historic landfilling that may give rise to contamination.

This report documents the potential for CASS and contaminated land and groundwater to exist within and adjacent to the project areas, and assesses potential impacts to human health and the environment from the construction and operation of the Edithvale and Bonbeach level crossing removal projects.

1.3 Project description

1.3.1 Overview

Edithvale

The Level Crossing Removal Authority (LXRA) proposes to remove the level crossing by lowering the Frankston railway line into a trench under Edithvale Road while maintaining Edithvale Road at the current road level. The trench would be located between Lochiel Avenue and Berry Avenue. It would be up to 1,300 metres in length and 14 metres wide at its narrowest point, widening to up to 24 metres (including pile widths) at the new Edithvale station platforms.

The rail track would be approximately eight metres below ground level, and sit above the trench base slab and infrastructure to collect and divert rain water from the trench. The maximum depth of the excavation would be 15 metres. Pile depths would be a maximum of 24 metres at the deepest point of the trench.

Barriers, fencing and screening would be erected along the trench at road level to prevent unauthorised access by vehicles or people. Decking above the rail trench would provide for the new station building, car parking and a new substation required to ensure sufficient power is available for passenger services on the Frankston railway line. New pedestrian bridges would be constructed to retain pedestrian access across the railway line. A new station is to be constructed with lift, ramp and stair access to the below-ground train platforms.

Bonbeach

LXRA proposes to remove the level crossing by lowering the Frankston railway line into a trench under Bondi Road while maintaining Bondi Road at the current road level. The trench would be located between Golden Avenue and The Glade. It would be up to 1,200 metres in length and 14 metres wide at its narrowest point, widening to up to 24 metres (including pile widths) at the new Bonbeach station platforms.

The rail track would be approximately eight metres below ground level, and sit above the trench base slab and infrastructure to collect and divert rain water from the trench. The maximum depth of the excavation would be 15 metres. Pile depths would be a maximum of 24 metres at the deepest point of the trench.

Barriers, fencing and screening would be erected along the trench at road level to prevent access by vehicles or people. Decking above the rail trench would provide for the new station building and car parking. New pedestrian bridges would be constructed to retain pedestrian access across the railway line. A new station building would be constructed with lift, ramp and stair access to the below-ground train platforms.

1.3.2 Construction

The key construction activities for the Edithvale and Bonbeach level crossing removal projects include:

- site establishment including:
  - clearing of vegetation and ground levelling
  - establishment of site fencing, staff facilities and temporary construction areas
- protection and/or relocation of utility services
- excavation for piling, foundations and the rail trench
- on site waste management including removal, management and disposal of excavated soil, rock and groundwater
- transport of spoil, excavated material and groundwater offsite
- demolition of existing stations and removal of existing rail and road infrastructure
- construction of bridge/deck structures to support Edithvale Road and Station Street/Bondi Road where they cross the railway line
- construction of base slab and waterproofing, including stormwater tanks
- construction of new station infrastructure including platforms and buildings
- construction of pedestrian overpasses and decking over the rail trench
- installation and commissioning of new rail infrastructure including ballast, overhead line equipment and rail.

In preparation for the main rail occupation, the existing Edithvale and Bonbeach train stations would be closed approximately four weeks in advance. Both projects would be constructed concurrently under the same rail closure which is anticipated to take six weeks.

During the closure of the rail corridor, construction activities would occur 24 hours per day, seven days per week. Additional periodic road closures and lane closures would be required and access along adjacent streets could be restricted. Additional weekend rail shutdowns would likely be required prior to and after the main rail occupation. Construction is expected to be completed within an 18 month period.

1.3.3 Operations and maintenance

Following the construction of the Edithvale and Bonbeach level crossing removal projects, the key operation and maintenance phase activities would include:

- operation – monitoring, controlling and operation of the asset in accordance with the rail and road network requirements
- maintenance – routine inspection and monitoring of the condition of the asset, planned routine maintenance and refurbishment work, and unplanned intervention and repair of the asset.

Operation and maintenance activities would be consistent with existing practices and subject to the evolving operational demands of the road and rail networks.

1.3.4 Spoil management considerations in the design

Review of existing information has indicated that excavation of CASS and/or contaminated spoil is expected and management of spoil will be required during the construction of the Edithvale and Bonbeach level crossing removal projects. The construction activities which would require management of spoil include:

- site establishment
  - stripping and clearing within the project area
  - establishment of site fencing, staff facilities and temporary construction areas
  - installation of access roads
- protection and/or relocation of utility services
- excavation for piling, foundations and the rail trench
- on site waste management
- transport of spoil, excavated material and groundwater offsite
- removal of existing level crossing infrastructure.

The estimated quantity of in situ spoil to be excavated during construction is:

- 134,720 cubic metres (m^3) from the Edithvale project area
- 140,760 m^3 from the Bonbeach project area.

Using a bulking factor of 1.3 to account for swelling of the spoil once excavated the approximate ex situ volume equates to the following for each of the project areas:

- 175,136 m^3 from the Edithvale project area
- 182,958 $m^3$from the Bonbeach project area.

The management of spoil is discussed further in Section 7.

1.4 Project area

1.4.1 Edithvale

The Edithvale Road, Edithvale level crossing project investigation area (Edithvale project area) extends from Lincoln Parade, Aspendale to Chelsea Road, Chelsea. It includes the rail corridor and all of Station Street and Nepean Highway to the east and west of the rail corridor, and small sections of adjacent road reserves. Refer to Figure 1.

1.4.2 Bonbeach

The Station Street/Bondi Road, Bonbeach level crossing removal project area (Bonbeach project area) extends from Chelsea Road, Chelsea to Patterson River, Bonbeach. It includes the rail corridor and all of Station Street and Nepean Highway located to the east and west of the rail corridor, and small sections of adjacent road reserves. Refer to Figure 2.

1.4.3 Temporary construction areas

Specific temporary construction areas have not been identified at this time. Temporary construction areas would be used for site offices, storing materials, plant and equipment, parking for construction works and construction traffic standby.

1.5 Study area

The study area for CASS and contamination field investigations included the Edithvale and Bonbeach project areas described in Section 1.4.

The study area for the desktop contamination assessment of current and historical activities that may impact upon the construction activities included the Edithvale and Bonbeach project areas described in Section 1.4, and the adjacent land within 500 metres of project area boundaries.

Figure 1 Edithvale project area

Figure 2 Bonbeach project area

2 Scoping Requirements

In order to meet statutory requirements, protect environmental values and sustain stakeholder confidence, the EES will include an Environmental Management Framework (EMF). The EMF will provide a transparent framework with clear accountabilities for managing and monitoring environmental effects and hazards associated with the construction and operational phases of the projects.

Section 3.5 of the Scoping Requirements (issued September 2017), states ‘Environmental Performance Requirements (EPRs) should be clearly described in the EMF’. The proposed objectives, indicators and monitoring requirements to be described that are relevant to this study are:

- solid and liquid waste, including recycling and handling of potentially hazardous or contaminated waste, CASS and other excavated spoil.

2.1 EES objectives

The following draft evaluation objective is relevant to CASS and contamination management and identifies the desired outcomes in the context of potential project effects. The draft evaluation objectives provide a framework to guide integrated assessment of the environmental effects of the project, in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*.

Table 3 Draft evaluation objectives for CASS and Contamination Management

Draft EES evaluation objective	Key legislation
To prevent adverse environmental or health effects from disturbing, storing or influencing the transport or movement of contaminated or acid-forming material.	*Environment Protection Act, 1970* and subordinate policy (refer Table 5) State environment protection policies

2.2 EES scoping requirements

The following extracts from the Scoping Requirements, issued by the Minister for Planning, are relevant to the CASS and Contamination draft evaluation objective.

Table 4 Scoping requirements for CASS and Contamination Assessment

Aspect	Scoping requirement	Refer
Key issues	• potential for adverse environmental or health effects resulting from disturbance of or influencing the transport/ movement of contaminated soil or groundwater	Section 9
	• potential for adverse environmental or health effects resulting from handling, storage or transportation of excavated contaminated spoil or PASS	Section 9
	• potential for adverse environmental or health effects from other waste materials/streams generated from project works	Section 9

Aspect	Scoping requirement	Refer
Priorities for characterising the existing environment	• identify likely occurrence of PASS, contaminated soil, and other potential sources of contaminated materials in the project area and their approximate location	Sections 5.1 and 6.2, Figure 6-11 and 16-17
	• Identify the likely occurrence of contaminated groundwater in the project area and nearby that has the potential to be altered or impacted by the project • identify volumes and characteristics of excavated spoil	Section 6 Section 7.1
	• identify other key waste streams that may be generated from the project	Section 7.2 and 7.1.2
Design and mitigation measures	• identify methods to manage the potential activation of PASS and contaminated soil during construction	Section 7
	• identify options for treating, reusing or disposing of excavation spoil with reference to the waste hierarchy and relevant best practice principles, 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	Section 7
	• identify suitable off-site disposal options for waste materials	Section 7.1.1
	• 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, or the West Gate Tunnel Project) that will also be generating spoil	Section 7.1
	• 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 environmental values, or human health, especially with regard to the project construction activities	Section 7.1
	• identify and evaluate effects of PASS and contaminated soil on environmental and human health values during construction	Section 9
	• identify and evaluate effects on environmental values from project construction waste streams.	Section 9
Approach to manage performance	• describe principles to be adopted for monitoring management of spoil and other waste streams	Section 10

3 Legislation, policy and guidelines

Table 5 summarises the relevant primary legislation that applies to the Edithvale and Bonbeach level crossing removal projects as well as the implications and required approvals. Descriptions of all relevant legislation are contained in Appendix A of this report.

Table 5 Primary legislation and associated information

Legislation/policy	Key policies/strategies	Implications for the projects
State		
Environment Protection Act 1970	The EP Act provides a framework for preventing and controlling air, land and water pollution as well as noise, increasing resource efficiency, reducing waste and improving environmental performance.	The management, movement and re-use of contaminated soil as defined by Special Gazette S177 published on 9 June 2009 requires a formal site declaration by Environment Protection Authority (EPA) Victoria in accordance with the State environment protection policy (SEPP) (Prevention and Management of Contamination of Land). This declaration enables the management, movement and re-use of contaminated soils within the site under the National Environment Protection (Assessment of Contamination) Amendment Measure 2003 (No. 1).
Environment Protection Act 1970	*State environmental protection policy (SEPP), Prevention and Management of Contamination of Land*	Compliance with the SEPP *Prevention and Management of Contamination of Land* is required, which is given effect under the EP Act
Environment Protection Act 1970	*Environment Protection (Industrial Waste Resource) Regulations 2009*	Compliance with the *Environment Protection (Industrial Waste Resource) Regulations* is required, which is given effect under the *Environment Protection Act*
Environment Protection Act 1970	*Industrial Waste Resource Guidelines (IWRG)*	The IWRG have been developed by EPA Victoria to provide guidance for the management of waste, including waste soil in Victoria. The following provide guidance in relation to sampling and categorisation of waste soils to be moved offsite for reuse or disposal: • EPA Victoria (2009c) Publication IWRG 621: Industrial Waste Resource Guidelines – Soil Hazard Categorisation and Management • EPA Victoria (2009d) Publication IWRG 655.1: Acid Sulfate Soil and Rock. • EPA Victoria (2009f) Publication IWRG 702: Soil Sampling. • EPA Victoria (2010) Publication IWRG 600.2: Waste Categorisation No approval is required, however the Guidelines are given effect under the *Environment Protection Act 1970*.

Legislation/policy	Key policies/strategies	Implications for the projects
Environment Protection Act 1970	*Industrial Waste Management Policy (Waste Acid Sulfate Soils)* Special Gazette S125 published on 18 August 1999	EPA approval is required for a facility receiving waste acid sulfate soils that is either not licenced to accept waste acid sulfate soil or has an EPA approved Environmental Management Plan prepared in accordance with the *Industrial Waste Management Policy (Waste Acid Sulfate Soils)*. Compliance with the *Industrial Waste Management Policy (Waste Acid Sulfate Soils)* is required, which is given effect under the *Environment Protection Act 1970*. As such, waste acid sulfate soils can only be disposed to an EPA licenced or EPA approved facility.
Environment Protection Act 1970	*Best Practice Environmental Guidelines (BPEG), Environmental Guidelines for Major Construction Sites*	The BPEG provides a framework within which due diligence obligations can be met and environmental damage can be avoided during the commissioning or construction of major developments. No approval is required, however the Guidelines are given effect under the *Environment Protection Act 1970*.
Planning and Environment Act 1987		Section 12 of the Act includes provisions to ensure that potentially contaminated land is suitable for the use allowed within the relevant planning scheme.
Catchment and Land Protection Act 1994		The Act provides a framework for the integrated and co-ordinated management of catchments in regards to long-term land productivity and maintenance of the quality of the State's land and water resources. All construction activities must comply with the general performance measures outlined in the legislation.

4 Method

This section describes the method that was used to assess the potential impacts of the Edithvale and Bonbeach level crossing removal projects.

A systematic risk based approach was applied to understand the existing environment, potential impacts of the projects and how to avoid, minimise or manage the risk of impacts.

The iterative nature of the assessment is illustrated in Figure 3.

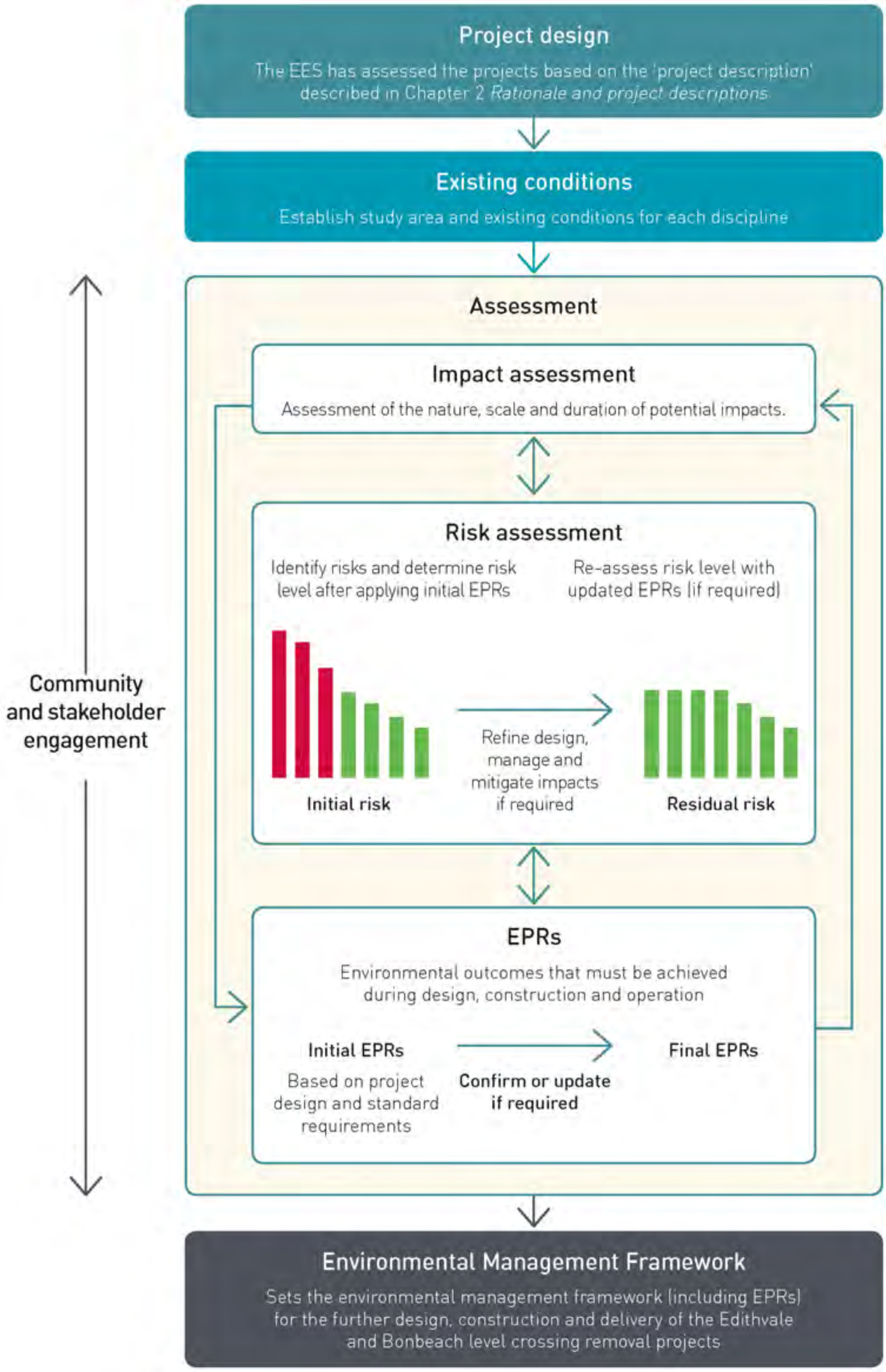


Figure 3 Overview of assessment process

4.1 Existing conditions assessment

This section documents the methods adopted to assess the existing CASS and contaminated land conditions at both Edithvale and Bonbeach project areas, and assess potential impacts to human health and the environment from the construction of the proposed project. It also assesses the potential impacts from the management of spoil during the construction activities.

4.1.1 Coastal acid sulfate soils

The CASS assessment was undertaken in accordance with the IWMP (2009) including EPA Publication 655.1, Acid Sulfate Soil and Rock (EPA, 2009) and *the Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soil* (CASS BPMG - DSE, 2010). which outlines four stages to the risk identification and assessment process:

- Stage A – Preliminary CASS hazard assessment
- Stage B – Detailed site soil sampling program and assessment
- Stage C – Surface/ groundwater sampling program and assessment
- Stage D – CASS hazard assessment.

The scope of works were undertaken to assess the existing conditions with respect to CASS to address the Scoping Requirements for each of these 'Stages' and is described below:

Stage A – Preliminary CASS hazard assessment

- Desktop review of available maps including:
    - Victorian ASS maps developed by Rampart (2003) for the study area
    - The Australian Soil Resource Information System (ASRIS), national ASS atlas developed by CSIRO
    - The Geological Survey of Victoria 1:63,360 scale Cranbourne Mapsheet (No. 859 Zone 7, 1967)
    - Site specific vegetation mapping undertaken by AECOM-GHD JV (2017a and b)
- Desktop review of previous investigation reports including:
    - AECOM-GHD JV. (2017c). Frankston package 18 – Edithvale Road, Edithvale. *Contamination / PASS Desktop assessment – Rail under road*. Report LXRA-LX31-18-HX-RPT-0003, revision 0, dated April 2017.
    - AECOM-GHD JV (2017d). Frankston package. 46 – Station Street/ Bondi Road, Bonbeach. *Contamination / PASS Desktop assessment – Rail under road*. Report LXRA-LX31-46-HZ-RPT-0003, revision 0, dated April 2017
    - Coffey Environments Pty. Ltd. (2017a) Level Crossing Removal Project – Cheltenham to Frankston. GEOTABTF10294AA-BA ID18 - Geotechnical Factual Report – Edithvale Road, Edithvale. Report for Metro Trains Melbourne Pty Ltd. 18 June 2017.
    - Coffey Environments Pty. Ltd. (2017b) Level Crossing Removal Project – Cheltenham to Frankston. GEOTABTF10294AA-BE ID46 – Geotechnical Factual Report – Bondi Road, Bonbeach, Report for Metro Trains Melbourne Pty Ltd. 3 May 2017.
- Site inspection to identify obvious field indicators (presented in Appendix B), was undertaken by a suitably qualified person on 19 April 2017 at both Edithvale and Bonbeach project areas.

Stage B – Detailed site soil assessment sampling program

The soil investigation included drilling of boreholes for collection of soil samples at both Edithvale and Bonbeach project areas. A Sampling and Quality Plan (SAQP) was developed in accordance with EPA 655.1 and CASS BPMG (DSE 2010).The key points of the SAQP are summarised below.

The following activities were completed prior to the commencement of intrusive works:

- Preparation of a Health and Safety Plan (including: Hazard Identification Checklist, Job Safety Analysis (JSA); and Work Method Statements).
- Underground services clearance of bore locations.
- Assessment of the sampling locations against planning, ecology and heritage constraints, including consultation with Council.
- Obtaining Council and Metro Trains Melbourne (MTM) access permits.

The intrusive soil investigation was completed between 11 July 2017 and 15 August 2017 and included:

- Drilling of 41 boreholes (21 boreholes at Edithvale project area and 20 at Bonbeach project area) to varying depths (dependant on the design) to maximum depth of 22.5 metres below ground surface (mbgs) across both project areas. It is noted that the maximum depth of boreholes is less than the maximum piling depth of 23 mbgs (Section 1.3.1). This was due to a change in design depths after the investigation was completed. The CASS risk for soils greater than 22.5 mbgs was assessed based on the lithologies observed during previous investigations undertaken in the area.
- Soil sampling at each borehole included a combination of:
    - Hand auger for locations shallower than 1.5 mbgs.
    - Direct push tube method from 1.5 to 12 mbgs up to 20 mbgs, which recovers continuous soil cores in disposable plastic sleeves.
    - Solid flight auger and split spoon drilling techniques for soil samples deeper than 12 mbgs to 22 mbgs.
- Collecting soil samples at surface, 0.5 metres (m), 1.0 m and every 0.5 m thereafter to the end of the borehole. Additional sampling was undertaken where field observations for CASS were identified.
- Collection of field duplicates and triplicate soil samples for analysis at the primary and secondary laboratory (both NATA accredited) respectively at a frequency of at least 5 %. At some locations, the recovered sample (especially with push tube method) was not sufficient to divide the sample into three parts, as such only duplicate samples were collected. In such instances, both the primary and duplicate samples were sent to the primary laboratory.
- The soil lithology and field observations were logged in the field as per Australian Soil Classification System (ASCS) including field observations for CASS such as the presence of shell, jarosite and hydrogen sulphide odour (rotten egg smell).
- All samples were collected in accordance with relevant guidelines. Samples were submitted under chain of custody procedures to ALS (primary laboratory) and Eurofins (secondary laboratory). Both laboratories are National Association of Testing Authorities (NATA) accredited for the analysis requested. Laboratory analysis of soil samples including:

- 1045 soil samples across both Edithvale and Bonbeach project areas for CASS field screening for including pH field (pH $_{(F)}$) and pH oxidised (pH $_{(Fox)}$.
- To confirm the field data analysis and to delineate the vertical extent of CASS layers, soil samples across all the profiles were selected for further laboratory analysis as per EPA 655.1 (*Table 2*) detailed later in this section. Selected samples were submitted for detailed laboratory analysis where field analysis showed an absence of PASS or limited potential to generate net acidity. At locations where majority of samples showed presence of CASS, the samples with maximum pH reduction and reaction rate were selected to assess the maximum acidity across the profile. Approximately 28% (292 primary samples) of field screening samples were selected for Chromium Reducible Sulfur (CRS) suite including existing acidity, potential acidity, neutralising capacity and acid base accounting.
- 51 quality control samples (duplicates and triplicates) at a frequency of 17% were analysed for Suspended Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) suite

- Survey of all bore locations for Australian Height Datum (AHD) and Australian Map Grid (AMG)

The locations of the CASS bores are presented in Figure 4 and Figure 5 for Edithvale and Bonbeach respectively. The borehole depths were selected based on the design and are shown below in Table 6 and Table 7.

Table 6 CASS Boreholes at ID18 Edithvale

Bore ID	EASTING	NORTHING	Depth (m bgs)
ID18-CASS01	333721.45	5788894.77	5.0
ID18-CASS02	333759.97	5788815.61	5.0
ID18-CASS03	333840.78	5788654.78	22.5
ID18-CASS04	333876.05	5788582.91	22.0
ID18-CASS05	333924.93	5788482.71	22.5
ID18-CASS06	333956.28	5788419.27	22.0
ID18-CASS07	333999.36	5788331.80	22.0
ID18-CASS08	334065.46	5788176.35	22.0
ID18-CASS09	334092.18	5788122.19	22.0
ID18-CASS10	334142.96	5788045.93	22.5
ID18-CASS11	334200.79	5787920.57	20.45
ID18-CASS12	334231.32	5787857.57	14.0
ID18-CASS13	334275.84	5787775.33	10.0
ID18-CASS14	334343.46	5787637.27	7.0
ID18-CASS15	334389.56	5787546.88	5.0
ID18-CASS16	334431.53	5787461.49	5.0

Bore ID	EASTING	NORTHING	Depth (m bgs)
ID18-CASS17	333793.79	5788610.37	7.0
ID18-CASS18	333927.17	5788328.49	7.0
ID18-CASS19	334016.38	5788139.66	7.0
ID18-CASS20	334237.59	5787673.16	7.0
ID18-CASS21*	333958.00	5788423.00	7.5

*Note - * ID18-CASS21 was only drilled to collect samples to gain an indication of the contamination status of soils. CASS samples were not collected at this location.*

Table 7 CASS Boreholes at ID46 Bonbeach

Bore ID	EASTING	NORTHING	Depth (m bgs)
ID46-CASS01	334927.37	5786156.76	5.0
ID46-CASS02	334950.63	5786078.25	5.0
ID46-CASS03	334979.38	5785982.16	7.0
ID46-CASS04	335012.23	5785867.61	10.0
ID46-CASS05	335037.90	5785753.45	17.5
ID46-CASS06	335050.28	5785679.84	21.0
ID46-CASS07	335062.07	5785600.28	19.0
ID46-CASS08	335075.43	5785435.02	22.0
ID46-CASS09	335086.08	5785366.98	22.0
ID46-CASS10	335102.84	5785283.41	20.0
ID46-CASS11	335116.47	5785181.24	17.0
ID46-CASS12	335128.14	5785098.30	17.0
ID46-CASS13	335142.71	5785010.95	10.0
ID46-CASS14	335165.97	5784907.92	7.2
ID46-CASS15	335195.90	5784780.87	5.2
ID46-CASS16	335213.88	5784703.60	5.2
ID46-CASS17	334868.69	5786102.58	7.0
ID46-CASS18	334972.73	5785725.81	7.0
ID46-CASS19	335045.83	5785269.53	7.0
ID46-CASS20	335057.80	5785058.47	6.0

Field pH Testing:

Field pH tests were conducted to provide an indication of the likely presence of AASS or PASS. Assessment criteria for the pH field (pH_F) and pH oxidised (pH_{FOX}) screening tests to evaluate the possible ASS or PASS occurrence are provided in EPA 655.1 (*Table 2*) and summarised below:

- pH_F greater than five and pH_{FOX} value less than or equal to five, with a reaction rate of one or two may indicate absence of CASS
- pH_F less than four and a high reaction rate (greater than two) with the peroxide indicates the presence of AASS
- PASS is determined by a combination of the following three factors:
  - A high reaction rate (greater than two) with the peroxide
  - A pH_{FOX} value at least two units below the pH_F may indicate PASS
  - If the pH_{FOX} value is less than three, and the other two conditions apply, then it strongly indicates PASS.

Note that, although a significant lowering of pH can potentially be due to the oxidation of reduced iron sulfides, it may also be caused by oxidation of organic matter or carbonates; and, as such, the pH_{FOX} test is an indication (only) and not a determinative test for PASS.

Acid Base Accounting

Acid base accounting (ABA) involves calculating the net soil acidity, which is the theoretical balance between the net effect of acid generating processes in the soil and acid-neutralising components that may be present. The net acidity of a soil sample is usually expressed in per cent oxidisable sulfur (%S) units or converted to equivalent acidity units (i.e. 1 %S is equivalent to 623.7 moles of acidity per tonne (mol H+/t)). The net acidity is defined (Ahern et al. 2004) as the sum of existing acidity (including actual and retained acidity) and potential acidity. These terms are explained below in detail:

- *Actual acidity* represents soluble and exchangeable acidity already present in the soil and is the acidity often formed as a consequence of previous oxidation of sulphides. This acidity will be mobilised and discharged following a rainfall event and measured by Titratable Actual Acidity (TAA).
- *Retained Acidity* is another component of existing acidity and represents the acidity stored in largely insoluble compounds such as jarosite and other iron and aluminium minerals. This acidity may be released slowly into the environment by hydrolysis of these relatively insoluble sulfate salts. Retained acidity cannot be measured in the laboratory by TAA only, hence an additional analysis step is performed when measured pH_{KCl} (i.e. pH measured in a 1:40 (w/v) suspension of soil in a solution of 1 molar (M) potassium chloride) is <4.5
- *Potential Acidity* is the 'hidden' acidity that will be released if all of the sulfide minerals contained within a soil (e.g. pyrite) are fully oxidised. In the CRS suite, potential acidity is measured by the chromium reducible sulfide (Scr) concentration.
- *Acid Neutralising Capacity (ANC)* is the measure of a soil's inherent ability to buffer acidity and resist the lowering of the soil pH. This may be provided by dissolution of calcium and/or magnesium carbonates (e.g. shell), cation exchange reactions, and by reaction with the organic and clay fractions. The efficiency of these buffering constituents and activities is further dependent on the type, amount and particle size of these minerals. For the CRS suite, ANC is measured by the Back Titration (ANC_{BT}) method.

- The fineness factor (FF) is a numerical value to account for non-homogeneous mixing, and variation in reactivity associated with the particle size of acid neutralising material (e.g. agricultural lime) and insoluble surface coatings (Dear et al. 2004). Moreover, since laboratory methods used to measure ANC are based on the analysis of finely-ground (high surface area) samples, these methods commonly overestimate the effective or actual amount of neutralising capacity that would be available under real field conditions. For this report, a minimum fineness factor of 1.5 is applied to the ANC result in the acid base account to allow for the poor reactivity of coarser carbonate material (consistent with Dear et al 2004).
- *Liming Rate*: Liming rate is defined as the dose of neutralising agent needed to neutralise the calculated net acidity for a select sample. A suitable neutralising material such as fine grained (<0.5 millimetres (mm)) agricultural limestone (aglime) is likely to be required. Depending on the severity and variability of the net acidity, the liming rate is typically calculated based on the maximum net acidity value. The calculated liming rates in this report were based on an assumed neutralising value (NV) for aglime of 1.00 (i.e. 100%). The contractors should adjust these lime rates in accordance with the neutralising value of the product being used. A minimum safety factor of 1.5 was applied to all liming rate calculations consistent with BPMG to account for incomplete mixing of neutralising material with soil. For conversion of liming rate from kg/t dry weight to kg/m^3 in-situ soil, the reported results should be multiplied with the wet bulk density of soil in t/m^3.

Stage C – Surface water/groundwater assessment sampling program

Surface water sampling was not undertaken as permanent surface water features were not identified at either of the Edithvale or Bonbeach project areas. A groundwater assessment for CASS and contamination was undertaken as part of the broader hydrogeological assessment for both the Edithvale and Bonbeach projects. The detailed sampling methodology is provided in the Groundwater Impact Assessment report for Edithvale and Bonbeach (EES Technical Report A – Groundwater). The groundwater data collected in December 2016 to June 2017 is extracted from the Coffey 2017 reports (Coffey 2017a and 2017b) and the data collected in July 2017 is obtained from the EES Technical Report A – Groundwater.

The groundwater sampling was undertaken between 18 July 2017 and 27 July 2017 and included the following with respect to the CASS assessment:

Groundwater monitoring (groundwater levels/groundwater sampling) from 11 existing groundwater monitoring bores along/adjacent the rail corridor at Edithvale, and 12 existing bores along/adjacent the rail corridor at Bonbeach, i.e. 23 bores total. These selected groundwater bores were part of the geotechnical investigation program undertaken by Coffey in 2016-17. The location of these bores is provided in Figure 4 and Figure 5 for Edithvale and Bonbeach respectively.

- The selected bores at each project area include:
  - Edithvale – ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH06, ID18-BH07, ID18-BH09, ID18-GWBH01, ID18-GWBH02, ID18-GWBH03, ID18-GWBH04 and ID18-GWBH05
  - Bonbeach – ID46-BH01, ID46-BH03, ID46-BH05, ID46-BH06, ID46-BH08, ID46-BH10, ID46-GWBH01, ID46-GWBH02, ID46-GWBH03, ID46-GWBH04, ID46-GWBH05 and ID46-GWBH06
- Collection of field chemistry data including pH, salinity, reduction potential, dissolved oxygen and temperature

Laboratory Analysis

The groundwater samples were submitted to a NATA accredited laboratory for analysis for key analytes specific to CASS as per EPA 655.1 (2009) and CASS BPMG (2010). The following analytes were selected as pH, salinity, major cations and anions, sulfate and sulphide, acidity, alkalinity, heavy metals (eight heavy metals including aluminium, arsenic, total iron and dissolved iron), chloride to sulfate ratio (calculation), nutrients including ammonia, nitrate, nitrite, phosphate and fluoride.

Stage D – CASS Assessment

The Stage D assessment for CASS includes determination of level of hazard associated with the CASS disturbance. The results of Stage D assessment may trigger actions including preparation of an Acid Sulfate Soil Management Plan (ASSMP) to manage CASS based on the hazard ratings. The methodology includes review of:

- results for Stage B soil assessment
- construction methodology and volume of material to be excavated
- CASS Hazard Table (DSE, 2010)
- stage C groundwater results to inform the management of CASS hazards

Figure 4 Location of CASS boreholes, historical boreholes and groundwater monitoring locations - Edithvale (Page 1 of 3)

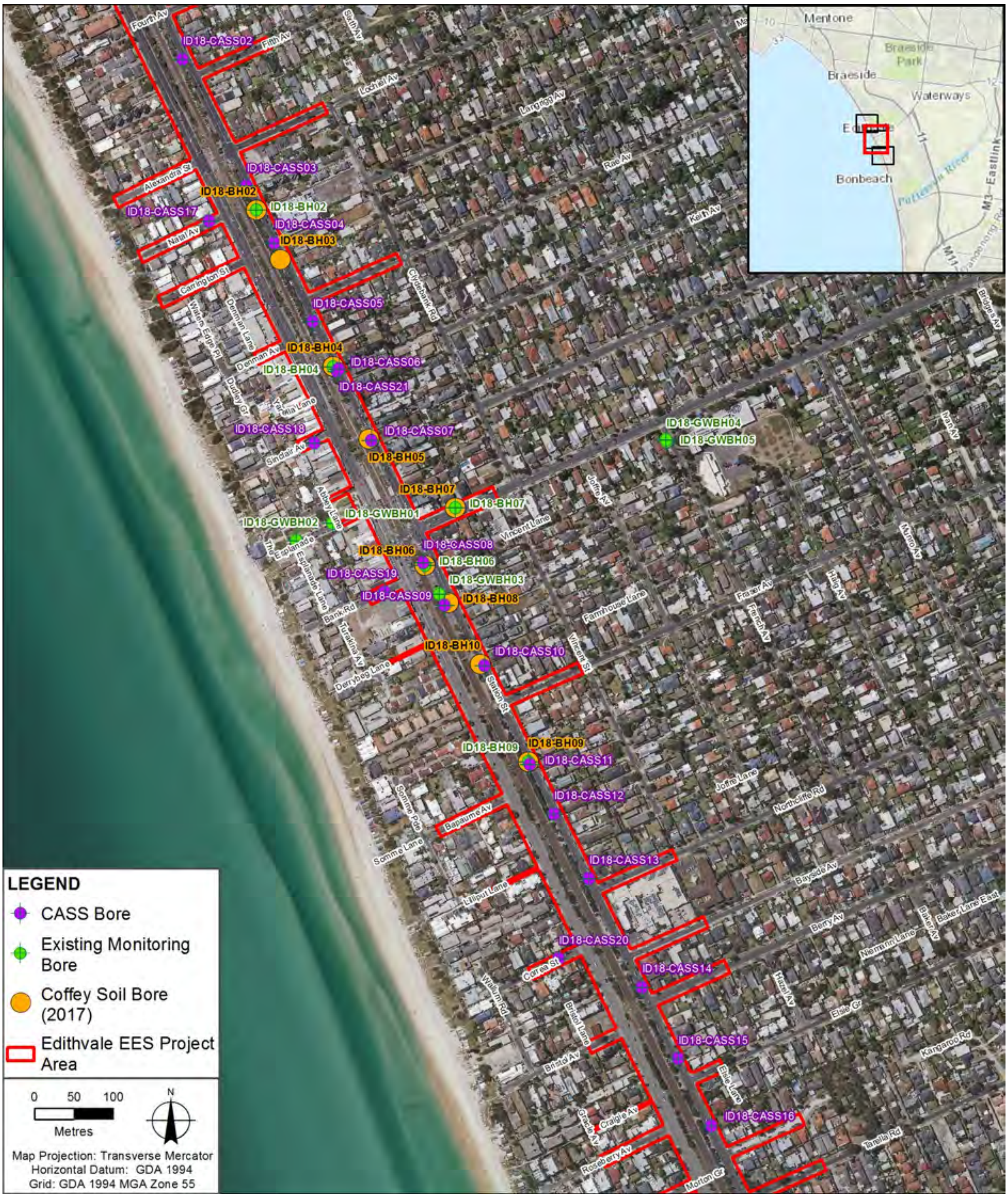


Figure 4 Location of CASS boreholes, historical boreholes and groundwater monitoring locations - Edithvale (Page 2 of 3)

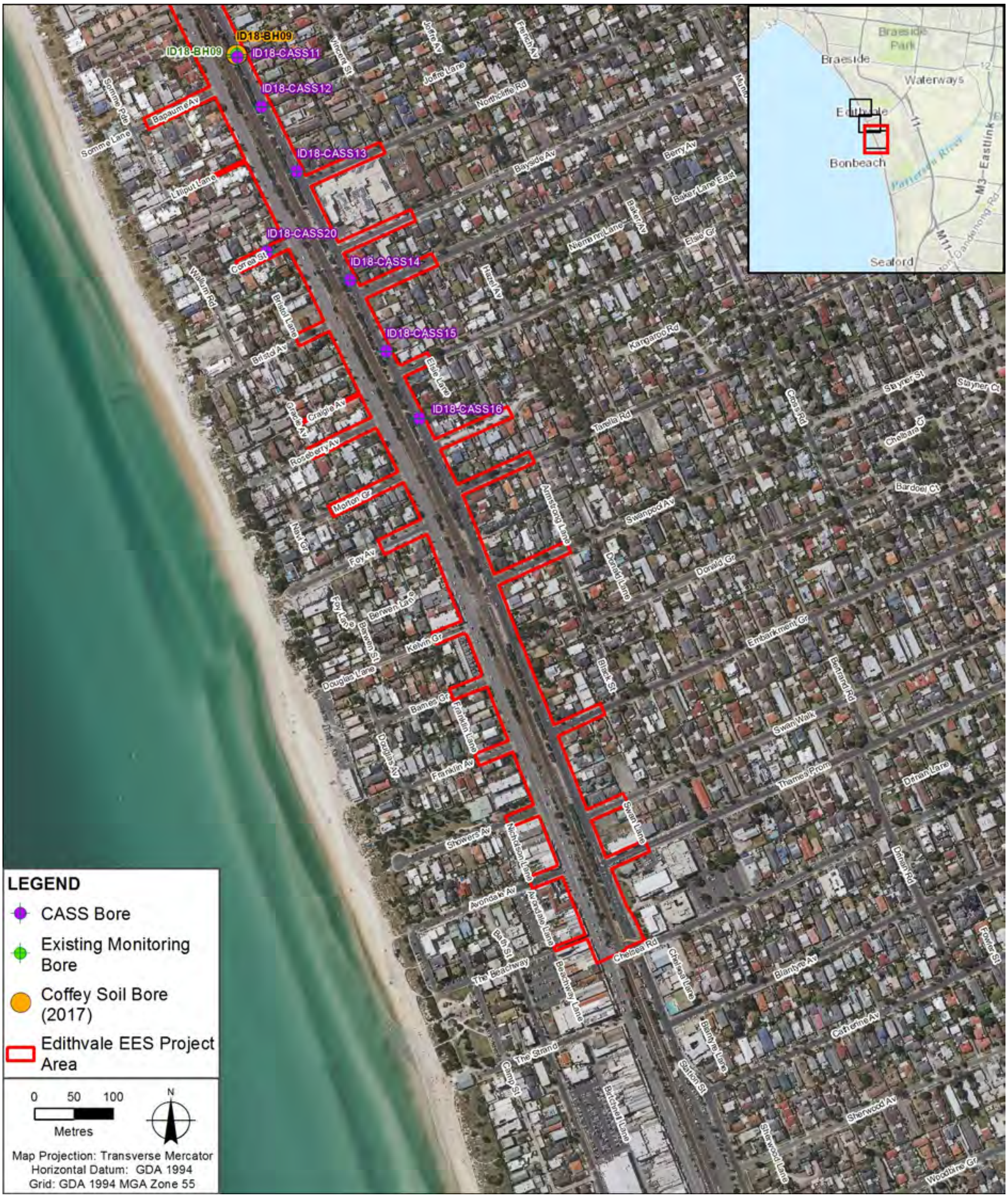


Figure 4 Location of CASS boreholes, historical boreholes and groundwater monitoring locations - Edithvale (Page 3 of 3)

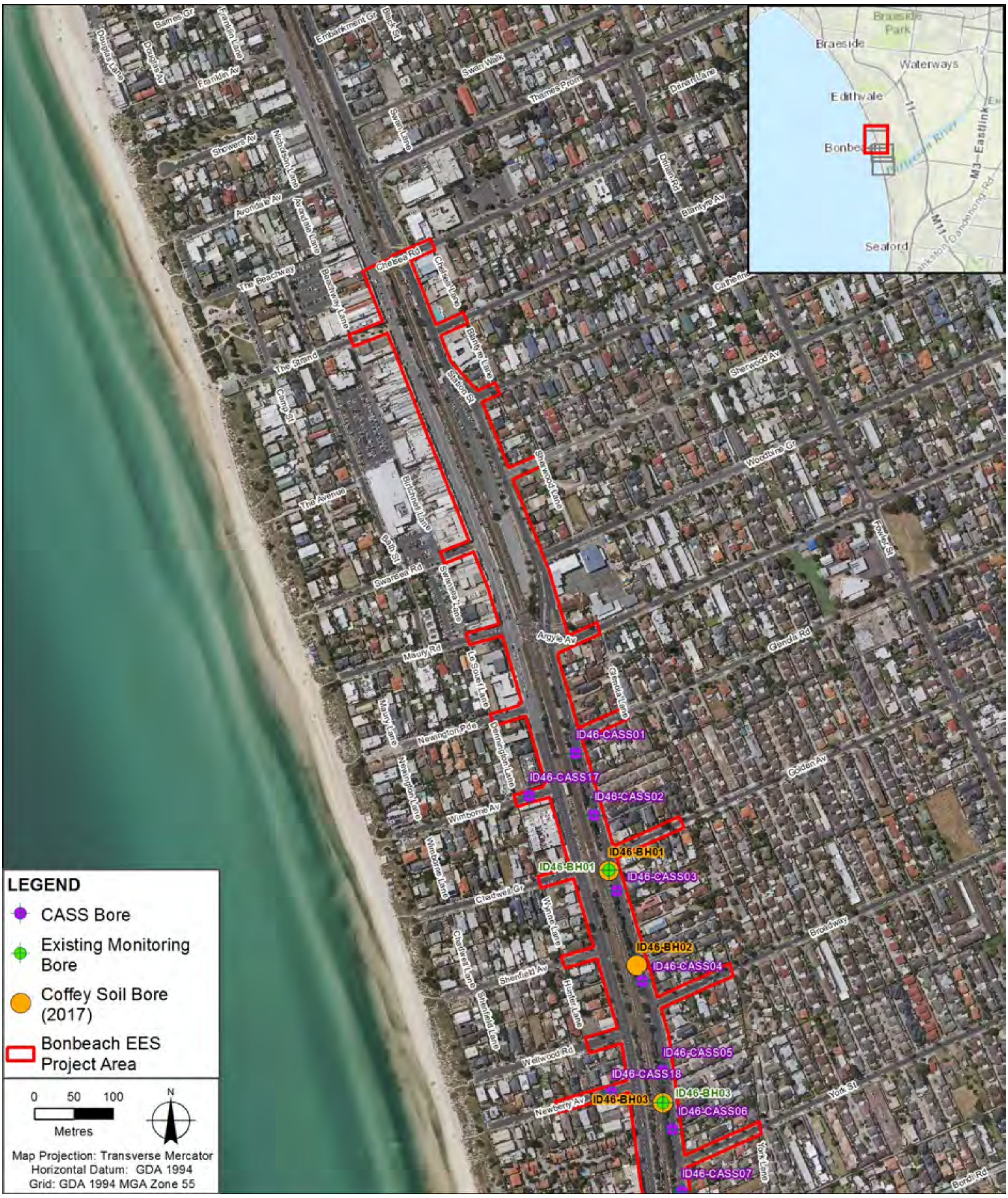


Figure 5 Location of CASS boreholes, historical boreholes and groundwater monitoring locations – Bonbeach (Page 1 of 3)

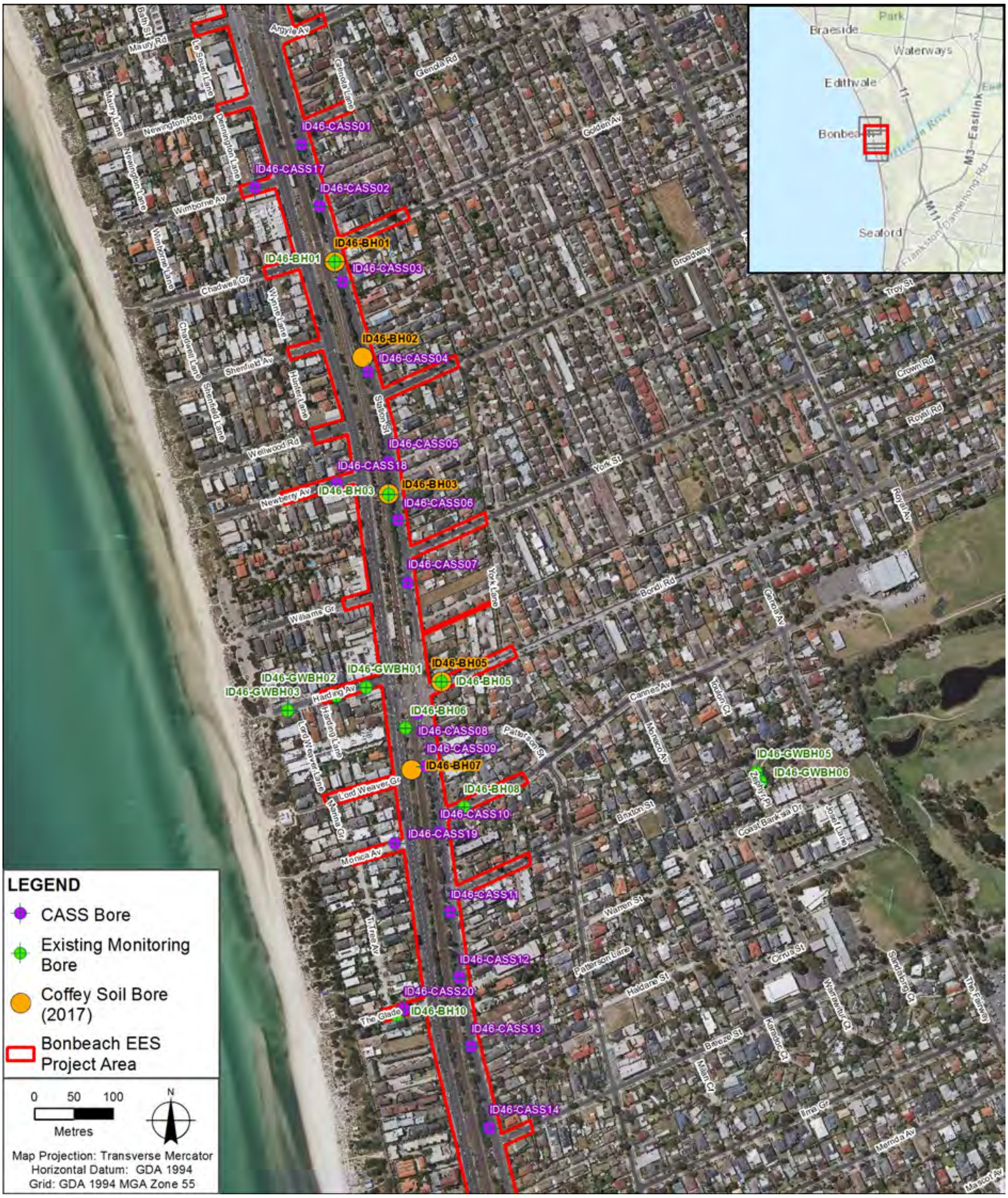


Figure 5 Location of CASS boreholes, historical boreholes and groundwater monitoring locations – Bonbeach (Page 2 of 3)

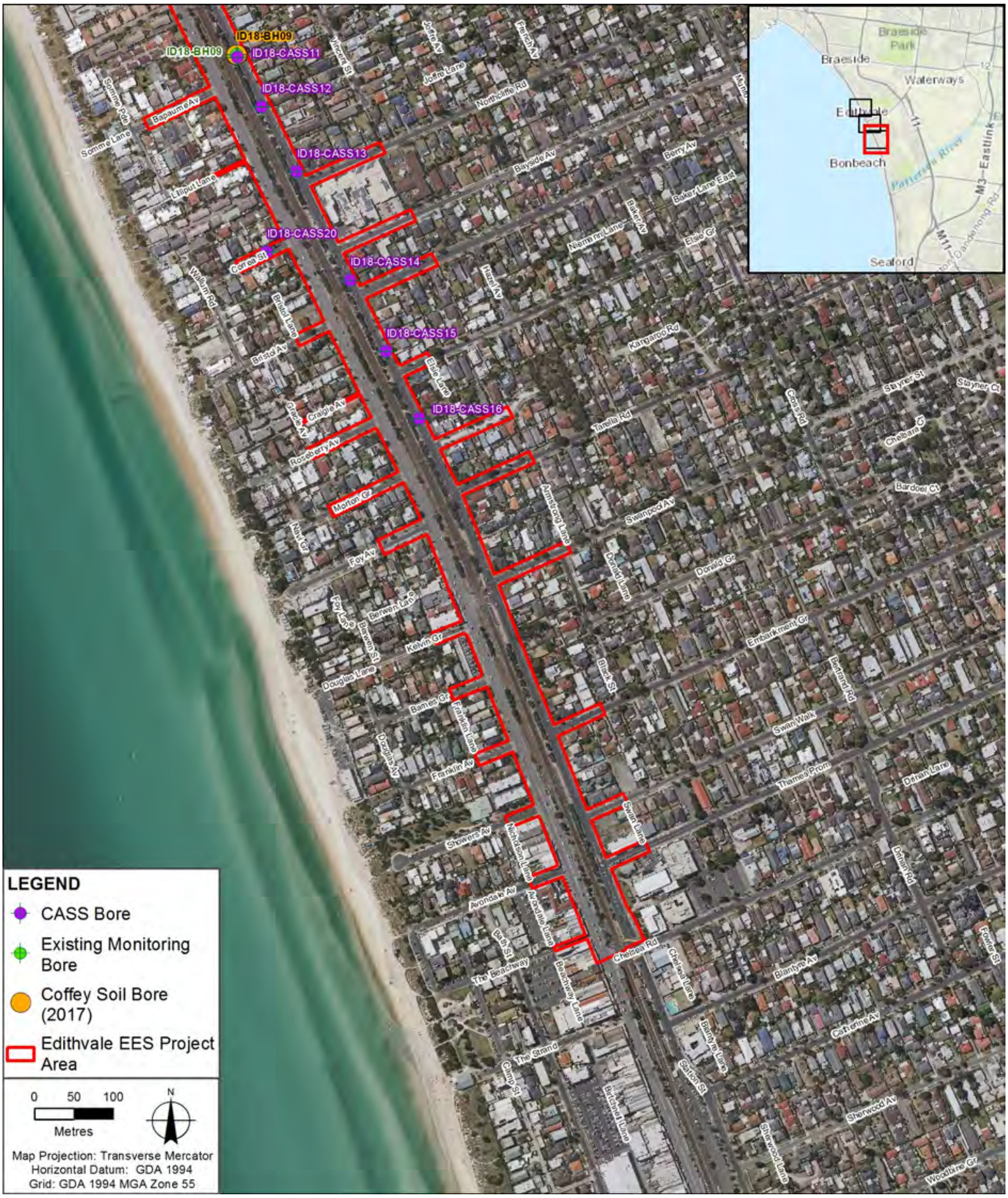


Figure 5 Location of CASS boreholes, historical boreholes and groundwater monitoring locations – Bonbeach (Page 3 of 3)

4.1.2 Contamination

A desktop review was undertaken to assess the existing contaminated land conditions and identify potential sources of contamination within or near the study areas defined in Section 1.5.

The scope of work for the assessment of the existing conditions in relation to contaminated land included a review of available information to address the Scoping Requirements. This comprised the following tasks:

- a review of historical aerial photographs of the project areas, where available, to assist in establishing the physical patterns of development over time
- a review of publically available literature relevant to the project areas:
  - a search of the list of Issued Certificates and Statements of Environmental Audit and EPA Victoria Licence database was conducted to determine if potential contamination associated with these properties could affect the project area
  - a review of the EPA Victoria Priority Sites Register which is a list of issued Clean-up Notices pursuant to Section 62A, and/or Pollution Abatement Notices pursuant to Section 31A or 31B (relevant to land and/or groundwater) of the EP Act
- review geological, hydrogeological and topographical conditions of the project areas
- review of the Melbourne and Metropolitan Board of Works (MMBW) historic sewer plans obtained from the State Library of Victoria
- a site inspection including: documentation and photographing of site features; confirmation of features documented in the current and historical land use review; inspection for potential sources of contamination; and confirmation of regional geology to identify anomalies or extraneous conditions within or near the project areas
- an assessment of the potential impacts from the management of spoil generated during the construction activities.

Soil sampling

Soil samples obtained during the Stage B: Detailed site soil sampling program and assessment (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of soils within the project areas.

All samples were collected in accordance with the following guidelines and protocols:

- National Environment Protection (Assessment of Site Contamination) Measure, 1999 (NEPM) as amended in 2013;
- Standards Australia, 2005. Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds. AS 4482.1 – 2005.

Samples were submitted under chain of custody procedures to ALS (primary laboratory) and Eurofins (secondary laboratory). Both laboratories are NATA accredited for the analysis requested.

Soil sample analysis

A total of 89 primary soil samples were collected from 41 locations as part of the indicative contamination investigation with all 89 primary soil samples selected for analysis. The soil sample analytical program is outlined in Appendix C.

Tabulated results are provided in Appendix C and copies of NATA certified analytical results and COC documentation are provided in Appendix E.

Groundwater sampling

Groundwater samples obtained during the Stage C: Surface water/groundwater assessment sampling program (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of groundwater within the project areas. All samples were collected in accordance with EPA Victoria Publication 669, *Groundwater Sampling Guidelines*, 2000 (EPA Publication 669). Samples were submitted under chain of custody procedures to Eurofins (secondary laboratory) and ALS (primary laboratory). Both laboratories are NATA accredited for the analysis requested.

Groundwater sample analysis

A total of 23 primary groundwater samples were collected from 23 locations (11 at Edithvale and 12 at Bonbeach) as part of the contamination investigation with all primary groundwater samples selected for analysis. The groundwater sample analytical program in respect to contamination is outlined in Appendix C.

Tabulated results are provided in Appendix C and copies of NATA certified analytical results and COC documentation are provided in Appendix E**.**

4.2 Risk assessment method

A risk-based approach is integral to the EES as required by Section 3 of the Scoping Requirements for the EES.

The risk management approach adopted for the Edithvale and Bonbeach EES is consistent with AS/NZS ISO 31000:2009 Risk Management Process and involves the following steps:

- establishment of the context of the risk assessment – this identifies the boundaries of the projects including the project definition, the duration of construction and operation, the design and environmental controls that would be in place (initial Environmental Performance Requirements (EPRs) – refer to section 4.4), and the location of the projects
- risk identification – identification of risk pathways by specialists in each relevant discipline area
- risk analysis – assessment of risk for each risk pathway, whereby risk is a combination of:
    - the likelihood of an event and its associated consequences occurring
    - the magnitude of potential consequences of the event.
- risk evaluation – review key risks posed by the projects to focus effort in terms of impact assessment and mitigation.
- risk treatment – identification of additional management and mitigation where required to reduce risk levels where possible.

An initial risk assessment was undertaken to assess potential risks to the environment arising from the implementation of the projects. Where risks were minor or above, further mitigation was explored. Risks were re-assessed to determine the residual risk based on further mitigation.

A more detailed description of each step in the risk assessment process is provided in EES Attachment II *Environmental Risk Report*.

The soil and groundwater data collected for the existing conditions assessment for the CASS and contamination study was used to identify the project risks associated with CASS (Stage D), contamination and spoil management. This technical report describes these risks.

4.3 Impact assessment method

This report focuses on the potential CASS and contamination impacts on human health with respect to nearby residents and the general public. It also focuses on the potential CASS and contamination impacts to the environment from the Edithvale and Bonbeach level crossing removal projects, including Edithvale wetlands and Port Phillip Bay. The potential impacts on human health and the environment from construction activities and management of spoil have been considered at a local context with regard to both CASS and contamination with reference to the Beneficial Uses identified in the SEPP *Prevention and Management of Contamination of Land* and the SEPP *Groundwaters of Victoria*.

The protected beneficial uses associated with the various land uses, defined in SEPP *Prevention and Management of Contamination of Land* and the SEPP *Groundwaters of Victoria* is detailed in Table 8 and Table 9 respectively. It is noted that based on the TDS concentration the salinity of the groundwater in the Quaternary sands at the project areas (as detailed in the EES Technical Report A – Groundwater), the groundwater ranges from Segment A1 to Segment A2. For the purpose of defining the relevant groundwater segment for this report, Segment A1 was adopted as a conservative measure.

Table 8 Protected beneficial uses of land

Beneficial Use	Land Use						
	Parks & Reserves	Agricultural	Sensitive use		Recreation / Open space	Commercial	Industrial
			High density	Other			
Maintenance of ecosystems							
Natural Ecosystems	✓						
Modified Ecosystems	✓	✓		✓	✓		
Highly Modified Ecosystems		✓	✓	✓	✓	✓	✓
Human Health	✓	✓	✓	✓	✓	✓	✓
Buildings and Structures	✓	✓	✓	✓	✓	✓	✓
Aesthetics	✓		✓	✓	✓	✓	
Production of food flora and fibre	✓	✓		✓	✓		

Table 9 Protected beneficial uses of groundwater segments

Beneficial Use	Segments (mg/L TDS)				
	A1 (0-500)	A2 (501-1 000)	B (1 001-3 500)	C (3 501-13 000)	D (> 13 000)
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply:					
Desirable	✓				
Acceptable		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks & gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation (e.g. Bathing, swimming)	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

The method for assessing potential impacts on human health and the environment from construction activities and management of spoil has included:

- assessment of historical activities at the project areas that may have caused contamination to soil and groundwater likely to be encountered during construction
- assessment of potential for acid sulfate soils to be encountered during construction
- assessment of the spoil management options to appropriately manage spoil produced during the construction project.

4.4 Environmental Performance Requirements

The environmental outcomes that must be achieved during design, construction and operation of the projects are referred to throughout the EES as Environmental Performance Requirements (EPRs). EPRs must be achieved regardless of the construction methodology or design solutions adopted. Measures identified in this EES to avoid, reduce or environmental impacts have formed part of the recommended EPRs for the projects.

The development of a final set of EPRs for the project has been iterative.

4.4.1 Initial EPRs

Environmental performance requirements were identified to inform the assessment of initial risk ratings (where appropriate). These initial EPRs were based on compliance with legislation and standard requirements that are typically incorporated into the delivery of construction contracts for rail projects.

4.4.2 Confirm or update EPRs

The risk assessment either confirmed that these EPRs were adequate or identified the need for further refinement.

EPRs were updated or new EPRs were developed for any initial risk that could not be appropriately managed by standard requirements. The risk and impact assessment processes confirmed the effectiveness of new or updated EPRs to determine the residual risk rating.

4.4.3 Final EPRs

The EPRs recommended for the project are outlined in Section 10 of this report and are included in the EES Environmental Management Framework.

The EPRs are applicable to the final design, construction approach and operation and provide certainty regarding the environmental performance of the projects.

4.5 Independent peer review

The role of the independent peer reviewer was:

- To assess the design of and adequacy of the CASS technical assessment to identify and assess the potential environmental effects of the projects, and address the scoping requirements (prepared by the Department of Land, Water Environment and Planning (DELWP) for the EES.

The peer review considered:

- relevant legislation and policy
- consistency of methodology with good industry practice, including the availability of relevant data sets and research
- the approach to field work, data collection and analysis
- the assumptions and integrity of the data used in the assessment
- confirmation that the conclusions of the assessment and any proposed mitigation are sound and reasonable and practicable.

The independent reviewer reviewed the proposed sampling and analysis plan prior to the works investigation being undertaken and reviewed two draft version of this report. Written comments were provided after each review (refer to Appendix M).

4.6 Linkage to other technical reports

This report relies on, or informs the following technical assessments:

- EES Technical Report A *Groundwater*
- EES Technical Report E *Surface water*
- EES Technical Report G *Traffic*
- EES Chapter 2 *Rationale and project descriptions*

5 Existing conditions - results of desktop and intrusive investigations

A summary of this section can be found in Section 6.

5.1 Regional existing conditions

5.1.1 Project area location

The Edithvale and Bonbeach project areas are located approximately 31 kilometres south east of Melbourne on the Frankston railway line between Aspendale Station and the Patterson River. Edithvale and Bonbeach project areas are separated by Chelsea Station. The prominent waterbodies in the region are:

- Port Phillip Bay located approximately 150 metres west of both project areas
- Edithvale – Seaford Wetlands located approximately1,300 metres east of the Edithvale Project area
- Patterson River located approximately five metres south of the Bonbeach project area.

Refer to Figure 1 and Figure 2.

5.1.2 Regional geology

The geological setting of the region is presented on the Geological Survey of Victoria 1:63,360 scale - Cranbourne Mapsheet. The Mapsheet indicates that typically, the Edithvale and Bonbeach project areas are underlain by Quaternary age aeolian and swamp deposits, which in turn overlie the Pliocene age Baxter Sandstone or Brighton Group sediments. A variable thickness of anthropogenic fill material overlies the natural geological materials associated with the construction of the local transport and residential/commercial infrastructure. An assessment of the available geological mapping suggests the stratigraphy beneath the sites within the depth of engineering works is anticipated to generally comprise the units identified below (listed in order of increasing depth):

- Variable (anthropogenic fill)
- Quaternary coastal aeolian dune deposits
- Quaternary coastal swamp deposits
- Tertiary (Pliocene) Baxter Sandstone/Brighton Group sediments
- Tertiary (Miocene) Fyansford Formation sediments.

5.1.3 Regional hydrogeology

Identified aquifers

The geological units above have been subdivided into key aquifer/aquitard systems nominated under the Victorian Aquifer Framework. The aquifer systems that could be potentially intersected during construction are summarised in Table 10.

Table 10 Aquifer systems

Period	Sub period	Geological formation	Aquifer or aquitard unit	Lithology
Quaternary	Holocene	Alluvium/Aeolian deposits	Quaternary Aquifer (QA)	sand, gravel, clay, silt
Tertiary	Late Miocene to Early Pliocene	Brighton Group/Baxter Sandstone	Upper Tertiary Aquifer (fluvial) (UTAF)	calcareous, ferruginous consolidated sands and sandstones
	Upper-Mid (Miocene)	Fyansford Formation	Upper-Mid Tertiary Aquitard (UMTD)	clay, silt, marl (fractured rock) and minor sand

Aquifer flow systems

Groundwater flow systems in the low-lying areas around Edithvale and Seaford Wetlands are described as localised, underlain by intermediate to regional flow systems.

Department of Environment, Land, Water and Planning (DELWP) Water Measurement Information System indicates the depth to groundwater is likely to be less than five metres below ground level. Limited site data obtained to date suggests groundwater levels at Bonbeach are likely to range from three metres to six metres below ground level, or less than two metres below the Australian height datum (AHD).

The local groundwater flow regimes at the project areas are influenced by the surface topography, which includes a coastal dune network. These dunes represent a local groundwater flow divide. The existing railway has been constructed generally along the top of this dune network. Local groundwater flows in different directions (east and west) on each side of the flow divide, while overall, the regional groundwater flow direction is westerly towards Port Phillip Bay. At Bonbeach, local groundwater flows in a generally south westerly direction towards both Port Phillip Bay and Patterson River.

The coastal dunes probably represent a local higher recharge (and higher groundwater quality) area due to coarser grained sediments. Local to topographic / hydraulic low points such as Eel Race Drain and the Patterson Lakes / River complex are also likely to influence flow systems.

The shallow surficial QA units are likely to be unconfined and form the water table. Depending upon the lithological profile, the Upper Tertiary Aquifer (fluvial) (UTAF) is considered to have variable connection with the overlying QA. Shallower parts of the UTAF may be hydraulically connected, however deeper sandy lenses may be partly to wholly confined by overlying fine grained lenses within the sequence.

The Bonbeach site comprises the same regional aquifers as the Edithvale Wetlands, and there is likely to be hydrogeological connection between these two areas. Conversely, Seaford Wetlands are unlikely to be hydrogeologically connected to the site, as it is hydraulically separated from Bonbeach by Patterson River, which also forms a groundwater divide and local discharge feature for shallow groundwater.

The regional flow system in the UTAF is generally from the east (where the unit outcrops and is recharged) towards the west and the coast, where groundwater discharges.

Recharge and discharge

The QA (local water table aquifer) is recharged largely by direct rainfall infiltration and artificial recharge to groundwater via stormwater runoff directed to the swamps. While the presence of a subsurface low permeability clay layer beneath the wetland would likely reduce local groundwater flow, the topographically low wetland areas are likely to represent discharge features for the local groundwater flow regime.

Regionally, and in deeper aquifer systems, groundwater discharge is to Port Phillip.

5.1.4 Regional topography and drainage

The area is relatively flat lying and occurs close to, and in the case of the swamps/wetlands, at or below sea level. This area comprises relatively fresh surface water features that are generally separate from the marine water west of the natural beach/dune barrier. The network of swamps/wetlands (including the Edithvale and Seaford Wetlands) are highly modified and are fresh (low salinity) to brackish. Surface water periodically enters the relatively brackish swamp area through diverted stormwater runoff, altering the natural salinity of the wetlands.

5.2 Edithvale

5.2.1 Edithvale project area description

The Edithvale project area is located approximately 31 kilometres south east of Melbourne on the Frankston railway line between Aspendale Station and Chelsea Station and is within the City of Kingston (Figure 1). Further details are provided in Table 11 below.

Table 11 Edithvale project area details

Item	Details
Location	Refer to Figure 1
Current land use	Rail and road
Municipality	City of Kingston
Current zoning of project area	Public Use Zone - Schedule 4 (Transport) Road Zone – Category 1 Road Zone – Category 2 General Residential Zone – Schedule 2 General Residential Zone – Schedule 3
Planning overlays	The southern portion of the project area is subject to a heritage overlay . The north western portion of the project area is within, or affected by, one or more areas of cultural heritage sensitivity.
Surrounding land use	North: General Residential, Commercial and Public Use - Transport South: General Residential, Commercial and Public Use - Transport East: General Residential, Public Use - Transport and Education, Commercial and Mixed Use West: General Residential and Commercial
Closest surface water	Port Phillip Bay at Edithvale Beach is situated approximately 150 metres

bodies	west of the project area.

5.2.2 Edithvale historical aerial photographs

Historical aerial photographs of the Edithvale project area and surrounding area (obtained from DELWP) were reviewed for the period 1945 to 2016. A copy of the aerial photographs are provided in 0 and summarised in Table 12 below. It is noted that image resolution of aerial photos can vary significantly and as a result, there may be uncertainties in interpretation. Furthermore, at the time of the review, the DELWP aerial photograph records were incomplete and some photographs were not available for review.

Table 12 Review of historical aerial photographs

Photograph	Observations
Date: Dec 1945 Run: 5, 6, 7 Photo: 64771, 64772, 64766, 64768, 64769, 64793, 64815 Project: 5 - Melbourne and Metropolitan Area	**Edithvale project area** The rail alignment was present in a north – south direction along the centre of the Edithvale project area. Nepean Highway and Station Street were visible parallel to the rail track to the west and east respectively. Aspendale Station and a level crossing were observed in the northern portion of the project area. An apparent building likely to be Aspendale Station was visible to the west of the rail alignment. The Lochiel Avenue level crossing was visible in the north central portion of the project area. Edithvale Station and Edithvale Road level crossing were observed in the central portion of the project area. Two buildings and the associated rail platforms were noted at Edithvale Station. The Swanpool Avenue level crossing was observed in the central south portion of the project area. Apparent vegetation (low lying trees, shrubs and grasses) was visible to the east and west of the majority the rail alignment. **Surrounds** The project area surrounds were observed to be predominantly residential. Possible commercial/industrial development was noted to the west along Nepean Highway in the vicinity of both Aspendale and Edithvale stations. Port Phillip Bay was located to the west. A grassed covered area and dirt track (possible sports field/horse training track) was located immediately to the north east of the project, adjacent to Aspendale station. The land east of the project area appeared to be have been used primarily for agriculture/farming. Rossdale golf course and vegetated sand dunes were present east of the northern portion of the project area.
Date: Dec 1957 Run: 22, 23 Film: 977, 978 Photo: 69, 75 Project: Metropolitan Base Map Project	**Edithvale project area** The project area was relatively unchanged. Less vegetation was apparent along the length of the rail alignment. The aerial photograph covering the northern portion of the project area was not available for review. **Surrounds** Further residential development had occurred to the east. Edithvale Wetlands were visible to the east.
Date: April 1963 Run: 28,29, 30 Film: 1828 Photo: 98,201, 207, 208 Project: 486 – Melbourne	**Edithvale project area** The project area was relatively unchanged. **Surrounds** Further residential development had occurred to the east. The grassed

Photograph	Observations
(1963) Project	covered area and dirt track (possible sports field/horse training track) located immediately to north east of the project had been developed for residential purposes.
Date: Jan 1970 Run: 2, 13 Film: 2560 Photo: 52, 53, 79, 81, 83 Project: Nepean Highway 1972, 769 – Port Phillip Foreshore 1968 Project	**Edithvale project area** The project area was relatively unchanged. **Surrounds** Further commercial development had occurred to the west of the project area in the vicinity of Edithvale Station. Commercial/industrial development had occurred to the west of the southern portion of the project area along Nepean Highway.
Date: Apr 1977 Run: 9 Film: 3195 Photo: 136 Project: Port Phillip Bay Foreshore 1977	**Edithvale project area** The project area was relatively unchanged. **Surrounds** The project area surrounds were relatively unchanged.
Date: Dec 1980 Run: 3 Film: 3533 Photo: 167 Project: Standard Mapsheet	**Edithvale project area** The project area was relatively unchanged. Car parking appeared to have been constructed to the east of the rail tracks at Aspendale Station in the northern portion of the project area. A structure (possible signal box) was visible to the west of the rail alignment in the northern portion of the project area. **Surrounds** Apparent commercial/industrial development was observed to the east of the central northern portion of the project area along Station Street. Further commercial/industrial development had occurred to the east and west of the southern portion of the project area.
Date: Jan 1987 Run: 7 Film: 4076 Photo: 101 Project: Nepean Highway	**Edithvale project area** The project area was relatively unchanged. **Surrounds** The project area surrounds were relatively unchanged.
Date: 2005 Project: DELWP CIP, Melbourne 2005	**Edithvale project area** The project area was relatively unchanged. Nepean Highway, Station Street and the level crossings at Aspendale Station, Lochiel Avenue, Edithvale Road and Swanpool Avenue appeared to have been widened. **Surrounds** Commercial/industrial buildings to the west of Aspendale Station of the project area had been demolished and were apparently being redeveloped for residential purposes.
Date: 2016 Project: DELWP CIP, Mordialloc 2016	**Edithvale project area** The project area was relatively unchanged. **Surrounds** The project area surrounds were relatively unchanged. The residential

Photograph	Observations
	redevelopment to the west of Aspendale Station was complete.

5.2.3 EPA Victoria priority sites register

Priority Sites are sites for which EPA Victoria has issued a Clean-up Notice pursuant to section 62A, or a Pollution Abatement Notice pursuant to section 31A or 31B (relevant to land and/or groundwater) of the EP Act. Typically these are sites where pollution of land and/or groundwater presents an unacceptable risk to human health and/or the environment.

A search of the register on 1 June 2017 indicated that there were no properties within the Edithvale project area listed on the database, nor was there any properties within a 500 metre radius of the Edithvale project area listed on the priority sites register.

5.2.4 EPA Victoria database of certificates and statements of environmental audit

The EPA Victoria maintains a database of properties issued with either a certificate or statement of environmental audit under Part IXD of the EP Act since the environmental audit system commenced in 1990. Typically these are sites where a statutory environmental audit under the Act has been completed.

A search of the database on 1 June 2017 indicated that there were no properties within the Edithvale project area listed on the database, but there were six properties within a 500 metre radius of the Edithvale project area for which an environmental audit was completed. The EPA Victoria database search is summarised in Table 13.

Table 13 Edithvale certificates and statements of environmental audits

Issue and CARMs no.	Address	Completed	Key audit findings
Statement [redacted][1]	[redacted]	17/12/2014	The site was unsuitable for issue of a Certificate of Audit due to the presence of soils contaminated with heavy metals, polycyclic aromatic hydrocarbons, total recoverable hydrocarbons, and waste in fill. Groundwater at the site was contaminated with low pH, heavy metals, nitrate and ammonia, which was considered attributable to background water quality. In summary, the conditions specified for ongoing use of the site were: • groundwater will not be abstracted for uses other than clean-up or monitoring as the site. • groundwater monitoring bores present at the time of reporting were to be decommissioned • the environmental auditor recommended that EPA Victoria identify the site as a groundwater quality restricted use zone.
Statement [redacted]	[redacted]	09/10/2006	The site was unsuitable for issue of a Certificate of Audit due to both on-site and off-site soil and groundwater

[1] Records provided by The City of Kingston show that the site at [redacted] was issued with a Certificate of Audit on 6 July 1992 as it was considered that the condition of the land was neither detrimental nor potentially detrimental to any beneficial use of the land at the site.

Issue and CARMs no.	Address	Completed	Key audit findings
	[redacted]		contaminated with total petroleum hydrocarbons and benzene, ethylbenzene, toluene and xylenes. In summary, the conditions specified for ongoing use of the site were: • areas of the site shall be 'quarantined' from use for construction of buildings or non-permeable pavement, unless a passive gas ventilation system is installed • excavations below the depth of 3.0 metres require a Health and Safety plan to address possible presence of localised petroleum related contaminants and odours • groundwater will not be abstracted for uses other than clean-up or monitoring as the site is within a groundwater quality restricted use zone • ongoing monitoring of groundwater was required.
[redacted]	[redacted]	09/03/2011	The site was unsuitable for issue of Certificate of Audit due to the presence of on-site and off-site groundwater contaminated with total petroleum hydrocarbons, heavy metals, ammonia and nitrate. In summary, the conditions specified for ongoing use of the site were: • a barrier layer comprising either concrete floor slabs, other form of 'permanent' paving material or a minimum layer of 0.5 metre depth clean soil shall be placed and maintained over the entire site • the integrity of the barrier layer will be managed through the implementation of a health and safety plan • in the event excavations below the depth of 3.0 metres occur on site, any construction workers shall be equipped with protective equipment to protect against inhalation of hydrocarbon vapours • groundwater will not be abstracted for uses other than clean-up or monitoring as the site is within a groundwater quality restricted use zone.
Certificate [redacted]	[redacted]	07/06/2000	The site was issued with a Certificate of Audit as it was considered that the condition of the land was neither detrimental nor potentially detrimental to any beneficial use of the land at the site.
Certificate [redacted]	[redacted]	06/07/1992	The site was issued with a Certificate of Audit as it was considered that the condition of the land was neither detrimental nor potentially detrimental to any beneficial use of the land at the site.

Issue and CARMs no.	Address	Completed	Key audit findings
Statement [redacted][2]	[redacted]	04/02/2009	The site was unsuitable for issue of Certificate of Audit due to the presence of buried building rubble and waste on-site, as well as on-site and off-site groundwater contaminated with total nitrates, arsenic, iron and a number of other heavy metals, and was mildly acidic. In summary, the conditions specified for ongoing use of the site were: • development for medium density residential use for the site as proposed to include a durable barrier to prevent access of occupiers to buried building rubble and waste • groundwater from the site is not suitable for the beneficial uses of drinking use, primary, contact recreation, stock-watering, maintenance of ecosystems, industrial use or agriculture, parks and gardens

5.2.5 EPA Victoria licence register

An EPA Victoria Licence is required for all 'scheduled premises', unless the premises are exempt from the regulations. Licences cover the actual operation of the site and set operating conditions, waste discharge limits, and waste acceptance conditions as appropriate. EPA Victoria maintains a database of Licences.

A search of the database on 1 June 2017 indicated that no properties within the Edithvale project area were listed as having an EPA Victoria licence. There were no scheduled premises within the vicinity of the project area (500 metre radius) listed on the database.

5.2.6 Historic MMBW sewer plans

The State Library of Victoria has an archive of plans produced for the Melbourne and Metropolitan Board of Works (MMBW) between the 1890s and 1950s. The plans were created to facilitate in the design and development of Melbourne's sewerage system.

A search of the archive on 11 October 2017 indicated that no plans were produced covering the Edithvale project area and surrounds.

5.2.7 Geology and hydrogeology

The Geological Survey of Victoria 1:63,360 scale Cranbourne Mapsheet indicates the Edithvale project area is underlain by Quaternary aged aeolian and swamp deposits overlying Pliocene aged Baxter Sandstone. A variable thickness of anthropogenic fill material materials associated with the urbanisation of the surrounding area is expected to be found overlying the natural geological formation.

An assessment of the available geological maps suggests the stratigraphy beneath the site within the depth of proposed engineering works is anticipated to comprise the units identified in Table 14.

[2] At the time of reporting the environmental audit completed for the site located [redacted] was not available on the EPA Victoria database for review. A copy of the environmental audit was provided by The City of Kingston.

Table 14 Geological summary

Period	Sub period	Geological unit (map abbreviation)	Approximate geological age (years)	Approximate depth to top of unit (mbgs)	Geological description**
Recent	-	Anthropogenic fill	200	0	Variable May include sand, gravel, silt and clay, and man-made artefacts.
Quaternary	Holocene	Coastal Dune Deposits	<1.8 million	<2	Siliceous and calcareous sand
		Coastal Swamp Deposits		<5	Peaty clay
Tertiary	Miocene – Pliocene	Baxter Sandstone	23 – 1.8 million	<5	Sandstone and sand, silty sand with minor gravels

*Notes: * Sourced from DELWP Groundwater Resource Reports*
*** Cited from Geological Survey Victoria 1:63,360 Scale Cranbourne Mapsheet*

The depths of various geological units expected at Edithvale is summarised below in Table 15 below.

Table 15 Edithvale geology

Geological Unit	Approximate depth to top of unit (mbgs)	Approximate thickness of unit (m)
Fill	0.0	0.3 to 0.5
Quaternary Sands	0.3 to 0.5	9.2 to 16.7
Tertiary Age Brighton Group Deposits	9.6 to 17.0	9.0 to 19.2
Tertiary Age Fyansford Formation	22.3 to 33.5	Greater than 25.5

An assessment of the Visualising Victoria's Groundwater Geodatabase, managed by the Centre of eResearch and Digital Innovation at Federation University Australia and the DELWP Groundwater Resource Database indicates that the depth to the water table is expected to be less than 10 metres (and less than five metres in places). Groundwater bores installed at Edithvale indicate groundwater occurring between 3.4 and 5.7 mbgs. Groundwater flow direction is anticipated to be to the west towards Port Phillip Bay and groundwater salinity in the range 3,500 milligrams per litre (mg/L) and 7,000 mg/L.

5.2.8 Topography, drainage, surface water

The topography of the Edithvale project area is generally flat within the rail corridor and local area, gradually sloping down to the east and west of the rail corridor. Edithvale station is approximately seven metres above sea level. The relative elevation is at approximately six metres AHD, with an overall east to west slope towards Port Phillip Bay.

The rail line through the project area forms a ridge with runoff on the west potentially flowing to Port Phillip Bay (approximately 200 metres from the level crossing). .

The project area is within the Port Phillip and Westernport Catchment Management Authority region. There are no known stormwater drainage assets crossing the rail line within the project area, and the project area is not subject to any flooding overlays within the local planning scheme. Further discussion is provided in EES Technical Report E *Surface water*.

5.2.9 CASS Mapping

The desktop assessment for CASS included review of the following available maps:

Victorian CASS Mapping

Rampart (2003) completed CASS hazard mapping along the Victorian coast based on available geological records and air photo interpretation as well as field work and laboratory analysis. These initial maps indicated if land either had a nil to low or low to high probability of occurrence for ASS.

Since 2003, the former Department of Primary Industries (DPI) and Department of Sustainability and Environment (DSE) have undertaken additional investigations to improve knowledge of where CASS occur along Victoria's coast. Land has also been mapped as 'prospective land' or 'made land', rather than mapping the individual bodies of CASS. The two classes of land have been defined below:

- prospective land: land that has the potential to contain CASS as indicated by geomorphology
- made land: land that has been modified by human impact but has the potential to contain CASS. Geomorphic features that once existed to indicate the potential to contain CASS no longer exist. Assessment of CASS potential depends on information such as geology maps or soil maps that pre-dates modification.

More recently, a new definition has been added to those above and is known as 'prospective water'. This definition includes water bodies such as lakes, rivers, creeks, drains and canal estates. The Department of Economic Development, Jobs Transport and Resources (DEDJTR) note that sediments under permanent water bodies in coastal environments such as those listed above should be assumed to contain metal sulfides. The DEDJTR CASS distribution map 3 for the central coast of Victoria indicates that the site falls within land that has been mapped as 'prospective' for CASS. A link for this map has been included in Appendix G.

Australian Soil Resource Information System (ASRIS) Mapping

The Australian Soil Resource Information System (ASRIS) national ASS atlas, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), was reviewed to identify the probability of CASS to be present at the project area.

The ASRIS mapping indicates that the project area has a 'high probability/high confidence' for the occurrence of ASS. Figure 6 shows the ASRIS ASS mapping at Edithvale project area. This risk was investigated further as a Stage B soil assessment (Section 5.2.12)

Vegetation Mapping

Vegetation mapping at the site has been completed by the JV (AECOM-GHD JV, 2017). The JV (2017b) indicated that vegetation in the area is generally of poor quality due to historical and ongoing use as an active rail line and intensive land use in the area. The JV reported a large number of weedy species in the area as well as native and introduced amenity plantings.

Remnant native vegetation includes Coastal Tea-tree *Leptospermum laevigatum* and Coastal Banksia *Banksia integrifolia.* These species are not listed as CASS occurrence indicators (refer Appendix B).

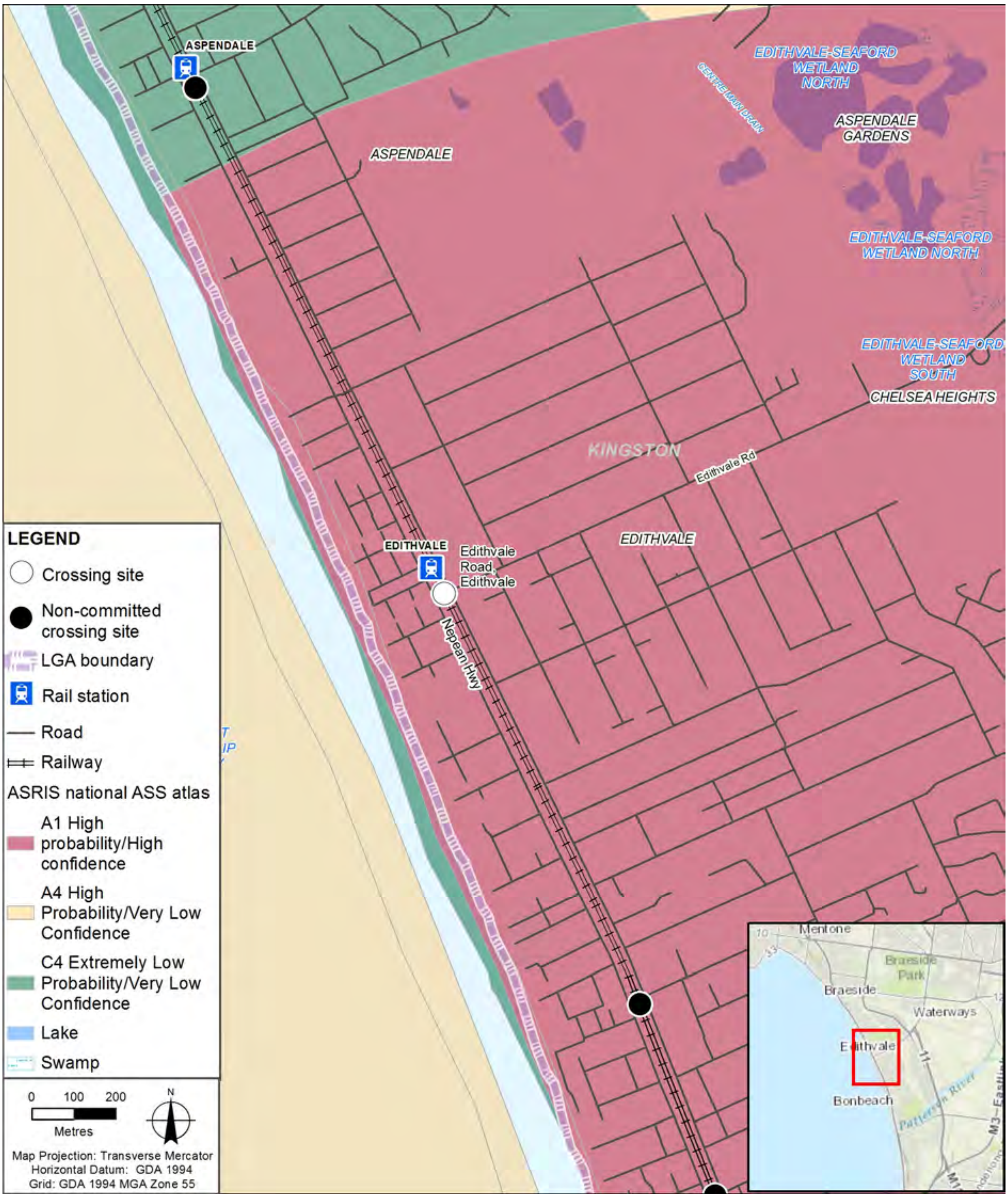


Figure 6 Edithvale ASRIS mapping

5.2.10 Review of previous investigations

Two available environmental reports were reviewed which included preliminary information on the history and the contamination status of soils at the Edithvale project area. The review of these reports is provided below.

AECOM-GHD Joint Venture 2016

The JV was contracted by LXRA to complete a contamination/Potential Acid Sulfate Soil (PASS) Desktop Assessment of the Edithvale project area. In summary, the findings included:

- potential sources of soil contamination are primarily associated with historical rail use and potential contaminants of concern include petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), asbestos, heavy metals (including arsenic) and organochlorine pesticides (OCPs)
- there was no specific information available indicating the contamination status of soils in the rail corridor, however, some contaminated soil was considered likely based on the history of rail use
- there was no specific information indicating the actual contamination status of groundwater.
- potential off-site sources of groundwater contamination were identified as follows (potential contaminants of concern in brackets):
    - service station at [redacted] (Petroleum hydrocarbons, PAHs, benzene, toluene, ethyl benzene, xylenes (BTEX), lead)
    - former dry cleaners at [redacted] (VOCs)
    - mechanic at [redacted] (Petroleum hydrocarbons, PAHs, lead, VOCs)
    - elevated background groundwater concentrations (heavy metals, arsenic, cobalt, copper, molybdenum, nickel, selenium and zinc), sulfate, nitrate, and low pH).
- based on the CASS risk map for the area compiled by the CSIRO, there was a 'High Probability of Occurrence' for CASS within the area.

Coffey Environments Pty Ltd 2017

Coffey Environments Pty Ltd was contracted by Metro Trains Melbourne Pty Ltd to complete a geotechnical, environmental and hydrogeological investigation of the Edithvale project area. In summary, the findings included:

- environmental soil sampling undertaken at 10 locations within the site included analysis of 10 samples of fill and 33 samples of natural soils
- concentrations of nickel, benzo(a)pyrene, total PAHs and/or TPH C10-C36 exceeded the upper limit of Fill Material in accordance with EPA Victoria publication IWRG 621 in samples of fill soils collected from four boreholes:
    - immediately west of [redacted]
    - immediately west of [redacted]
    - immediately west of [redacted]
    - immediately west of [redacted]
- all other soil samples reported concentrations of chemicals analysed below the upper limit of Fill Material

- acid sulfate soil pH screening tests indicated a low potential for acid sulfate soils to be present in the shallow natural soil at the site (up to one mbgs)
- the results from both of the acid sulfate soil testing and chromium reducible sulfur analysis undertaken on deeper natural soils within the Quaternary Sands (at depths of between about 8.0 metres and 11.5 mbgs) indicated that the deeper natural soils have a high potential for acid sulfate soils to be present
- further evaluation of acid sulfate soil generation capacity should be undertaken when the design is finalised and likely soil disturbances have been determined. Further contamination assessment is also required to confirm classification for off-site disposal once the types and quantities of soils requiring disposal are better defined.

5.2.11 Project area inspection

An inspection of the Edithvale project area was conducted on 19 April 2017 and 7 June 2017. Table 16 summarises the results of the inspection with respect to CASS and contamination field observations respectively. The rail corridor was inspected from outside the rail corridor for significant potential contamination sources. No buildings were accessed during the inspection.

It should be noted that evidence of soil contamination is not always obvious by visual inspection or desktop review.

Table 16 Edithvale project area inspection observations

Item	Details
Surface coverage	The Edithvale project area comprises the rail corridor with Station Street and Nepean Highway to the east and west, and small sections of adjacent road reserves.
Topography	The Edithvale project area was generally flat within the rail corridor and local area, gradually sloping down to the east and west of the rail corridor.
Drainage	The rail line through the project area forms a ridge with runoff on the east flowing to the Edithvale Wetlands (approximately 1,300 metres from the level crossing) and runoff on the west side flowing to Port Phillip Bay (approximately 200 metres from the level crossing).
Observations	The following observations were made within the Edithvale project area: • the rail corridor ran north-south through the entire length of the project area • Edithvale train station at the western end of Edithvale Road, Edithvale • No field indicators for CASS were observed. The CASS field indicators are detailed in Appendix B The following observations made regarding properties adjacent to the Edithvale project area: • a [redacted] service station was located at [redacted] • a former Edithvale fire station was located at [redacted] and is current being re-built • a car park was located at [redacted] • a mower sales/service centre was located at [redacted] • a car park was located at [redacted] • a former boat storage and potential former service station at [redacted]

Item	Details
	[redacted] • a former service station was present at [redacted] • an upholsterer was located at [redacted] • a potential former service station was located at [redacted], Chelsea • a Goodyear Tyre Centre and former car dealer was located at [redacted] • a dry cleaners was located at [redacted].

5.2.12 Coastal acid sulfate soils assessment

The desktop assessment demonstrated sufficient information to infer the potential presence of acid sulfate soils within the project area. As such, a field assessment was conducted in accordance with IWMP (2009) including EPA publication 655.1 (2009) and CASS BPMG (DSE, 2010) to obtain site specific data to confirm the presence of CASS and allow determination of suitable liming rates (if required). This section presents and discusses findings of the detailed field assessment for acid sulfate soils.

Assessment Criteria

The action criteria define when CASS disturbed at a site will need to be managed. The data for Edithvale was compared against the action criteria given in the CASS BPMG (DSE, 2010). The net acidity[3] criteria of 0.03 percentage sulfur (%S) or 18 moles hydrogen equivalent ions per tonne (mol H+/t) defines whether there is a need to manage the soil as CASS., and is irrespective of soil textures (coarse, medium and fine), the amount of CASS disturbed, and the buffering capacity of the soil. The buffering or acid neutralising capacity is generally excluded in the net acidity calculation for CASS assessment as the laboratory methods used to measure neutralisation capacity are based on the analysis of finely-ground (high surface area) samples. These methods commonly overestimate the effective or actual amount of neutralising (or buffering) capacity that would be available under real field conditions. The guideline also prohibits use of mean or average of a range of net acidity values to describe the CASS characteristics of the whole site. It is noted that soils with existing plus potential acidity below the action criteria may still be CASS, but may not require management.

Data Validation

The data validation was undertaken in accordance with the BPMG and is presented in Appendix H.

The data validation concluded that the data collected during this assessment is considered suitable for the purpose of this assessment.

Soil Assessment Results

Field Observations

The soil lithology observed during drilling of boreholes is presented as borelogs (Appendix I) and is summarised below in Table 17.

[3] Net acidity and other related terms are explained in detail in Section 4.2.1

Table 17 Summary of observed lithology at Edithvale

Depth (mbgs)	Lithology
0-0.2 to 0.7	Fill material consisting of grey brown to dark brown sand and silty material with gravel and rootlets
0.2 to 0.7 - 6.5 to 10.5	SAND, fine to medium, light grey to dark brown
6.5 to 10.5 – 9.5 to 16.5	Interbedded layers of grey to dark brown silty sand, clayey sand and sandy silt, silty clay and clay with occasional ferricrete and/or gravel
9.5 to 16.5 - 22	SAND, fine to coarse, rounded, grey to brown, with silt and clay

A review of the borelogs from previous investigations (Coffey 2017) identified similar lithologies especially at deeper layers greater than20 mbgs.

Small to large broken shells were encountered at almost all the locations at depths ranging between 4.0 mbgs and 16 mbgs. Additionally, a hydrogen sulphide odour which indicates presence of PASS was observed at depths ranging from 8 to 18.5 mbgs. Some hydrocarbon odour was observed at CASS03 at depth of 6-7 mbgs.

Field pH Testing:

Field pH tests were conducted to provide an indication of the likely presence of AASS or PASS horizons. Assessment criteria for the pH_F and pH_{FOX} screening tests to evaluate the possible AASS or PASS occurrence are provided in EPA 655.1 (*Table 2*) and summarised in Section 4.1.1. The results are presented in Table D1 (Appendix C) and summarised below. The complete ALS laboratory reports are provided in Appendix E.

The reaction rates for the majority of samples (approximately 80%) were recorded as one and two indicating lower aggressivity and the presence of low to moderate amount of sulfides. A total of 553 primary samples were analysed for field testing. 155 of the 553 samples (28%), generally associated with deeper (greater than 15 mbgs) natural sand layers, have limited potential to generate net acidity based on the field results. This indicates that negligible or small amounts of oxidisable sulfides are present in these samples, or the sample might be poorly reactive or acid buffering/neutralising components (i.e. carbonates) are present in the soil sample to resist the lowering of the soil pH. Similarly, 27% samples (149 primary samples) where the results indicated absence of CASS or was uncertain. The remaining 45% (249 soil samples), consisting of silty sand, sandy silts, sandy clay and silty clay, returned results indicating presence of existing/actual acidity or AASS (20%) and potential acidity or PASS (25%).

It should be noted that the field pH tests do not provide a quantitative measure of the amount of acid that has been or could be produced through the oxidation process. However, the field pH analysis (Table D1) was used to select samples for detailed laboratory testing to verify the field analysis and to delineate the vertical extent and nature of acid sulfate soils.

Laboratory Testing

Based on the field pH testing, approximately 29% of samples (160 samples) were analysed using the CRS suite to evaluate whether they are likely to generate net acidity, and if so, quantify the maximum amount of existing and potential soil acidity that will require treatment and management if CASS are disturbed. The CRS suite test results are summarised in Table D2 (Appendix C). The complete ALS laboratory reports are provided in Appendix E.

Table 18 below provides a summary of the CRS results for Edithvale and is described in this section.

Table 18 Summary of CRS results – Edithvale

Analyte	No of samples (>LOR)	Min (%S)	Max (%S)
Actual Acidity	10	0.02	0.14
Retained Acidity	1	0.15	0.15
Potential Acidity	113	0.005	1.58
Buffering Capacity	26	0.01	9.37
Net Acidity* (AA + RA + PA)	66	0.02	1.58

LOR – Laboratory Limit of reporting

Actual Acidity

The actual acidity was only encountered in 10 samples out of a total 160 samples selected for further analysis. The TAA concentrations were recorded for samples collected from sandy to silty clay layer (5-10 mbgs) ranging from 0.02 %S (CASS15-5) to 0.14%S (CASS13-10).

Retained Acidity

The pH_{KCl} values were greater than or equal to 4.5 for all samples except for one sample. This indicates that retained acidity was absent in all of the selected soil samples except for ID18-CASS13 at 10 mbgs where 0.15 %S was recorded.

Potential Acidity

Approximately 71% samples (113 of 160 samples selected for further analysis) recorded potential acidity with S_{cr} concentrations ranging between 0.005 %S and 1.18 %S. The S_{Cr} results indicate that the majority of the samples collected across the entire profile (sand and silty clays to clays) are PASS and can produce acidity when disturbed.

Acid Neutralising Capacity (Buffering Capacity)

A total of 26 samples collected from the shallow fill and sand layer (0-2 mbgs) and deeper silty clay to clay layers (8 to 18 mbgs) contained moderate concentrations of buffering capacity ranging from 0.01 %S to 9.37 %S. The ANCBT values for five samples (ID18-CASS03_10.5, ID18-CASS03_13, ID18-CASS04_15, ID18-CASS05_10.5, and ID18-CASS08_15) were higher than their corresponding acid producing potential (i.e. sum of existing and potential acidity). This suggests that these soil horizons contain sufficient amounts of carbonate materials to neutralise and buffer the acidity that could be generated as a result of the oxidation of sulfides within the soil. However the ANC measured in the laboratory (due to sample preparation process) may provide values in excess of buffering capacity which would normally be available from the soil *in-situ*.

Liming rates

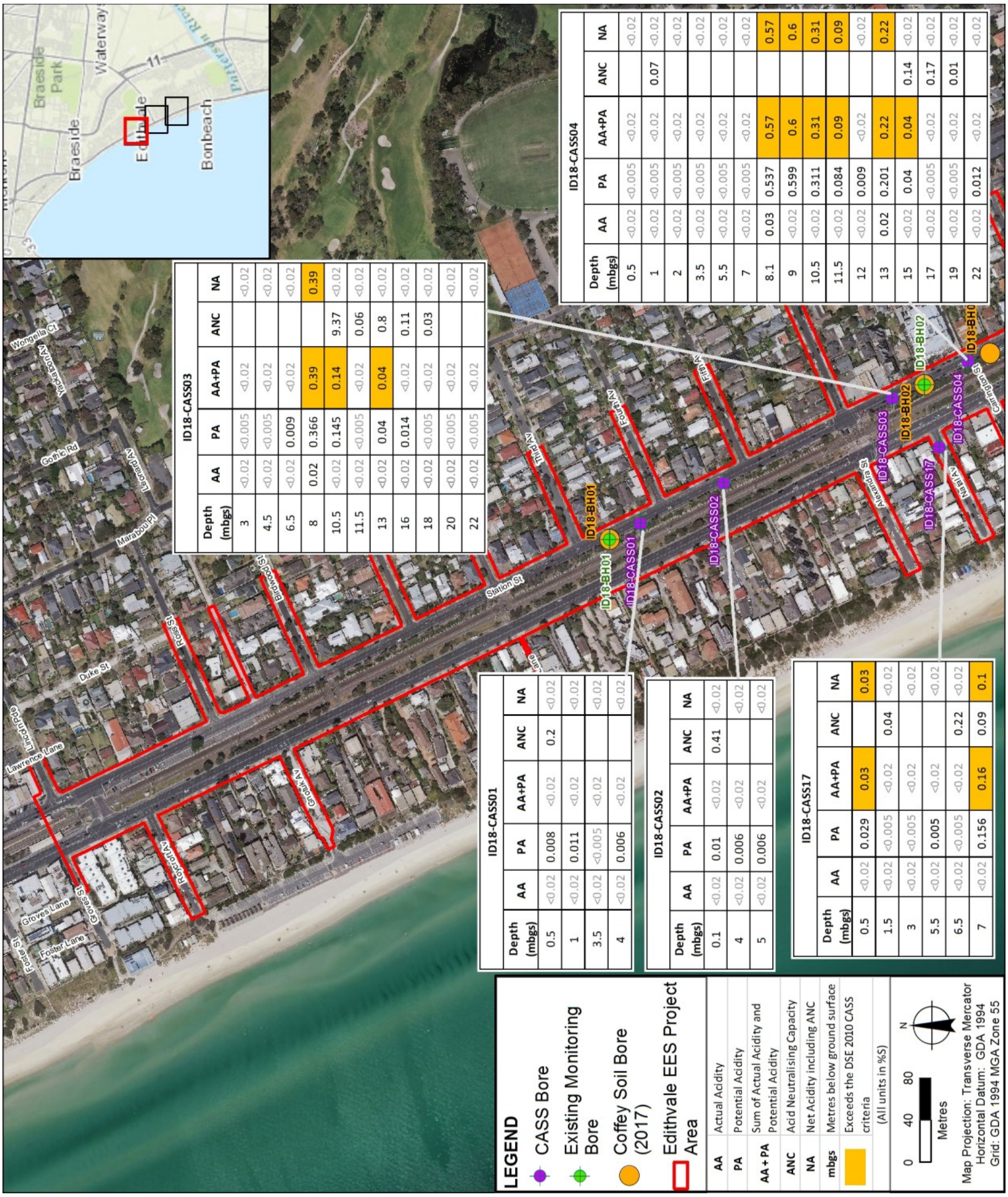
The calculated liming rates (without considering measured ANC for the samples) for treatment of the PASS due to excavation range from 1 kg $CaCO_3$/t to 74 kg $CaCO_3$/t. The maximum liming rate (74 kg CaCO3/t) was calculated for samples collected at ID18-CASS12 at depth of 10 mbgs. These liming rates are based on the NV for aglime of 1.00 (i.e. 100%) and need to be adjusted based on the neutralising value of the product being used for treatment. The method of lime application (in-situ or ex-situ) will depend on the spoil management techniques (discussed later in Section 7) during construction.

Summary

A comparison of net acidity values (excluding ANC, in accordance with the BPMG) with the adopted action criteria showed that 53 of 160 samples (approximately 33%) exceeded the action criteria for CASS management (DSE, 2010). The net acidity of majority of the samples exceeded the DSE, 2010 criteria due to raised potential acidity values. Actual acidity exceeding the criteria was recorded for only two samples collected at ID18-CASS09 at 5.0 mbgs (0.03%S), and ID18-CASS12 at 5.0 mbgs (0.08%S) where the retained acidity and potential acidity values were recorded less than the laboratory limits of reporting. This implies that the acidity in this sample is potentially not due to oxidation of sulfides, but may be from other sources like presence of organic matter. A summary of existing conditions at the Edithvale project area is provided in Section 6.1.These exceedances are presented in Figure 7 and are summarised below in Table 19.

Table 19 Summary of net acidity exceedances -Edithvale

Borehole ID	Range of Net Acidity (excluding ANC) %S		Depths where samples collected (mbgs)	
	Minimum	Maximum	From	To
ID18-CASS01	*<0.02*	*<0.02*	*No exceedances noted*	
ID18-CASS02	*<0.02*	*<0.02*	*No exceedances noted*	
ID18-CASS03	0.04	0.39	8	13
ID18-CASS04	0.04	0.57	8.1	15
ID18-CASS05	0.06	0.38	7	14.5
ID18-CASS06	0.04	0.14	5, 8	15
ID18-CASS07	0.11	0.19	9	14.5
ID18-CASS08	0.03	0.12	6	15
ID18-CASS09	0.03	1.01	7	14
ID18-CASS10	0.1	0.1	8	14
ID18-CASS11	0.06	1.18	10	14
ID18-CASS12	0.08	1.58	10	14
ID18-CASS13	0.88	0.88	10	
ID18-CASS14	*<0.02*	*<0.02*	*No exceedances noted*	
ID18-CASS15	*<0.02*	0.02	*No exceedances noted*	
ID18-CASS16	*<0.02*	*<0.02*	*No exceedances noted*	
ID18-CASS17	0.03	0.16	0.5 and 7 respectively	
ID18-CASS18	0.06	0.12	4	5.5
ID18-CASS19	0.05	0.05	5.5	6
ID18-CASS20	*<0.02*	*<0.02*	*No exceedances noted*	



ID18-CASS01					
Depth (mbgs)	AA	PA	AA+PA	ANC	NA
0.5	<0.02	0.008	<0.02	0.2	<0.02
1	<0.02	0.011	<0.02		<0.02
3.5	<0.02	<0.005	<0.02		<0.02
4	<0.02	0.006	<0.02		<0.02

ID18-CASS02					
Depth (mbgs)	AA	PA	AA+PA	ANC	NA
0.1	<0.02	0.01	<0.02	0.41	<0.02
4	<0.02	0.006	<0.02		<0.02
5	<0.02	0.006	<0.02		<0.02

ID18-CASS17					
Depth (mbgs)	AA	PA	AA+PA	ANC	NA
0.5	<0.02	0.029	0.03		0.03
1.5	<0.02	<0.005	<0.02	0.04	<0.02
3	<0.02	<0.005	<0.02		<0.02
5.5	<0.02	0.005	<0.02		<0.02
6.5	<0.02	<0.005	<0.02	0.22	<0.02
7	<0.02	0.156	0.16	0.09	0.1

ID18-CASS03					
Depth (mbgs)	AA	PA	AA+PA	ANC	NA
3	<0.02	<0.005	<0.02		<0.02
4.5	<0.02	<0.005	<0.02		<0.02
6.5	<0.02	0.009	<0.02		<0.02
8	0.02	0.366	0.39		0.39
10.5	<0.02	0.145	0.14	9.37	<0.02
11.5	<0.02	<0.005	<0.02	0.06	<0.02
13	<0.02	0.04	0.04	0.8	<0.02
16	<0.02	0.014	<0.02	0.11	<0.02
18	<0.02	<0.005	<0.02	0.03	<0.02
20	<0.02	<0.005	<0.02		<0.02
22	<0.02	<0.005	<0.02		<0.02

ID18-CASS04					
Depth (mbgs)	AA	PA	AA+PA	ANC	NA
0.5	<0.02	<0.005	<0.02		<0.02
1	<0.02	<0.005	<0.02	0.07	<0.02
2	<0.02	<0.005	<0.02		<0.02
3.5	<0.02	<0.005	<0.02		<0.02
5.5	<0.02	<0.005	<0.02		<0.02
7	<0.02	<0.005	<0.02		<0.02
8.1	0.03	0.537	0.57		0.57
9	<0.02	0.599	0.6		0.6
10.5	<0.02	0.311	0.31		0.31
11.5	<0.02	0.084	0.09		0.09
12	<0.02	0.009	<0.02		<0.02
13	0.02	0.201	0.22		0.22
15	<0.02	0.04	0.04	0.14	<0.02
17	<0.02	<0.005	<0.02	0.17	<0.02
19	<0.02	<0.005	<0.02	0.01	<0.02
22	<0.02	0.012	<0.02		<0.02

Figure 7 Edithvale CASS Soil and Groundwater results (Page 1 of 3)

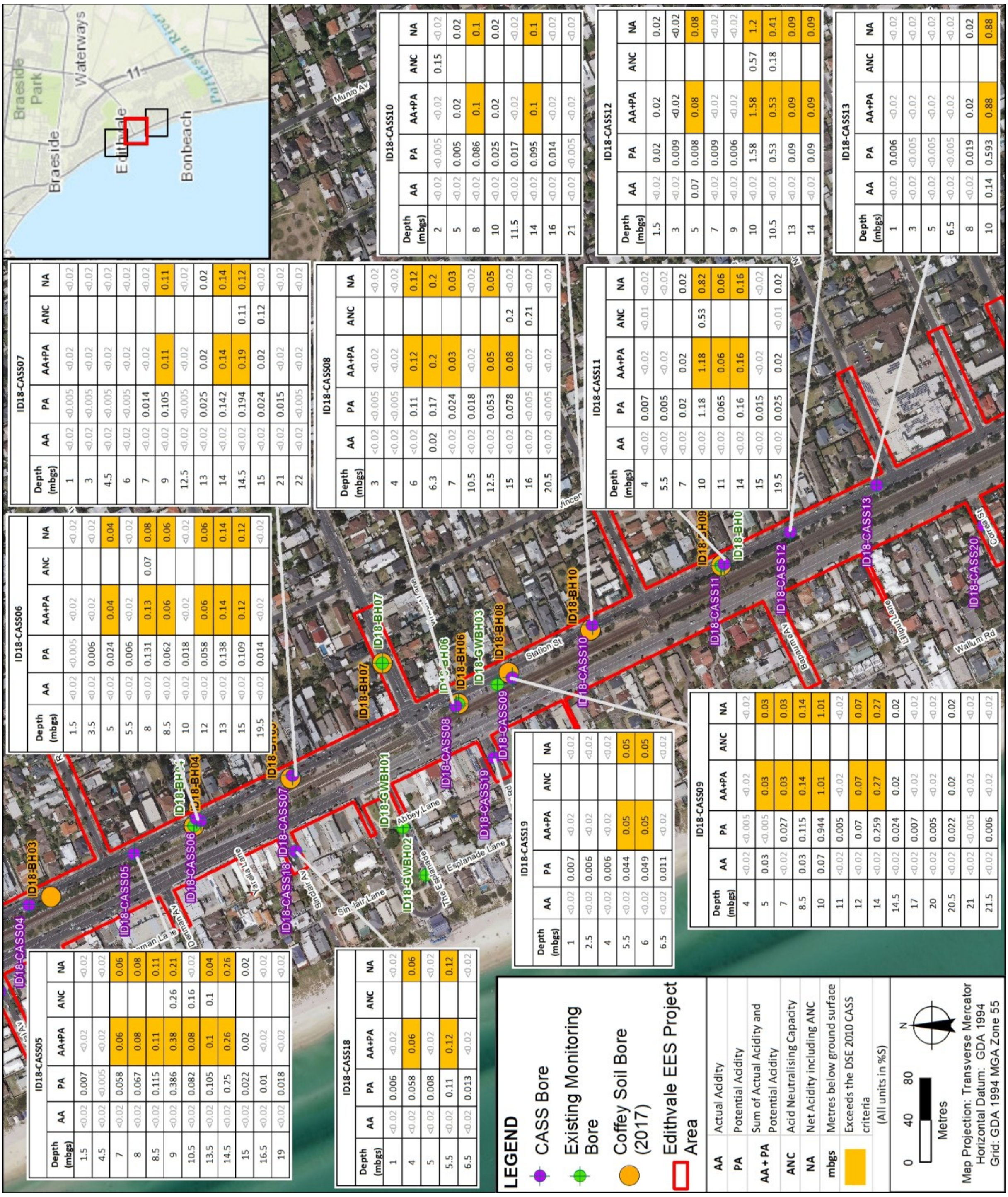


Figure 7 Edithvale CASS Soil and Groundwater results (Page 2 of 3)

Figure 7 Edithvale CASS Soil and Groundwater results (Page 3 of 3)

5.2.13 CASS groundwater assessment

The Stage C groundwater field chemistry measurements and the laboratory results are provided in Table D3 and Table D4 (Appendix C) respectively. A brief summary of the results is provided below:

Assessment Criteria

The groundwater field and laboratory results were compared with the CASS specific criteria given in CASS BPMG (2010) to indicate presence of AASS and Department of Environment Regulation (DER), 2015, Western Australia, *Treatment and management of soil and water in acid sulfate soil landscapes*, The adopted criteria are given below:

- pH – Groundwater pH <5.0
- Dissolved Mass-based chloride sulfate ration ($Cl:SO_4$) <4.0
- Total alkalinity and sulfate ratio ($ALK:SO_4$) <5. As per DER (2015), the chloride to sulfate ratio has little relevance in a freshwater groundwater environment. As the '*Quarternery aquifer'* was inferred to be fresh, this ratio was also taken into account to analyse for any existing acidity.

In addition, the other criteria used for data analysis as given in the DER (2015) guidelines include:

- A soluble aluminium concentration greater than 1 mg/L; and
- Total Alkalinity threshold values dependant on pH as given in *Table 5* of DER 2015 guidelines:
    - >180 mg/L with pH >6.54
    - 60-80 mg/L with pH >6.0
    - 30-60 mg/L with pH ranging between 5.5-7.5

Groundwater Levels

Based on the screening and total depths of the monitoring wells, the groundwater was described as two different aquifers:

- Quaternary – The groundwater wells selected for the shallow aquifer included ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH09, ID18-GWBH01, ID18-GWBH03 and ID18-GWBH04. The standing water level (SWL) of the groundwater for '*Quaternary Aquife*r' was measured ranging between 1.03 mbgs (ID18-GWBH04) and 5.73 mbgs (ID18-BH02). The water levels relative to the elevation ranged from 0.68 mAHD (ID18-GWBH01) to 1.30 mAHD (ID18-GWBH04).
- Upper Tertiary Aquifer – The groundwater wells selected for the deep aquifer include ID18-BH06, ID18-BH07, ID18-GWBH02 and ID18-GWBH05. The SWL of the groundwater for '*Upper Tertiary Aquifer'* was measured ranging between 1.31 mbgs (ID18-GWBH05) to 5.85 mbgs (ID18-BH06) and 0.56 mAHD (ID18-GWBH02) to 1.07 mAHD (ID18-GWBH05)

The water levels indicated that the groundwater in and around the Edithvale project area flowed in a westerly direction towards Port Phillip Bay

Field Chemistry

For the samples collected from Quaternary Aquifer, the pH ranged from 5.01 (ID18-GWBH03) to 7.36 (ID18-BH04) indicating that the groundwater is acidic to near neutral (Table D3, Appendix C). The electrical conductivity (EC) was measured ranging from 307 microsiemens per centimetre (µS/cm) (ID18-BH9) to 731 µS/cm (ID18-BH02) indicating that the groundwater in shallow aquifer is fresh to slightly saline. The dissolved oxygen values ranged from 0.40 to 5.31 parts per million (ppm). The reduction potential of the groundwater was recorded ranging between 53 to 285 milli Volts (mV). This indicates that the groundwater has reducing to slightly oxidizing potential.

For '*Upper Tertiary Aquifer*' samples, the pH ranged from 7.00 (ID18-BH06) to 8.52 (ID18-GWBH02) indicating that the groundwater is neutral to alkaline. The EC of the samples was measured ranging from 2,544 µS/cm (ID18-GWBH05) to 21,653 µS/cm (ID18-BH02) indicating that the groundwater in the deeper aquifer is saline to highly salineThe dissolved oxygen values ranged from 0.30 to 2.92 ppm. The reduction potential of the groundwater was recorded ranging between -62 to 116 mV. This indicates that the groundwater has reducing potential.

Laboratory Analytical Results

The analytical results and analytes specific for CASS assessment as detailed in Section 4.1.1 are provided in Table D4 (Appendix C) and the results are summarised below (Table 21).

Quaternary Aquifer

A total of 15 samples were collected from seven wells during the various sampling events in 2016 - 2017.

Table 20 Summary of laboratory analysis for groundwater samples – Quaternary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
TDS	220	755	359	2	ADWG (2015) Aesthetic (600 mg/L)
Sodium	17	116	43	-	
Chloride (Cl)	34	110	56	-	
Sulfate (SO_4)	13	95	37	-	
Cl:SO_4 Ratio	1	3	2	15	DSE 2010 value of 4
Total Acidity	11	40	28	NA	
Total Alkalinity	38	222	123	NA	
Alkalinity: SO_4 Ratio	1	11	5	9	DER 2015 value of 5

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
Soluble Aluminium	0.07	0.91		-	DER 2015 value of 1 mg/L
Ammonia	0.04	2.15	0.75	5	ANZECC (2000), 95% Fresh water (0.9 mg/L)
Total Nitrogen	1.1	7.4	2.6	1	ANZECC (2000) Irrigation Long term trigger levels (5 mg/L and 0.05 mg/L)
Total Phosphorus	0.23	0.58	0.4	4	

NA – Not Applicable

Laboratory measured total dissolved solids concentrations from the a total of 15 samples collected from the '*Quaternary Aquifer*' corresponded with EC measurements recorded in the field, ranging from 220 milligram per litre (mg/L) (ID18-GWBH01) to 755 mg/L (ID18-BH09). Two samples exceeded the adopted criteria.

For these 15 samples, sodium was the major cation measured with concentrations ranging from 17 mg/L to 116 mg/L. Similarly chloride and sulfate concentrations were measured ranging from 34 mg/L to 110 mg/L and 13 mg/L and 95 mg/L respectively.

The Total Acidity (as $CaCO_3$) was recorded for seven samples collected in the July sampling round and ranged between 11 mg/L and 40 mg/L with the average value of 28 mg/L. The Total Alkalinity was measured for all 15 samples across the three sampling rounds and ranged between <20 mg/L and 222 mg/L with an average total alkalinity value of 123 mg/L. As per '*Table 5' given in Treatment and management of soil and water in acid sulfate soil landscapes, Department of Environment Regulation* (DER), 2015, the Total Alkalinity values > 60 mg/L combined with pH > 6.0 are generally adequate to maintain acceptable pH level in the future. All the samples recorded Total Alkalinity values higher than 60 mg/L except for the samples at ID18-GWBH03 and ID18-BH09 collected in July 2017.

The calculated chloride to sulfate ratio was below 4 (DSE, 2010) for the 15 groundwater samples collected from '*Quaternary Aquifer*' indicating presence of actual acidity in the shallow aquifer due to presence of AASS. The chloride to sulfate ratio is less reliable in the fresh water scenario, hence the alkalinity to sulfate ratio was also calculated. The calculated alkalinity to sulfate ratio for these 15 samples ranged from 1 to 11 indicating presence of existing acidity at select locations (ID18-BH01, ID18-BH02, ID18-BH09 and ID18-GWBH03) where the ratio was below 5 as per DER 2015 guidelines. The ratio stayed the same for the two sampling rounds in December 2016 and July 2017 for all the samples except for ID18-BH09 where the ratio decreased from 7 to 2 respectively. This may be attributed to the seasonal variation at this location.

The soluble or dissolved aluminium measured for the seven samples collected in July 2017 ranged from 0.07 mg/l to 0.91 mg/L. All the values were below the concentration of 1 mg/L (DER, 2015) indicating absence of existing acidity. It is pertinent to note that whilst no groundwater sample had a pH <5, dissolved aluminium is prevalent in all samples of the shallow aquifer. This may indicate an issue with filtration practices prior to acid preservation (possibly due to turbid samples). Alternatively, it indicates presence of micro-colloids (i.e. <0.45 µm) containing aluminium.

As per DER (2015) guidelines, increased levels of sulfate relative to chloride and alkalinity, combined with low pH and high concentrations of iron and aluminium, are indicative of the oxidation of PASS. For the shallow aquifer at Edithvale, the alkalinity to sulfate ratio indicate presence of actual acidity, however the pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicates that the groundwater has sufficient buffering capacity to neutralise any acidity being produced.

Five samples of 15 total samples exceeded the ANZECC (2000) 95% Fresh water criteria for ammonia.

Total nitrogen and total phosphorus was exceeded in one and four samples respectively in 15 samples for ANZECC (2000) long term irrigation trigger levels.

Upper Tertiary Aquifer

A total of seven samples were collected for the four wells during various sampling events in 2016 - 2017. Table 21 below provides a summary of laboratory analysis for groundwater samples for the Upper Tertiary Aquifer.

Table 21 Summary of laboratory analysis for groundwater samples for the Upper Tertiary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
TDS	1300	12000	4296	7 and 2	ADWG (2015) Aesthetic (600 mg/L) ANZECC 2000 Stock watering
Sodium	400	4400	1554	7	ADWG (2015) Aesthetic (180 mg/L)
Chloride (Cl)	510	6300	2211	7	ADWG (2015) Aesthetic (250 mg/L)
Sulfate (SO_4)	106	1200	374	2	ADWG (2015) Aesthetic (250 mg/L) ANZECC 2000 Stock watering
Cl:SO_4 Ratio	5	102	21	-	
Total Acidity	<10	42	28	NA	-
Total Alkalinity	69	560	390	NA	-

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
Alkalinity: SO_4 Ratio	0.1	92	15	6	DER 2015 value of <5
Soluble Aluminium	<0.05	<0.05	<0.05	-	
Ammonia	0.54	3.0	1.32	5	ANZECC (2000), 95% Fresh water (0.9 mg/L)
Total Nitrogen	1.6	4.1	2.7	-	
Total Phosphorus	0.23	0.58	0.4	4	ANZECC (2000) Irrigation Long term trigger levels 0.05 mg/L and 1 mg/L respectively
Fluoride	0.8	1.1	0.9	1	

NA – Not applicable

The seven samples collected from the Upper Tertiary Aquifer returned total dissolved solids ranging from 1,300 milligram per litre (mg/L) (ID18-GWBH05) to 12,000 mg/L (ID18-GWBH02). All the seven samples exceeded the ADWG (2015) for aesthetic beneficial use.

For the seven samples, sodium and chloride were the major ions measured with concentrations ranging from 400 mg/L to 4400 mg/L and 510 mg/L to 6300 mg/L respectively. All the seven samples exceeded the adopted criteria for ADWG (2015) for aesthetic beneficial use for sodium and chloride. Similarly sulfate concentrations were measured ranging from 106 mg/L and 1200 mg/L and three samples exceeded the ADWG (2015) for aesthetic and health beneficial use.

The Total acidity (as $CaCO_3$) was recorded for four samples collected in the July sampling round and ranged between less than 10 mg/L and 42 mg/L with the average value of 28 mg/L. The Total Alkalinity was measured for all seven samples across the three sampling rounds and ranged between 69 mg/L and 560 mg/L with an average total alkalinity value of 390 mg/L indicating that the groundwater in the deeper aquifer is generally adequate to maintain acceptable pH levels in the future.

The calculated chloride to sulfate ratio was greater than 4 (DSE, 2010) for the seven groundwater samples collected from Upper Tertiary Aquifer indicating absence of actual acidity in the deeper aquifer

The soluble aluminium measured for the seven samples collected in July 2017 was below laboratory limit of reporting (LOR) for all the samples indicating the absence of existing acidity.

Five of the seven samples exceeded the ANZECC (2000) 95% fresh water criteria for ammonia.

Total phosphorus and fluoride was exceeded in four and one sample respectively from seven samples for ANZECC (2000) long term irrigation trigger levels.

5.2.14 Indicative soil contamination assessment

Soil samples obtained during the CASS Stage B: Detailed site soil sampling program and assessment (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of soils within the Edithvale project area.

Soil bores ID18_CASS04 and ID18_CASS21 were located in the project area targeting the former Edithvale fire station. Select soil samples collected from soil bores ID18_CASS04 and ID18_CASS21 were analysed for PFAS to assess the potential for soil contamination from the historical use and storage of PFAS at the former fire station.

The results of the soil sampling program are discussed in the following sections, and have been compared to the adopted investigation levels for disposal threshold values outlined below. The sampling program was not designed to provide characterisation of soils for disposal purposes.

Assessment criteria

The EPA Industrial Waste Resource Guidelines Publication IWRG 621 (2009) criteria were adopted to assess the soil contamination status of the Edithvale project area. A detailed explanation of the IWRG 621 criteria is provided in Appendix A.

Results of investigation

Edithvale analytical results

The tabulated analytical results of soil samples obtained and analysed from the Edithvale project area are provided in Appendix C (Tables D5 to Table D7).

PFAS

Concentrations of PFASs detected in the Edithvale project area are summarised in Table 22.

Table 22 Summary of detectable PFASs

Investigation level	PFHxS (mg/kg)	PFOA (mg/kg)	PFOS (mg/kg)
PFAS NEMP 2017 – Soil health based screening level: Residential	0.009	0.1	0.009
PFAS NEMP 2017 – Soil health based screening level: Industrial/Commercial	20	100	20
PFAS NEMP 2017 – Soil health based screening level: Urban residential/Public open spaces	-	29	32
ID18CASS05_1.5	0.0006	0.0003	0.0015
ID18CASS06_1	0.0003	0.0002	0.0003
ID18CASS06_1.5	0.0005	0.0002	0.0006

Concentrations of PFAS in all samples analysed were below the adopted health based screening levels.

Detectable concentrations of PFHxS, PFOA and PFOS were reported in soil samples obtained in the vicinity for the former Edithvale fire station located at 206 Station Street, Edithvale.

Further soil sampling and analysis would be required to understand the full vertical and horizontal extent of the PFAS contamination, in particular in the vicinity of samples included in Table 22.

Concentrations of all other PFASs tested for were below the laboratory detection limits.

Leachability testing was not undertaken for PFAS on the soil samples.

Environmental soil results and categorisation

The results of the soil sampling program were compared to the threshold concentrations listed in Table 2 of EPA Publication IWRG 621. A summary of analytical elevated results presented in Table 23. All other analytes were reported below the maximum threshold limits for fill material.

Table 23 Summary of elevated results in the Edithvale project area

Investigation Level	Lead (mg/kg)	Benzo(a)pyrene (mg/kg)
EPA Publication IWRG 621 Fill Material upper limit	300	1
ID18CASS02_0.1	307	0.5
ID18CASS16_0.3	<0.1	1.9

Leachate results

Based on the results of the primary laboratory analysis, leachate analysis was requested on 10 samples with reported total concentrations greater than 20 times the Category C leachable concentration upper limits listed in Table 2 of EPA Publication IWRG 621 for lead and/or benzo(a)pyrene.

All leachable results were reported as either below the adopted threshold concentrations listed in Table 2 of EPA Publication IWRG 621 or the laboratory detection limits, indicating that lead and benzo(a)pyrene in the soil samples analysed had limited mobility. As such, soil samples ID18CASS02_0.1 and ID18CASS16_0.3 would be classified as **Category C contaminated soil**. It is noted that these samples were all collected from anthropogenic fill material.

Results of the leachate analysis are presented in Appendix C and tabulated in Table D7.

5.2.15 Groundwater contamination assessment

Groundwater samples obtained during the CASS Stage C: Surface water/groundwater assessment sampling program (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of groundwater within the Edithvale project area.

Groundwater samples collected from bores ID18_BH02 and ID18_BH04 (located down gradient or cross gradient from the former Edithvale fire station) were also analysed for PFAS to assess the potential for groundwater contamination from the historical use and storage of PFAS at the former Edithvale fire station.

The groundwater sample analytical program is outlined in Appendix C. The results of the groundwater sampling program are discussed below, and have been compared to the adopted investigation levels for relevant beneficial uses outlined below.

Assessment criteria

For the purposes of this assessment, the adopted groundwater beneficial uses have been assessed against Segment A1 (refer to Appendix J). The protected beneficial uses of Segment A1 are:

- Maintenance of ecosystems
- Potable water supply: Desirable
- Potable mineral water supply
- Agriculture, parks & gardens
- Stock watering
- Industrial water use
- Primary contact recreation
- Buildings and structures

The following criteria were adopted to assess the groundwater contamination status of the project areas:

- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Aquatic Ecosystems) – Maintenance of freshwater ecosystems (95%) criteria
- PFAS National Environment Management Plan Consultation Draft (2017) - interim/draft criteria for PFAS for slightly to moderately modified aquatic ecosystems (95% species protection)
- ADWG (2015) Australian Drinking Water Guidelines – health and aesthetic criteria
- PFAS National Environment Management Plan Consultation Draft (2017) - interim/draft health based criteria for PFAS in drinking water.
- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Primary Industries) – Investigation levels for long and short term irrigation
- ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, investigation levels for Primary Industries (Chapter 4.3 Livestock drinking water quality)
- NHMRC (2008) Guidelines for Managing Risks in Recreational Water.

Edithvale analytical results

The tabulated analytical results of groundwater samples included in the Stage C: Surface water/groundwater assessment sampling program (refer to Section 4.1.1) from the Edithvale project area are provided in Appendix C (Tables D10 and D11).

The results of the groundwater sampling program are summarised below.

Quaternary Aquifer

A number of metals (aluminium, arsenic, chromium (III + IV), iron, manganese, nickel and zinc) concentrations exceeded the adopted site investigation levels, as outlined below in Table 24.

Table 24 Summary of inorganic exceedances – Quaternary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
Aluminium (Total)	0.13	5.3	2.53	7	ADWG (2015) Aesthetic (0.2 mg/L) ANZECC (2000) 95% Fresh water (0.055 mg/L) ANZECC (2000) Irrigation long term trigger levels (5 mg/L)
Aluminium (Filtered)	0.07	0.91	0.41	7	ADWG (2015) Aesthetic (0.2 mg/L) ANZECC (2000) 95% Fresh water (0.055 mg/L)
Arsenic (Filtered)	0.002	0.043	0.013	4	ADWG (2015) Health (0.01 mg/L) ANZECC (2000) 95% Fresh water (0.013 mg/L)
Chromium (III+VI) (Filtered)	0.001	0.01	0.003125	7	ANZECC (2000) 95% Fresh water (0.001 mg/L)
Iron (Total)	2.8	25	9.1	7	ADWG (2015) Aesthetic (0.3 mg/L) ANZECC (2000) Irrigation short term trigger levels irrigation (10 mg/L)
Iron (Filtered)	0.3	14	2.9	7	
Manganese (Filtered)	0.021	0.228	0.06	1	ANZECC (2000) Irrigation long term trigger levels irrigation (10 mg/L)
Nickel (Filtered)	0.002	0.028	0.009	6	ADWG (2015) Health (0.02 mg/L) ANZECC (2000) 95% Fresh water (0.011 mg/L)
Zinc (Filtered)	0.005	0.6	0.06	9	ANZECC (2000) 95% Fresh water (0.008

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
					mg/L)

Upper Tertiary Aquifer

A number of metals (aluminium, arsenic, boron, iron, nickel and zinc) concentrations exceeded the adopted site investigation levels, as outlined below in Table 25.

Table 25 Summary of inorganic exceedances – Upper Tertiary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of exceedances	Criteria exceeded
Aluminium (Total)	0.08	1.1	0.59	2	ADWG (2015) Aesthetic (0.2 mg/L) ANZECC (2000) 95% Fresh water (0.055 mg/L)
Arsenic (Filtered)	0.002	0.032	0.008	1	ANZECC (2000) 95% Fresh water (0.013mg/L)
Boron (Filtered)	0.46	0.84	0.65	3	ANZECC (2000) 95% Fresh water (0.37 mg/L) ANZECC (2000) Irrigation long term trigger levels irrigation (0.5 mg/L)
Iron (Total)	0.12	3.6	2.3	3	ADWG (2015) Aesthetic (0.3 mg/L)
Iron (Filtered)	0.84	3.1	1.85	3	
Nickel (Filtered)	0.004	0.027	0.012	2	ADWG (2015) Health (0.02 mg/L) ANZECC (2000) 95% Fresh water (0.011 mg/L)
Zinc (Filtered)	0.005	0.074	0.039	3	ANZECC (2000) 95% Fresh water (0.008 mg/L)

PFAS

Concentrations of PFHxS+PFOS and PFOS were reported above the PFAS NEMP 2017 freshwater ecosystem or the PFAS NEMP 2017 Drinking water (health) in groundwater samples obtained in the vicinity for the former Edithvale fire station located at 206 Station Street, Edithvale.

Detectable concentrations of PFHxS, 6:2 FTS, PFOA and PFHxA were reported in groundwater samples obtained in the vicinity for the former Edithvale fire station located at 206 Station Street, Edithvale.

Concentrations of all other PFASs tested for were below the laboratory detection limits.

Concentrations of PFASs detected in the Edithvale project area are summarised in Table 26.

Table 26 Summary of detectable PFASs

Sample ID	PFHxS+PFOS (µg/L)	PFHxS(µg/L)	6:2 FTS (µg/L)	PFOA (µg/L)	PFHxA (µg/L)	PFOS (µg/L)
PFAS NEMP 2017 Ecological freshwater 95% protection	-	-	-	220	-	0.13
PFAS NEMP 2017 Drinking water (health)	0.07	-	-	0.56	-	-
ID18-BH02	0.14	0.07	<0.05	0.03	0.02	0.07
ID18-BH04	0.07	0.04	0.13	<0.01	<0.02	0.66

A detailed groundwater assessment is required to determine if a PFAS plume exists within the Edithvale level crossing removal construction footprint in the vicinity of the former Edithvale fire station.

Organic compounds

Five samples were analysed for organic compounds including TRH, BTEX, PAH, phenols, OC OP pesticides and other volatile organic compounds. All the analytes were reported below laboratory limit of reporting for all the samples except for ID18-BH09 collected in December 2016 where 3&4 methylphenol and phenol was detected with concentration of 72.4 µg/L and 1.4 µg/L. However the sample collected from ID18-BH09 in June 2017 recorded these analytes below LOR. ID18-BH09 was located in the vicinity for the former boat storage facility located at 279 and 280 Nepean Highway, Edithvale.

Assessment of beneficial uses

Maintenance of ecosystems

All concentrations reported in filtered samples were found to be within ANZECC (2000) Maintenance of Ecosystems FW 95% guidelines for slightly to moderately modified aquatic ecosystems with the exception of:

- Ammonia as N (ID18-BH02, ID18-BH04 and ID18-GWBH04), aluminium (ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH09, ID18-GWBH01, ID18-GWBH03, ID18-GWBH04), arsenic (ID18-BH09), chromium (III+VI) (ID18-BH04, ID18-BH09 and ID18-GWBH04), nickel (ID18-BH01, ID18-BH02, ID18-BH04, ID18-GWBH01, ID18-GWBH03 and ID18-GWBH04) and zinc (ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH09, ID18-GWBH01, ID18-GWHB03 and ID18-GWBH04) concentrations in the Quaternary aquifer

- Ammonia as N (ID18-BH06, ID18-BH07, ID18-GWBH02 and ID18-GWBH05), arsenic (ID18-GWBH02), boron (ID18-BH06, ID18-BH07), nickel (ID18-BH06) and zinc (ID18-BH06, ID18-GWBH05) concentrations in the Upper Tertiary aquifer.

Potable water supply

All concentrations reported in filtered samples were found to be within ADWG (2015) Health guidelines, with the exception of:

- Arsenic (ID18-BH01, ID18-BH09) and nickel (ID18-GWBH03) concentrations in the Quaternary aquifer
- Sulphate (ID18-BHGW02), arsenic (ID18-GWBH02), boron (ID18-BH06 and ID18-BH07) and nickel (ID18-BH06) concentrations in the Upper Tertiary aquifer

All concentrations reported in filtered samples were found to be within ADWG (2015) Aesthetic guidelines, with the exception of:

- Total dissolved solids (ID18-BH04 and ID18-BH09), aluminium (ID18-BH04, ID18-BH09, ID18-GWBH03 and ID18-GWBH04), iron (ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH09, ID18-GWBH01, ID18-GWBH03 and ID18-GWBH04) and manganese (ID18-BH09) concentrations in the Quaternary aquifer
- Total dissolved solids (ID18-BH06, ID18-BH07, ID18-GWBH02 and ID18-GWBH05), sulphate (ID18-BH07), iron (ID18-BH06, ID18-BH07 and ID18GWBH05) concentrations in the Upper Tertiary aquifer

Agriculture, parks & gardens

All concentrations reported in filtered samples were found to be within ANZECC (2000) Irrigation – Long-term Trigger Values guidelines, with the exception of:

- Nitrogen (ID18-GWBH03), phosphorus (Total) (ID18-BH01, ID18-BH02, ID18-BH04 and ID18-BH09), iron (ID18-BH01, ID18-BH02, ID18-BH04, ID18-BH09, ID18-GWBH01, ID18-GWBH03 and ID18-GWBH04) and manganese (ID18-BH09) concentrations in the Quaternary aquifer
- Fluoride (ID18-BH07), Phosphorus (Total) (ID18-BH06, ID18-BH07), boron (ID18-BH06 and ID18-BH07) and iron (ID18-BH06 and ID18-BH07) concentrations in the Upper Tertiary aquifer

All concentrations reported in filtered samples were found to be within ANZECC (2000) Irrigation – Short-term Trigger Values guidelines, with the exception of:

- Iron (ID18-BH09) concentrations in the Quaternary aquifer

Stock watering

All concentrations from filtered samples were found to be within ANZECC (2000) Stock Watering guidelines, with the exception of:

- Sulphate (ID18-GWBH02) and sulphate as S (ID18-GWBH02) concentrations in the Upper Tertiary aquifer

Primary contact recreation

All concentrations reported in filtered samples were found to be within the adopted NHMRC 2008 guidelines for recreational waters (health).

Buildings and structures

As specified in the SEPP GoV, contamination must not cause groundwater to become corrosive or adversely affect the structural integrity or building materials or structures.

A summary of existing conditions at the Edithvale project area is provided in Section 6.1.

5.3 Bonbeach

5.3.1 Bonbeach project area description

The Bonbeach project area is located approximately 34 kilometres south east of Melbourne on the Frankston railway line between Chelsea Station and Patterson River and is within the City of Kingston (Figure 2). Further details are provided in Table 27 below.

Table 27 Bonbeach project area details

Item	Details
Location	Refer to Figure 2
Current land use	Rail and road
Municipality	City of Kingston
Current zoning of project area	Public Use Zone - Schedule 4 (Transport) Road Zone – Category 1 Road Zone – Category 2 General Residential Zone – Schedule 2 General Residential Zone – Schedule 3
Planning overlays	The northern portion of the project area is subject to a heritage overlay. The southern portion of the project area is within, or affected by, one or more areas of cultural heritage sensitivity.
Surrounding land use	North: General Residential, Commercial and Public Use - Transport South: General Residential, Commercial, and Public Park and Recreation East: General Residential, Public Use - Transport and Commercial West: General Residential and Commercial
Closest surface water body	Patterson River is located 5 metres south of the project area and Port Phillip Bay is situated approximately 150 metres west of the project area.

5.3.2 Bonbeach historical aerial photographs

Historical aerial photographs of the Bonbeach project area and surrounding area (refer to 5.2.2) were reviewed for the period 1945 to 2016. A copy of the aerial photographs are provided in 0 and summarised in Table 28 below.

Table 28 Review of historical aerial photographs

Photograph	Observations
Date: Dec 1945 Run: 5, 6, 7 Photo: 64771, 64772, 64766, 64768, 64769, 64793, 64815 Project: 5 - Melbourne and Metropolitan Area	**Bonbeach project area** The rail alignment was present in a north – south direction along the centre of the Bonbeach project area. Station Street and Nepean Highway were visible parallel to the rail track to the east and west respectively. Chelsea Station was observed in the northern portion of the project area. A small building was noted to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area). The Argyle Avenue level crossing was visible in the northern portion of the project area. Bonbeach Station and Bondi Road level crossing were visible in the central portion of the project area. Apparent vegetation (low lying trees, shrubs and grasses) was visible to the east and west of the majority of the rail alignment. **Surrounds** The project area surrounds were observed to be predominantly residential. Possible commercial/industrial development was noted to the west along Nepean Highway in the vicinity of Chelsea Station, Wimborne Avenue (northern portion of project area) and Newberry Avenue (central portion of project area). Extensive earthworks were noted to the east of the southern portion of the project area. Patterson River golf course and the land east of the southern portion of the project area appeared to have been used primarily for agriculture/farming. Patterson River golf course and vegetated sand dunes were present east of the southern portion of the project area. Port Phillip Bay was visible to the west and Patterson River to the south.
Date: Dec 1957 Run: 22, 23 Film: 977, 978 Photo: 69, 75 Project: Metropolitan Base Map Project	**Bonbeach project area** The project area was relatively unchanged. A building (possible substation) had been constructed to the west on the rail track near the intersection of Wimborne Avenue and Nepean Highway (northern portion of project area). **Surrounds** Further residential development had occurred to the east of the project area, in particular in the region of extensive earthworks noted in the 1945 image to the east of the southern portion of the project area.
Date: April 1963 Run: 28,29, 30 Film: 1828 Photo: 98,201, 207, 208 Project: Melbourne (1963) Project	**Bonbeach project area** The project area was relatively unchanged. **Surrounds** Further commercial/industrial development was observed along Nepean Highway to the west of the northern portion of the project area. Further residential development had occurred to the east of the project area. A school was noted adjacent to the Patterson River golf course to the east of the southern portion of the project area.
Date: Jan 1972 Run: 2, 13 Film: 2560 Photo: 52, 53, 79, 81, 83 Project: Nepean Highway 1972, 769 – Port Phillip Foreshore 1968 Project	**Bonbeach project area** A number of small buildings appeared to have been constructed to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area). **Surrounds** The project area surrounds were relatively unchanged.
Date: December 1978 Run: 3	**Bonbeach project area**

Photograph	Observations
Film: 3357 Photo: 191 Project: Mentone - Chelsea	The project area was relatively unchanged. **Surrounds** The project area surrounds were relatively unchanged.
Date: Aug 1982 Run: 2 Film: 3684 Photo: 7, 8 Project: 7921IV11	**Bonbeach project area** The small building to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area) appeared to have changed, suggesting possible demolition. **Surrounds** The project area surrounds were relatively unchanged.
Date: Jan 1987 Run: 7, 8 Film: 4076 Photo: 97, 99 Project: 1869 – Nepean Highway	**Bonbeach project area** The layout of the small buildings to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area) had changed, suggesting possible demolition and or refurbishment. **Surrounds** The project area surrounds were relatively unchanged. The Patterson Lakes development was visible to the south east.
Date: 2005 Project: DELWP CIP, Melbourne 2005	**Bonbeach project area** The layout of the small buildings to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area) were no longer apparent, suggesting possible demolition. The area had been redeveloped as a car park (sealed). **Surrounds** The layout of a number of buildings to the west of the southern portion of the project area appeared to have changed, suggesting possible redevelopment. The commercial/industrial building on the northern corner of Wimborne Avenue and Nepean Highway (west of the northern portion of the project area) was no longer apparent, suggesting possible demolition.
Date: 2016 Project: DELWP CIP, Mordialloc 2016	**Bonbeach project area** The car park (sealed) to the east of the rail track near the intersection of Station Street and Sherwood Avenue (northern portion of the project area) had been extended to the south. **Surrounds** A building had been constructed on the northern corner of Wimborne Avenue and Nepean Highway (west of the northern portion of the project area).

5.3.3 EPA Victoria priority sites register

A search of the EPA Victoria priority sites register was conducted on 1 June 2017 (refer to Section 5.2.5) and identified that there were no properties within the Bonbeach project area listed on the database, nor was there any properties within a 500 metre radius of the Bonbeach project area listed on the register.

5.3.4 EPA Victoria database of certificates and statements of environmental audit

A search was conducted of the list of Issue Certificates and Statements of Environmental Audit on 1 June 2017 (refer to Section 5.2.4). The search identified that were no properties within the Bonbeach project area listed on the database, but there were two properties within a 500 metre radius of the Bonbeach project area with details of the audits provided in Table 29.

Table 29 Bonbeach certificates and statements of environmental audits

Issue and CARMs no.	Address	Completed	Key audit findings
Statement [redacted]	[redacted]	09/10/2006	The site is unsuitable for issue of a Certificate of Audit due to both on-site and off-site soil and groundwater contaminated with total petroleum hydrocarbons and benzene, ethylebenzene, toluene and xylenes. In summary, the conditions specified for ongoing use of the site were: • areas of the site shall be 'quarantined' from use for construction of buildings or non-permeable pavement, unless a passive gas ventilation system is installed • excavations below the depth of 3.0 metres require a Health and Safety plan to address possible presence of localised petroleum related contaminants and odours • groundwater will not be abstracted for uses other than clean-up or monitoring as the site is within a groundwater quality restricted use zone • ongoing monitoring of groundwater is required.
Statement [redacted]	[redacted]	09/10/2006	The site is unsuitable for issue of a Certificate of Audit due to the presence of heavy metals in soil and groundwater. . In summary, the conditions specified for ongoing use of the site were: • access to groundwater be restricted • access to soils be restricted through either building slab and/or at least 500 millimetres of clean fill.

5.3.5 EPA Victoria licence register

A search was conducted of EPA Victoria licence register on 1 June 2017 (refer to Section 5.2.5). The search identified that there were no scheduled premises within the vicinity of the project area (500 metre radius) listed on the database.

5.3.6 Historic MMBW sewer plans

The State Library of Victoria has an archive of plans produced for the Melbourne and Metropolitan Board of Works (MMBW) between the 1890s and 1950s. The plans were created to facilitate in the design and development of Melbourne's sewerage system.

A search of the archive on 11 October 2017 indicated that no plans were produced covering the Bonbeach project area and surrounds.

5.3.7 Geology and hydrogeology

The geological setting of the region is presented on the Geological Survey of Victoria 1:63,360 scale - Cranbourne Mapsheet. The mapsheet indicates that typically, the Bonbeach project area is underlain by Quaternary age aeolian and swamp deposits, which in turn overlie the Pliocene age Baxter Sandstone or Brighton Group sediments. A variable thickness of anthropogenic fill material overlies the natural geological materials associated with urbanisation of the local area.

An assessment of the available geological maps suggests the stratigraphy beneath the project area within the depth of engineering works is anticipated to comprise the units identified in Table 30.

Table 30 Geological summary

Period	Sub period	Geological unit (map abbreviation)	Approximate geological age (years)	Approximate depth to top of unit (mbgs)*	Geological description**
Recent	-	Anthropogenic fill	200	0	Variable May include sand, gravel, silt and clay, and man-made artefacts.
Quaternary	Holocene	Coastal Dune Deposits	<1.8 million	<2	Siliceous and calcareous sand
		Coastal Swamp Deposits		<5	Peaty clay
Tertiary	Miocene – Pliocene	Baxter Sandstone	23 – 1.8 million	<5	Sandstone and sand, silty sand with minor gravels

Notes: bgs – below ground surface
** Sourced from DELWP Groundwater Resource Reports*
*** Cited from Geological Survey Victoria 1:63,360 Scale Cranbourne Mapsheet*

Table 31 below shows the generalised subsurface profile.

Table 31 Bonbeach geology

Geological Unit	Approximate depth to top of unit (mbgs)	Approximate thickness of unit (m)	Description of material
Fill	0.0	0.1 to 0.3	Concrete, Asphalt, Sand, Gravel, Sandy Gravel.
Quaternary Sands	0.1 to 0.3	3.2 to 13.8	Sand
Quaternary Swamp Deposits	8.2	1.8	Sandy Clay
Tertiary Age Brighton Group Deposits	3.5 to 14.0	16.0 to 30.5	Silty Clay, Clay, Silty Sand, Sandy Clay, Clayey Sand, Sandy Silt
Tertiary Age Fyansford Formation	30.0 to 38.4	Greater than 8.05	Clay, Silty Clay, Clayey Silt, Silt, Silty Sand, Sandy Silt, Gravelly Clay

A review of the Victorian Groundwater Beneficial Use Map Series (South Western Victoria) Water Table Aquifers (DNRE, 1995) indicates that groundwater beneath the project area occurs within the Quaternary aquifer.

An assessment of the Visualising Victoria's Groundwater Geodatabase, managed by the Centre of eResearch and Digital Innovation at Federation University Australia and the Department of Environment, Land, Water and Planning Groundwater Resource Database, indicates that the depth to the water table is expected to be less than 10 metres (and less than five metres in places). Groundwater bores installed at Bonbeach indicate groundwater occurring between 3.1 and 5.2 metres below ground level. Groundwater flow direction is anticipated to be to the west towards Port Phillip Bay and groundwater salinity in the range 3,500 mg/L and 7,000 mg/L.

5.3.8 Topography, drainage, surface water

The topography of the project area is relatively flat, and gradually slopes down toward the Edithvale Wetlands, approximately 2.5 kilometres to the east of the level crossing, and to Port Phillip Bay, approximately 250 metres to the west of the rail corridor. Patterson River is approximately one kilometre to the south of the level crossing.

Bonbeach Station is located seven metres above sea level, and the rail line is relatively elevated above the surrounding area with runoff on the west potentially flowing to Port Phillip Bay (approximately 200 metres from the level crossing).

The project area is within the Port Phillip and Westernport Catchment Management Authority region. There are no known stormwater drainage assets crossing the rail line within the project area, and the site is not subject to flooding overlays within the local planning scheme. Further discussion is provided in EES Technical Report E *Surface water.*

5.3.9 CASS Mapping

The desktop assessment for CASS at Bonbeach included review of following available maps:

Victorian CASS mapping

The DEDJTR CASS distribution map 3 Rampart (2003) for the central coast of Victoria indicates that the Bonbeach project area falls within land that has been mapped as 'Prospective' for CASS. A copy of this map has been included in Appendix G.

Australian Soil Resource Information System mapping

Review of the ASRIS mapping indicates that the site has a 'high probability/high confidence' for the occurrence of CASS. Figure 8 shows the ASRIS ASS mapping at the site. This risk was investigated further as a Stage B soil assessment (Section 5.3.12)

Vegetation mapping

Vegetation mapping at the project areas was completed by the JV (AECOM-GHD JV, 2017b). The JV indicated that vegetation in the area is generally of poor quality due to historical and ongoing use as an active rail line and intensive land use in the area. The JV reported a large number of weedy species in the area as well as native and introduced amenity plantings.

Remnant native vegetation includes Coastal Tea-tree *Leptospermum laevigatum* and Coastal Banksia *Banksia integrifolia.* These species are not listed as CASS occurrence indicators (refer Appendix B).

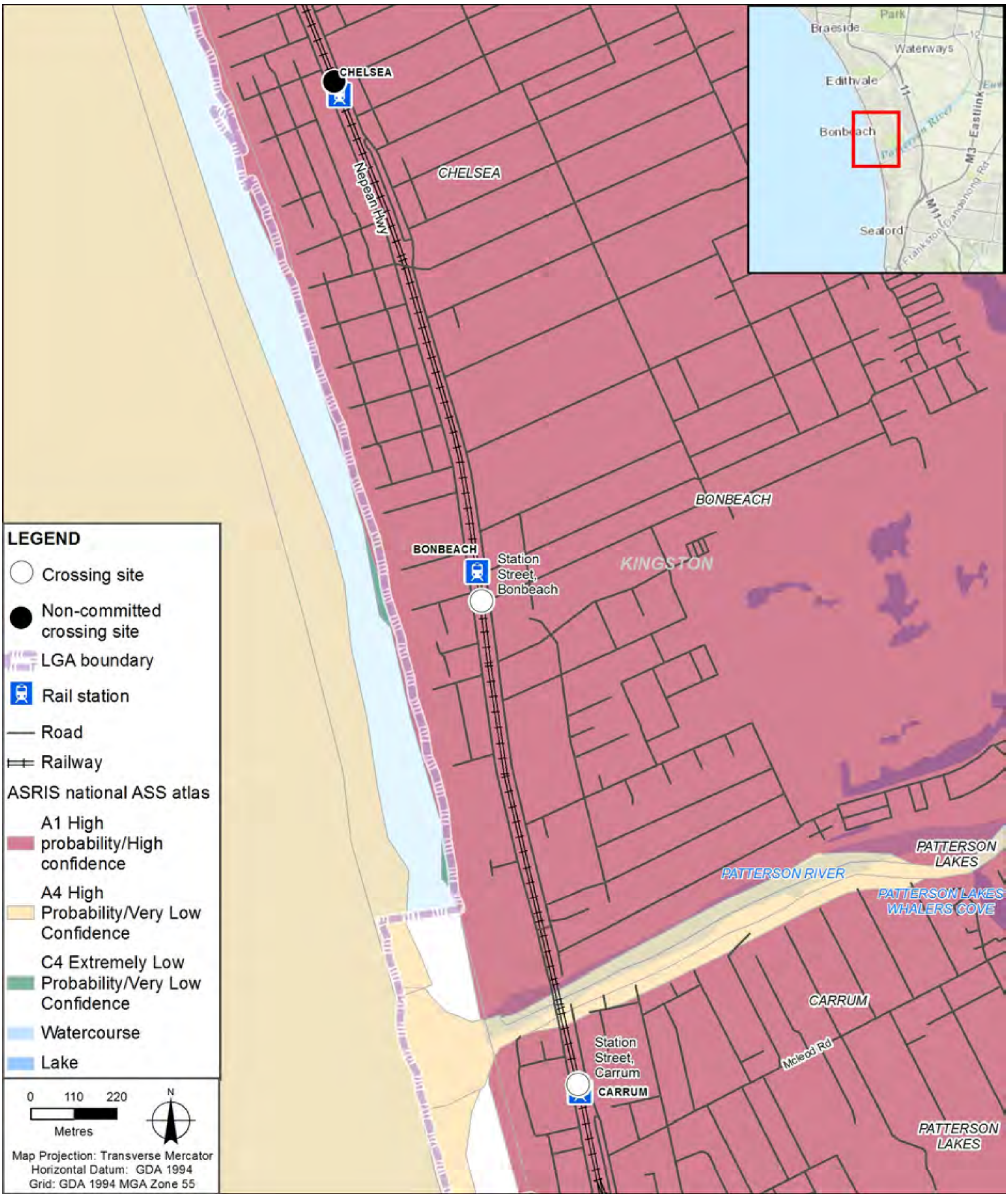


Figure 8 Bonbeach ASRIS mapping

5.3.10 Review of previous investigations

Two available environmental reports were reviewed, which included preliminary information on the history and the contamination status of soils at the Bonbeach project area. The review of these reports is provided below.

AECOM-GHD Joint Venture 2016

The JV was contracted by LXRA to complete a contamination/PASS Desktop Assessment of the Edithvale project area. In summary, the findings included:

- potential sources of soil contamination are primarily associated with historical rail use and potential contaminants of concern include petroleum hydrocarbons, PAHs, asbestos, heavy metals (including arsenic) and OCPs
- there was no specific information available indicating the contamination status of soils in the rail corridor, however, some contaminated soil was considered likely based on the history of rail use
- there was no specific information indicating the actual contamination status of groundwater
- potential off-site sources of groundwater contamination were identified as follows:
- former service stations at [redacted] and [redacted] (potential contaminants of concern are petroleum hydrocarbons, PAHs, BTEX and lead)
- elevated background groundwater concentrations of heavy metals, sulfate and nitrate, and low pH
- based on the CASS risk map for the area compiled by the CSIRO, there was a 'High Probability of Occurrence' for CASS within the area.

Coffey Environments Pty Ltd 2017

Coffey Environments Pty Ltd was contracted by Metro Trains Melbourne Pty Ltd to complete a geotechnical, environmental and hydrogeological investigation of the Bonbeach project area. In summary, the findings included:

- environmental soil sampling undertaken at the 10 locations within the site included analysis of seven samples of fill and 27 samples of natural soils.
- the concentrations of arsenic, copper and fluoride exceeded the upper limit of Fill Material in accordance with EPA Victoria publication IWRG 621 in samples of fill soils collected from two boreholes located at:
  - intersection of Lord Weaver Grove and Nepean Hwy
  - intersection of Brixton Street and Station Street
- all other fill samples reported concentrations of chemicals analysed below the upper limit of Fill Material
- the concentrations of copper and nickel exceeded the upper limit of Fill Material in accordance with EPA Victoria publication IWRG 621 in samples of natural soils collected from two boreholes located at:
  - opposite [redacted]
  - western end of Cannes Avenue

- all other natural soil samples reported concentrations of chemicals analysed below the upper limit of Fill Material
- acid sulfate soil pH screening tests indicated a low potential for acid sulfate soils to be present in the shallow natural soil at the site (up to one mbgs)
- the results of the both the acid sulfate soil testing and chromium reducible sulfur analysis undertaken on deeper natural soils within the Quaternary Sands (at depths of between about 10 to 11 mbgs) indicate that the deeper natural soils have a high potential for acid sulfate soils to be present
- it was recommended that further evaluation of acid sulfate soil generation capacity be undertaken when the design is finalised and likely soil disturbances had been determined. Further contamination assessment was also recommended to confirm classification for off-site disposal once the types and quantities of soils requiring disposal were defined.

5.3.11 Project area inspection

An inspection of the Bonbeach project area was conducted on 19 April 2017 and 7 June 2017. Table 32 summarises the results of the project area inspection. No buildings were accessed during the inspection of the project area. The rail corridor was inspected from outside the rail corridor for significant potential contamination sources:

It should be noted that evidence of soil contamination is not always obvious by visual inspection or desktop review.

Table 32 Bonbeach project area inspection observations

Item	Details
Surface coverage	The Bonbeach project area comprised the rail corridor with Station Street and Nepean Highway located to the east and west, and small sections of adjacent road reserves.
Topography	The Bonbeach project area is relatively flat, and gradually slopes down toward the Edithvale Wetlands, approximately 2.5 kilometres to the east of the level crossing, and to Port Phillip Bay, approximately 250 metres to the west of the rail corridor. Patterson River is approximately one kilometre to the south of the level crossing.
Drainage	Bonbeach Station is located seven metres above sea level, and the rail line is relatively elevated above the surrounding area. Based on visual assessment, drainage is likely to flow in an easterly and westerly direction from the highest point being the rail lane and easement to nearby surface drains to the receiving water body of Port Phillip Bay. The project area is within the Port Phillip and Westernport Catchment Management Authority region. There are no known stormwater drainage assets crossing the rail line within the project area, and the site is not subject to any flooding overlays within the local planning scheme.
Observations	The following observations were made within the Bonbeach project area: • the rail corridor ran north-south through the entire length of the project area • Chelsea Station is located at the western end of Chelsea Road, Chelsea • a substation is located at the eastern end of Wimborne Avenue, Chelsea • Bonbeach Station is located at the western end of Bondi Road, Bonbeach • No field indicators for CASS were observed. The CASS field indicators are detailed in Appendix B

Item	Details
	The following observations made regarding properties adjacent to the Bonbeach project area: • a panel beaters was present at [redacted] • a Telstra exchange was located at [redacted] • a laundromat was located at [redacted] • a vacant block was located at [redacted] • an ambulance station was located at [redacted] • a Woolworths service station was located at [redacted] • a former service station was located at [redacted] • a furniture factory and builder was located at [redacted] • a mower sales/service centre was located at [redacted] • a laundromat was located at [redacted]

5.3.12 Coastal acid sulfate soils assessment

The desktop assessment at Bonbeach demonstrated sufficient information to infer the potential presence of acid sulfate soils within the project area. As such, a field assessment was conducted in accordance with IWMP (2009) including EPA publication 655.1 (2009) and CASS BPMG (DSE, 2010) to obtain site specific data to confirm the presence of CASS and allow determination of suitable liming rates (if required). This section presents and discusses findings of the detailed field assessment for acid sulfate soils.

Assessment Criteria

The data for Bonbeach was compared against the action criteria (0.03% S) included in the CASS BPMG (DSE, 2010). The details are presented in Section 5.2.13.

Data Validation

The data validation was undertaken in accordance with BPMG and presented in Appendix H.

The data validation concluded that the data collected during this assessment is considered suitable for the purpose of this assessment.

Soil Assessment Results

Field Observations

The soil lithology observed during drilling of boreholes is presented as borelogs (Appendix I) and is summarised below in Table 33.

Table 33 Summary of observed lithology at Bonbeach

Approximate Depth (mbgs)	Lithology
0-0.2 to 0.7	Fill material consisting of grey brown to dark brown sand and silty material with gravel and rootlets
0.2 to 0.7 - 5.0 to 10.5	SAND, fine to medium, light grey to dark brown, medium dense
5.0 to 10.5 – 9.5 to 17	Interbedded layers of grey to dark brown silty sand, clayey sand and sandy silt, silty clay and clay with occasional ferricrete and/or gravel
9.5 to 17 - 22	SAND, fine to coarse, rounded, grey to brown, with silt and clay

A review of the borelogs from previous investigations (Coffey 2017) identified similar lithologies especially at deeper layers greater than 20 mbgs.

Small to large broken shells were encountered at almost all the locations at depths ranging between 3.5 mbgs and 22 mbgs. Additionally, a hydrogen sulphide odour which indicates presence of PASS was observed at depths ranging from 9.0 to 19.0 mbgs.

Field pH Testing

Field pH tests were conducted to provide an indication of the likely presence of AASS or PASS horizons. Assessment criteria for the pH_F and pH_{FOX} screening tests to evaluate the possible AASS or PASS occurrence are provided in EPA 655.1 (*Table 2*) and summarised in Section 4.1.1. The field pH_F and pH_{FOX} results are presented in Table D8 (Appendix C) and summarised below. The complete ALS laboratory reports are provided in Appendix E.

A total of 492 primary samples were analysed for field testing. The reaction rates for majority (approximately 79%) of samples were recorded as one and two indicating lower aggressivity and presence of low to moderate amount of sulfides. Approximately 31% (155 soil samples), consisting of silty sand, sandy silts, sandy clay and silty clay, returned results indicating presence of existing acidity or AASS (18%) and potential acidity or PASS (13%). Of the 492 samples, 138 samples (28%), were generally associated with deeper (> 15 mbgs) natural sand layers and have limited potential to generate net acidity. This indicates that negligible or small amounts of oxidisable sulfides are present in these samples, or the sample might be poorly reactive or acid buffering/neutralising components (i.e. carbonates) are present in the soil sample to resist the lowering of the soil pH. Approximately 40% samples (199 primary samples) recorded results indicating absence of CASS or were uncertain.

It should be noted that the field pH tests do not provide a quantitative measure of the amount of acid that has been or could be produced through the oxidation process. As such, detailed laboratory testing was conducted on selected samples (Table D8) to verify the nature and extent of acid sulfate soils.

Laboratory Testing

Based on the field pH testing, approximately 27% of samples (132 samples which were selected for further analysis) were analysed using the CRS suite to evaluate whether they are likely to generate net acidity, and if so, quantify the maximum amount of existing and potential soil acidity that will require treatment and management if CASS are disturbed. The CSR test results are summarised in Table D9 (Appendix C). The complete ALS laboratory reports are provided in Appendix E.

Table 34 given below provides a summary of the CRS results for Bonbeach and is described in this section.

Table 34 Summary of CRS results - Bonbeach

Analyte	No of samples (>LOR)	Min (%S)	Max (%S)
Actual Acidity	4	0.02	0.07
Retained Acidity	1	<0.02	<0.02
Potential Acidity	97	0.005	1.01
Buffering Capacity	58	0.01	1.95
Net Acidity (AA + PA)	60	0.02	1.01

LOR – Laboratory Limit of reporting

Actual Acidity

The actual acidity was encountered in four samples out of total 132 samples selected for further analysis. The TAA concentrations were recorded for samples collected from fill sand and sandy to silty clay layer ranging from 0.02%S (ID46-CASS07at depth of 15.0 mbgs) to 0.07 %S (ID46-CASS15at depth of 1.0 mbgs).

Retained Acidity

The pH_{KCl} values were greater than or equal to 4.5 for all samples except for one sample. This indicates retained acidity was absent for all of the selected soil samples except for the sample collected at ID46-CASS15 at 1.0 mbgs, however the net acid soluble sulfur was recorded below LOR for this sample.

Potential Acidity

Approximately 73% samples (97 of 132 samples) recorded potential acidity with Scr concentrations ranging between 0.005 %S and 1.01 %S. The S_{Cr} results indicate that the majority of the samples collected across the entire profile (sand and silty clays to clays) are PASS and can produce acidity when disturbed.

Acid Neutralising Capacity

A total of 58 samples (44%) collected across the whole profile contained moderate concentrations of buffering capacity ranging from 0.01%S (CASS12 at a depth of 3.0 mbgs) to 1.95% S (CASS06 at a depth of 6.5 mbgs). The ANC_{BT} values for 17 samples of these 58 samples collected between 7-15 mbgs were higher than their corresponding acid producing potential (i.e. sum of existing and potential acidity). This suggests that these soil horizons contain sufficient amounts of carbonate materials to neutralise and buffer the acidity that could be generated as a result of the oxidation of sulfides within the soil. It should be noted that the ANC measured in the laboratory (due to sample preparation process) may provide values in excess of buffering capacity which would normally be available from the soil *in-situ*.

Liming rates

The calculated liming rates (without considering measured ANC for the samples) for treatment of the PASS once excavated range from 1 kg $CaCO_3$/t to 47 kg $CaCO_3$/t. The maximum liming rate (47 kg $CaCO_3$/t) was calculated for samples collected at ID46-CASS06 at a depth of 10.5 mbgs. These liming rates are based on the neutralising value (NV) for aglime of 1.00 (i.e. 100%) and need to be adjusted based on the NV of the product being used for treatment. The method of lime application (in-situ or ex-situ) will depend on the spoil management techniques (discussed later in Section 7) during construction.

Summary

A comparison of net acidity values (excluding ANC, in accordance with the BPMG) with the adopted action criteria showed that 51 of 132 samples (approximately 39%) exceeded the action criteria for CASS management (DSE, 2010). The net acidity of almost all the samples exceed the BPMG criteria due to high potential acidity values except for samples collected at ID46-CASS03 at depth of 0.1 mbgs, ID46-CASS10 at depth of 4.0 mbgs, ID46-CASS15 at depth of 1.0 mbgs where reported net acidity (ranging between 0.03%S and 0.08%S) is due to actual acidity and the retained acidity and potential acidity values are <LOR. This implies that the acidity in this sample is potentially not due to oxidation of sulfides but maybe from other sources like presence of organic matter. A summary of existing conditions at the Bonbeach project area is provided in Section 6.2.

These exceedances are presented in Figure 9 and are summarised below in Table 35:

Table 35 Summary of exceedances for net acidity – Bonbeach

Borehole ID	Range of Net Acidity (excluding ANC) %S		Depths where samples collected (mbgs)	
	Minimum	Maximum	From	To
ID46-CASS01	*<0.02*	*<0.02*	*No exceedances noted*	
ID46-CASS02	<0.02	<0.02	No exceedances noted	
ID46-CASS03	0.04	0.04	7	
ID46-CASS04	0.04	0.32	5.5	10.0
ID46-CASS05	0.03	0.26	7.5	14.5
ID46-CASS06	0.04	1.01	10.5	14.0
ID46-CASS07	0.04	0.62	10.5	15.0
ID46-CASS08	0.04	0.14	9.5	15.0
ID46-CASS09	0.09	0.74	11.0	16.0
ID46-CASS10	0.03	0.55	10.0	14.5
ID46-CASS11	0.04	0.48	9.5	12.0
ID46-CASS12	0.12	0.85	8.5	14.5
ID46-CASS13	0.07	0.33	8.0	10.0
ID46-CASS14	0.03	0.07	3.5 and 6.0 respectively	
ID46-CASS15	0.08		1.0*	
ID46-CASS16	*<0.02*	*<0.02*	*No exceedances noted*	
ID46-CASS17	0.04	-	4.0	-
ID46-CASS18	*<0.02*	*<0.02*	*No exceedances noted*	
ID46-CASS19	*<0.02*	*<0.02*	*No exceedances noted*	
ID46-CASS20	*<0.02*	*<0.02*	*No exceedances noted*	

** It is noted that the elevated net acidity at ID46-CASS15 at 1.0 mbgs reflects existing acidity potentially from non-sulfide sources.*

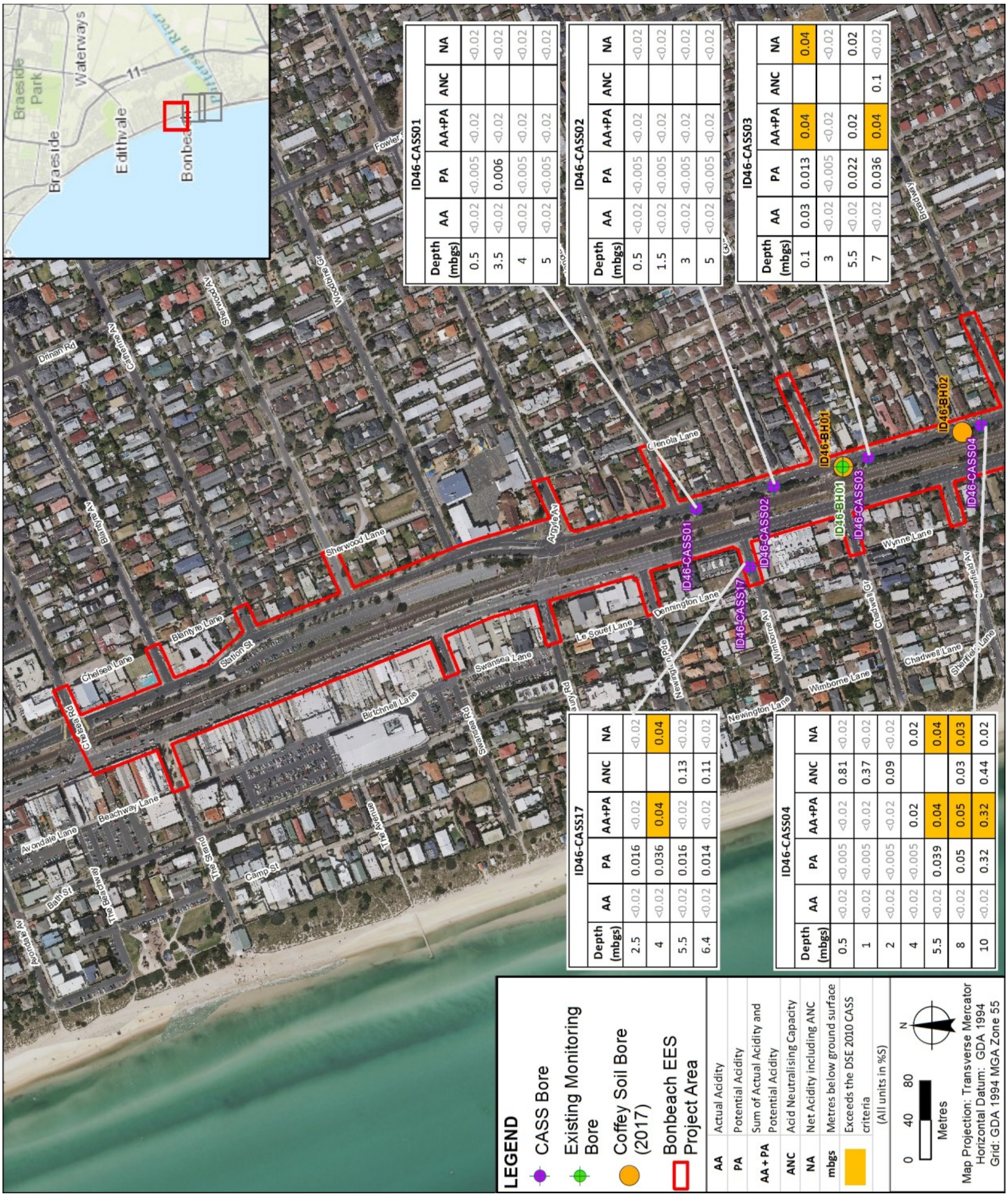


Figure 9 Bonbeach CASS Soil and Groundwater results (Page 1 of 3)

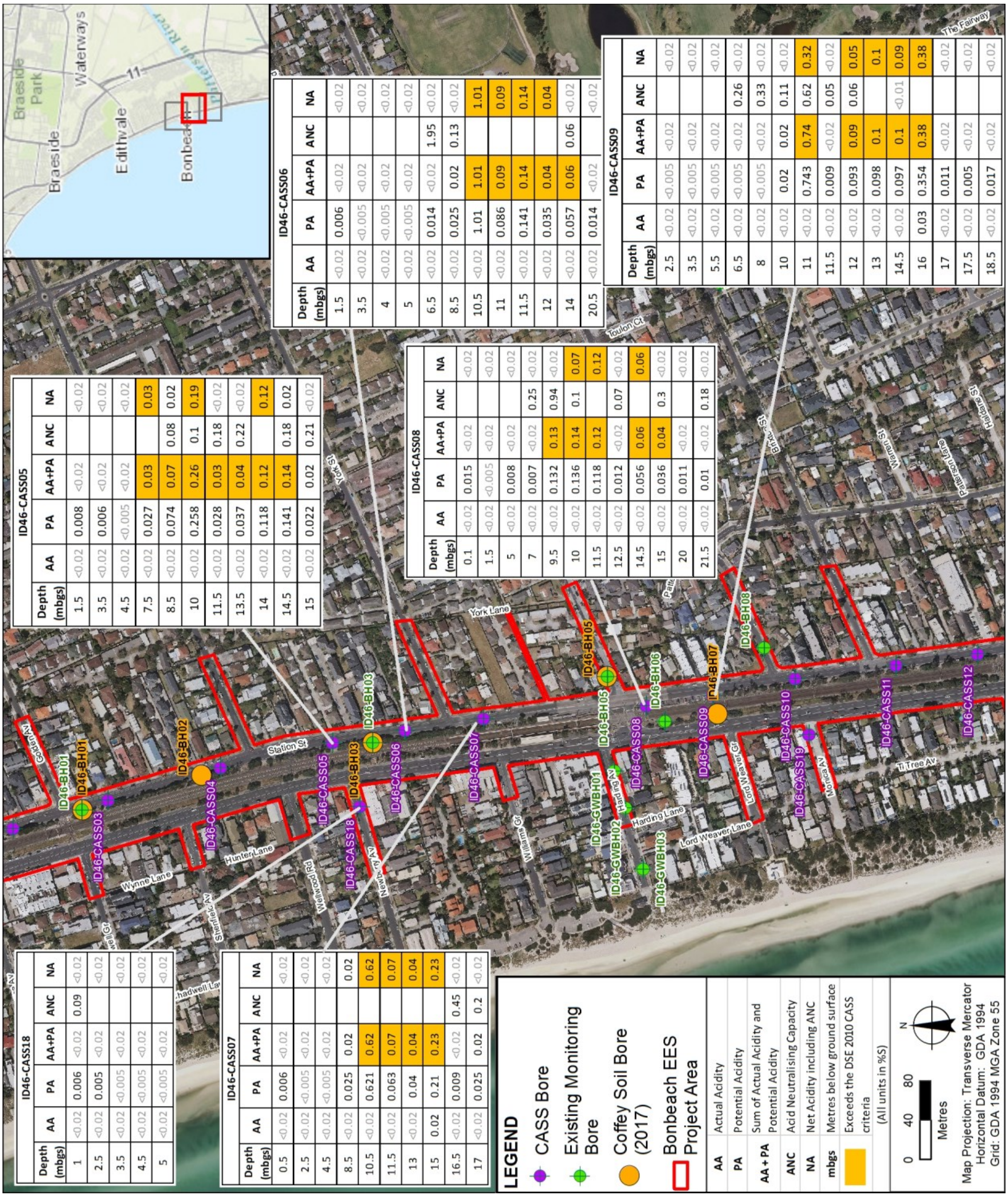


Figure 9 Bonbeach CASS Soil and Groundwater results (Page 2 of 3)

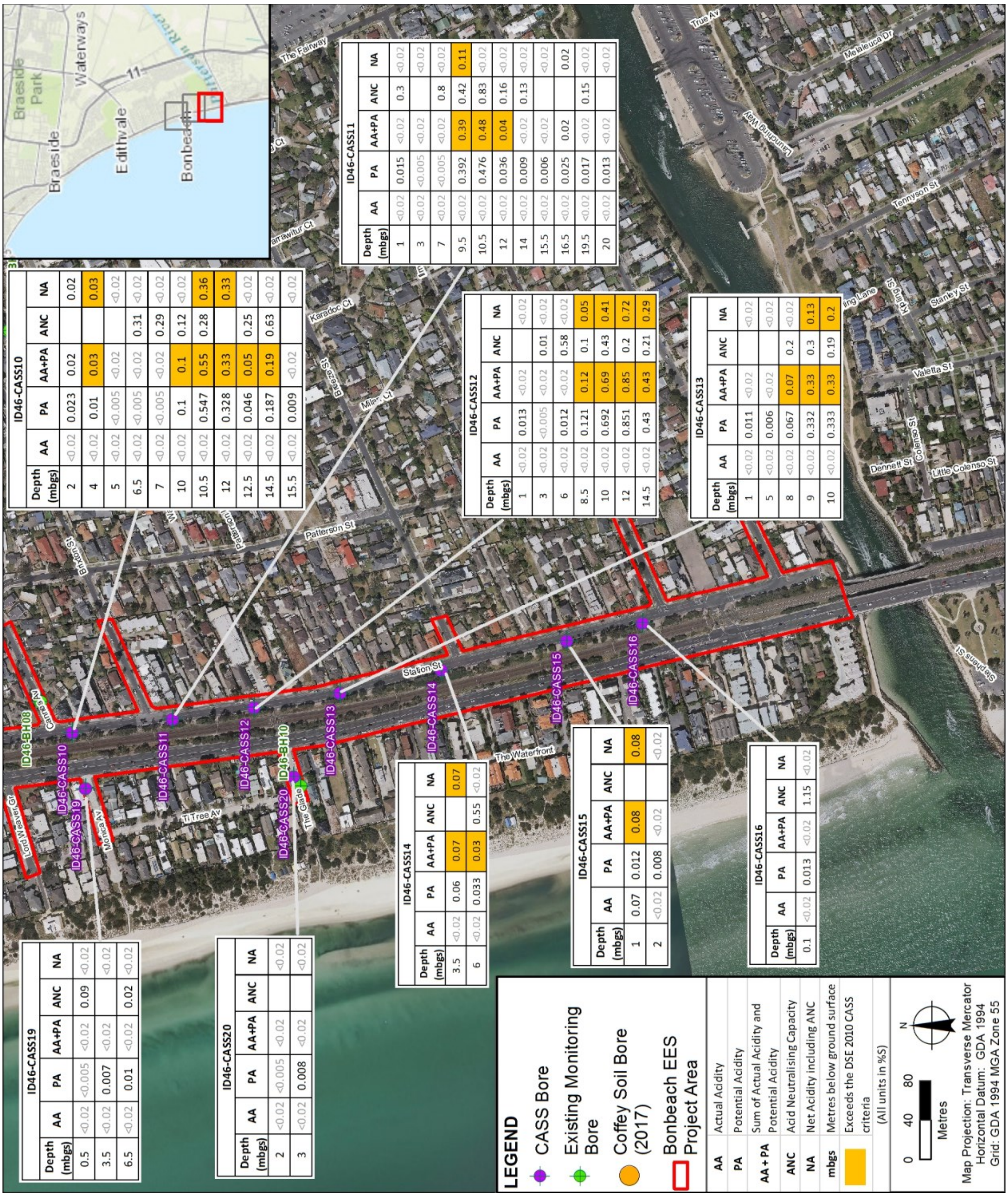


Figure 9 Bonbeach CASS Soil and Groundwater results (Page 3 of 3)

5.3.13 CASS groundwater assessment

The groundwater field chemistry measurements and the laboratory results are provided in Table D10 and Table D11 (Appendix C) respectively. A brief summary of the results is provided below:

Assessment Criteria

The groundwater field and laboratory results were compared with the CASS specific criteria given in CASS BPMG (2010) and (DER), 2015. The details are presented in Section 5.2.13.

Groundwater Levels

Based on the screening depths and total depths of the monitoring wells, the groundwater was described as two different aquifers:

- Quaternary – The groundwater wells selected for the shallow aquifer are ID46-BH08, ID46-BH10, ID46-GWBH02, ID46-GWBH04 and ID46-GWBH05. The SWLs of the groundwater for '*Quaternary Aquife*r' was measured ranging between 2.96 mbgs (ID46-GWBH04) and 5.92 mbgs (ID46-GWBH05). The water levels relative to the elevation ranged from 0.05 mAHD (ID46-GWBH05) to 0.91 mAHD (ID46-BH10).
- Upper Tertiary Aquifer – The groundwater wells selected for the deep aquifer are ID46-BH01, ID46-BH03, ID46-BH05, ID46-BH06, ID46-GWBH01, ID46-GWBH03 and ID46-GWBH06. The SWL of the groundwater for '*Upper Tertiary Aquifer'* was measured ranging between 4.32 mbgs (ID46-GWBH03) to 5.47 mbgs (ID46-GWBH01) and -0.23 mAHD (ID46-GWBH01) to 1.06 mAHD (ID46-BH01)

The water levels indicated that generally, the groundwater in and around the Bonbeach project area flowed in a south-westerly direction towards Port Phillip Bay and Patterson River.

Field Chemistry

For the samples collected from Quaternary Aquifer, the pH ranged from 7.61 (ID46-GWBH05) to 9.67 (ID46-BH10) indicating that the groundwater is neutral to alkaline (Table D10, Appendix C). The EC was measured ranging from 521 µS/cm (ID46-BH10) to 883 µS/cm (ID46-BH08) indicating that the groundwater in shallow aquifer is fresh to slightly saline. The dissolved oxygen values ranged from 0.17 to 4.14 ppm. The reduction potential of the groundwater was recorded ranging between -17 to 47 mV. This indicates that the groundwater has reducing potential.

For Upper Tertiary Aquifer samples, the pH ranged from 7.37 (ID46-GWBH03) to 12.74 (ID46-GWBH01) indicating that the groundwater is neutral to highly alkaline. The EC of the samples were measured ranging from 543 µS/cm (ID46-BH01) to 9,447 µS/cm (ID46-BH02) indicating that the groundwater is fresh to highly saline. The dissolved oxygen values ranged from 0.30 to 3.80 ppm. The reduction potential of the groundwater was recorded ranging between -56 to 50 mV. This indicates that the groundwater has reducing potential.

Laboratory Analytical Results

The analytical results are provided in Table D11 (Appendix C) and the results are summarised below in Table 36.

Quaternary Aquifer

A total of 10 samples were collected for five wells during the various sampling events in 2016-17.

Table 36 Summary of laboratory analysis for groundwater samples – Quaternary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
TDS	300	1840	571	2	ADWG (2015) Aesthetic (600 mg/L)
Sodium	32	130	71	-	
Chloride (Cl)	42	128	83	-	
Sulfate (SO_4)	22	164	58	-	
Cl:SO_4 Ratio	1	4	-	9	DSE (2010) value of 4
Total Acidity	<10	13	13	NA	
Total Alkalinity	110	2140	401	NA	
Alkalinity: SO_4 Ratio	2	13		6	DER 2015 value of 5
Soluble Aluminium	<0.05	0.91			DER 2015 value of 1 mg/L
Ammonia	0.47	1.7	1.03	6	ANZECC (2000), 95% Fresh water (0.9 mg/L)
Total Nitrogen	1.1	4.9	2.2	-	
Total Phosphorus	0.25	0.25	0.25	1	ANZECC (2000) Irrigation Long term trigger levels (0.05 mg/L and 1 mg/L)
Fluoride	0.2	1.1	0.58	1	

NA – Not applicable

Laboratory measured total dissolved solids concentrations from the a total of 10 samples collected from the '*Quaternary Aquifer*' corresponded with EC measurements recorded in the field, ranging from 300 mg/L (ID46-GWBH04) to 1840 mg/L (ID46-BH10). Two samples exceeded the adopted criteria of ADWG (2015) for aesthetic beneficial use.

Sodium was the major cation measured with concentrations ranging from 32 mg/L to 130 mg/L in the 10 samples. Similarly chloride and sulfate concentrations were measured ranging from 42 mg/L to 128 mg/L and 22 mg/L and 164 mg/L respectively in all the 10 samples.

The Total acidity (as $CaCO_3$) was recorded for five samples collected in the July sampling round and ranged between <10 mg/L and 13 mg/L with the average value of 13 mg/L. The Total Alkalinity was measured for all 10 samples across the three sampling rounds and ranged between 110 mg/L and 2140 mg/L with an average total alkalinity value of 401 mg/L indicating that the shallow groundwater is generally adequate to maintain acceptable pH level in the future.

The calculated chloride to sulfate ratio was below 4 (DSE, 2010) for the 10 groundwater samples collected from '*Quaternary Aquifer*' indicating presence of actual acidity in the shallow aquifer due to presence of AASS. The chloride to sulfate ratio is less reliable in fresh water scenario, hence the alkalinity to sulfate ratio was also calculated. The calculated alkalinity to sulfate ratio for these 10 samples ranged from two to 13 indicating presence of existing acidity at four locations (ID46-BH08, ID46-BH10, ID46-GWBH02 and ID46-GWBH04) where the ratio was below five as per DER 2015 guidelines. The ratio stayed similar for the two sampling rounds in December 2016 and July 2017 for all the samples except for ID46-BH08 and ID46-BH10 where the ratio varied from four to 13 and 13 to two from December 2016 to June/July 2017 respectively. This may be attributed to the seasonal variation at these locations.

The soluble aluminium measured for the five samples collected in July 2017 ranged from less than 0.05 mg/l to 0.91 mg/L. All the values were below the concentration of one mg/L (DER, 2015) indicating absence of existing acidity. It is pertinent to note that whilst no groundwater sample had a pH less than 5, dissolved aluminium is prevalent in all samples of the shallow aquifer. This may indicate an issue with filtration practices prior to acid preservation (possibly due to turbid samples). Alternatively, it indicates presence of micro-colloids (i.e. less than 0.45 µm) containing aluminium.

For the shallow aquifer at Bonbeach, the alkalinity to sulfate ratio indicate presence of actual acidity at select locations, however the pH of the samples (less than 5) and the measured buffering capacity (less than 60 mg/L) indicates that the groundwater has sufficient buffering capacity to neutralise any acidity being produced.

Ammonia was detected greater than LOR in all 10 samples and six samples exceeded the ANZECC (2000) 95% fresh water criteria.

Total phosphorus was analysed for only two samples and one sample exceeded ANZECC (2000) long term irrigation trigger levels. Fluoride was detected above LOR in five samples of total 11 samples and one sample (BH08) collected in December 2016 exceeded the ANZECC (2000) long term irrigation trigger levels.

Upper Tertiary Aquifer

A total of 13 samples were collected for seven wells during the various sampling events in 2016-17.

Table 37 below provide a summary of laboratory analysis for groundwater samples for Upper Tertiary Aquifer

Table 37 Summary of laboratory analysis for groundwater samples for Upper Tertiary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of Exceedances	Criteria exceeded
TDS	314	4700	1522	9 and 1	ADWG (2015) Aesthetic (600 mg/L) ANZECC (2000) Stock watering
Sodium	45	1700	304	4	ADWG (2015) Aesthetic (180 mg/L)
Chloride (Cl)	35	2600	397	4	ADWG (2015) Aesthetic (250 mg/L)
Sulfate (SO_4)	10	280	77	1	ADWG (2015) Aesthetic (250 mg/L)
Cl:SO_4 Ratio	1	4		7	DSE (2010) value of 4
Total Acidity	<10	23	21	NA	
Total Alkalinity	113	2720	760	NA	
Alkalinity: SO_4 Ratio	2	190		4	DER 2015 value of 5
Soluble Aluminium	<0.05	0.63	0.33	-	DER 2015 value of 1 mg/L
Ammonia	0.4	3.9	2.0	12	ANZECC (2000), 95% Fresh water (0.9 mg/L)
Total Nitrogen	1.9	5.5	2.9	1	ANZECC (2000) Irrigation Long term trigger levels 5 mg/L, 0.05 mg/L and 1 mg/L respectively
Total Phosphorus	<0.01	0.2	0.09	2	
Fluoride	0.2	1.2	0.6	1	

NA – Not applicable

The samples collected from the '*Upper Tertiary Aquifer*' returned total dissolved solids ranging from 314 mg/L (ID46-BH01) to 4,700 mg/L (ID46-GWBH06). 9 samples of 13 samples exceeded the ADWG (2015) for aesthetic beneficial use and one sample exceeded the ANZECC(2000) for stock watering use.

For 13 samples, sodium and chloride were the major ions measured with concentrations ranging from 45 mg/L to 1,700 mg/L and 35 mg/L to 2,600 mg/L respectively. Of 13 samples, four samples exceeded the adopted criteria for ADWG (2015) for aesthetic beneficial use for sodium and chloride. Similarly sulfate concentrations were measured ranging from and 10 mg/L and 280 mg/L and one sample (ID46-GWBH03 collected in July 2017) exceeded the ADWG (2015) for aesthetic and beneficial use.

The total acidity (as $CaCO_3$) was analysed for five samples collected in the July sampling round and ranged between <10 mg/L and 23 mg/L. The total alkalinity was measured for all 13 samples across the three sampling rounds and ranged between 113 mg/L and 2720 mg/L with an average total alkalinity value of 760 mg/L indicating that the deeper groundwater is generally adequate to maintain acceptable pH levels in the future.

The calculated chloride to sulfate ratio was below 4 (DSE, 2010) for the seven groundwater samples collected from four locations indicating presence of actual acidity in the deeper aquifer due to presence of AASS. The calculated alkalinity to sulfate ratio for these 13 samples ranged from 2 to 190 indicating the presence of existing acidity at four locations (ID46-BH01, ID46-BH05, ID46-GWBH03 and ID46-GWBH06) where the ratio was below 5 as per DER (2015) guidelines. The ratio stayed similar for the two sampling rounds in December 2016 and July 2017 for all the samples except for ID46-BH01 and ID46-BH05 where the ratio varied from 2 to 5 and 7 to 2 from December 2016 to June/July 2017 respectively. This may be attributed to the seasonal variation at these locations.

The soluble aluminium measured for the five samples collected in July 2017 ranged from <0.05 mg/l to 0.63 mg/L. All the values were below the concentration of 1 mg/L (DER, 2015) indicating absence of existing acidity.

For the deeper aquifer at Bonbeach, the alkalinity to sulfate ratio indicate presence of actual acidity at select locations, however the pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicates that the groundwater has sufficient buffering capacity to neutralise any acidity being produced.

Of 13 samples analysed for ammonia, 12 samples exceeded the ANZECC (2000) 95% fresh water.

ANZECC (2000) long term irrigation trigger levels were exceeded for total nitrogen (ID46-BH06 collected in July 2017) and fluoride (ID46-BH05 collected in July 2017) and total phosphorus (ID46-BH03 and ID46-BH05 collected in December 2016).

5.3.14 Indicative soil contamination assessment

Soil samples obtained during the CASS Stage B: Detailed site soil sampling program and assessment (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of soils within the Bonbeach project area. The results of the soil sampling program are discussed in the following sections, and have been compared to the adopted investigation levels for disposal threshold values outlined below.

Assessment criteria

The EPA Industrial Waste Resource Guidelines Publication IWRG 621(2009) criteria were adopted to assess the soil contamination status of the Bonbeach project area. A detailed explanation of the IWRG621 criteria is provided in Appendix A.

Results of investigation

Bonbeach analytical results

The tabulated analytical results of soil samples obtained and analysed from the Bonbeach project area are provided in Appendix C (Tables D12 – D13).

Environmental soil results and categorisation

The results of the soil sampling program were compared to the threshold concentrations listed in Table 2 of EPA Publication IWRG 621. A summary of elevated analytical results are presented in Table 38. All other analytes were reported below the maximum threshold limits for fill material.

Table 38 Summary of elevated results in the Bonbeach project area

Investigation Level	Copper (mg/kg)	Lead (mg/kg)	Benzo(a)pyrene (mg/kg)	TRH (C_{10}-C_{36}) (mg/kg)
EPA Publication IWRG 621 Fill Material upper limit	100	300	1	1000
ID46 CASS01_0.1	199	370	2.6	600
ID46 CASS02_0.1	222	98	<0.5	2,290
ID46 CASS02_0.3	93	56	2.8	670
ID46CASS10_0.5	56	71	1.4	<50
ID46 CASS15_0.1	199	126	1.0	150

Leachate results

Based on the results of the primary laboratory analysis, leachate analysis was requested on 15 samples with reported total concentrations greater than 20 times the Category C leachable concentration upper limits listed in Table 2 of EPA Publication IWRG 621 for either leachable copper, lead and/or benzo(a)pyrene.

All leachable results were reported as either below the adopted threshold concentrations listed in Table 2 of EPA Publication IWRG 621 or the laboratory detection limits, indicating that copper, lead, TRH and benzo(a)pyrene in the soil samples analysed had limited mobility. As such, soil samples ID46 CASS01_0.1, ID46 CASS02_0.1, ID46 CASS02_0.3, ID46CASS10_0.5 and ID46 CASS15_0.1 would be classified as **Category C contaminated soil**. These samples were all collected from anthropogenic fill material.

5.3.15 Groundwater contamination assessment

Groundwater samples obtained during the Stage C: Surface water/groundwater assessment sampling program (refer to Section 4.1.1) were analysed for a broad suite of contaminants to gain an indication of the contamination status of groundwater within the Bonbeach project area. The groundwater sample analytical program is outlined in Appendix C. The results of the groundwater sampling program are discussed below, and have been compared to the adopted investigation levels for relevant beneficial uses outlined below.

Assessment criteria

For the purposes of this assessment, the adopted groundwater beneficial uses have been assessed against Segment A1 (refer to Appendix J). The protected beneficial uses of Segment A1 are:

- Maintenance of ecosystems
- Potable water supply: Desirable
- Potable mineral water supply
- Agriculture, parks & gardens
- Stock watering
- Industrial water use
- Primary contact recreation
- Buildings and structures

The following criteria were adopted to assess the groundwater contamination status of the project areas:

- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Aquatic Ecosystems) – Maintenance of freshwater ecosystems (95%) criteria
- PFAS National Environment Management Plan Consultation Draft (2017) - interim/draft criteria for PFAS for slightly to moderately modified aquatic ecosystems (95% species protection)
- ADWG (2015) Australian Drinking Water Guidelines – health and aesthetic criteria
- PFAS National Environment Management Plan Consultation Draft (2017) - interim/draft health based criteria for PFAS in drinking water.
- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Primary Industries) – Investigation levels for long and short term irrigation
- ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, investigation levels for Primary Industries (Chapter 4.3 Livestock drinking water quality)
- NHMRC (2008) Guidelines for Managing Risks in Recreational Water.

Bonbeach analytical results

The tabulated analytical results of groundwater samples included in the Stage C: Surface water/groundwater assessment sampling program (refer to Section 4.1.1) from the Bonbeach project area are provided in Appendix C (Tables D10 and D11).

The results of the groundwater sampling program are summarised below.

Inorganics

Quaternary Aquifer

A number of metals (aluminium, arsenic, chromium (III + IV), copper, iron, lead, molybdenum, nickel and zinc) concentrations exceeded the adopted site investigation levels, as outlined below in Table 39.

Table 39 Summary of inorganic exceedances – Quaternary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of exceedances	Criteria exceeded
Aluminium (Total)	0.42	72	19.45	6	ADWG (2015) Aesthetic (0.2 mg/L) ANZECC (2000) Irrigation short term trigger levels irrigation (5 mg/L)
Aluminium (Filtered)	0.33	0.91	0.62	2	ADWG (2015) Aesthetic (0.2 mg/L)
Arsenic (Filtered)	0.003	0.013	0.005	1	ADWG (2015) Aesthetic (0.01 mg/L)
Chromium (III+VI) (Filtered)	0.001	0.029	0.0087	4	ANZECC (2000) 95% Fresh water (0.001 mg/L)
Copper (Filtered)	0.001	0.004	0.0025	1	ANZECC (2000) 95% Fresh water (0.014 mg/L)
Iron (Total)	0.47	79	16.22	6	ANZECC (2000) 95% Fresh water (0.3 mg/L) ANZECC (2000) Irrigation long term trigger levels irrigation (2 mg/L) ANZECC (2000) Irrigation short term trigger levels irrigation (10 mg/L)
Iron (Filtered)	0.2	2.6	0.95	4	
Lead (Filtered)	0.002	0.009	0.006	1	ANZECC (2000) 95% Fresh water (0.0034 mg/L)
Molybdenum (Filtered)	0.012	0.012	0.012	1	ANZECC (2000) Irrigation long term trigger levels irrigation (0.01 mg/L)

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of exceedances	Criteria exceeded
Nickel (Filtered)	0.001	0.11	0.022	4	ADWG (2015) Health (0.02 mg/L) ANZECC (2000) 95% Fresh water (0.011 mg/L)
Zinc (Filtered)	0.008	0.13	0.052	4	ANZECC (2000) 95% Fresh water (0.008 mg/L)

Upper Tertiary Aquifer

A number of metals (aluminium, arsenic, chromium (III + IV), copper, iron, nickel, selenium and zinc) concentrations exceeded the adopted site investigation levels, as outlined below in Table 40.

Table 40 Summary of inorganic exceedances – Upper Tertiary Aquifer

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of exceedances	Criteria exceeded
Aluminium (Total)	0.15	1.9	0.85	5	ADWG (2015) Aesthetic (0.2 mg/L) ANZECC (2000) 95% Fresh water (0.055 mg/L)
Aluminium (Filtered)	0.08	0.63	0.33	4	
Arsenic (Filtered)	0.001	0.012	0.01	3	ADWG (2015) Health (0.01 mg/L)
Chromium (III+VI) (Filtered)	0.001	0.036	0.01	3	ANZECC (2000) 95% Fresh water (0.001 mg/L)
Copper (Filtered)	0.003	0.011	0.01	2	ANZECC (2000) 95% Fresh water (0.0014 mg/L)
Iron (Total)	0.29	2.5	1.26	5	ADWG (2015) Aesthetic (0.3 mg/L) ANZECC (2000) Irrigation long term trigger levels irrigation (0.2 mg/L)
Iron (Filtered)	0.27	1.4	0.84	2	

Analyte	Minimum Conc (mg/L)	Maximum Conc (mg/L)	Average Conc (mg/L)	No of exceedances	Criteria exceeded
Lead (Filtered)	0.003	0.005	0.004	1	ANZECC (2000) 95% Fresh water (0.0034 mg/L)
Nickel (Filtered)	0.002	0.1	0.02	5	ADWG (2015) Health (0.02 mg/L) ANZECC (2000) 95% Fresh water (0.011 mg/L)
Selenium (Filtered)	0.001	0.03	0.01	3	ANZECC (2000) 95% Fresh water (0.011 mg/L) ANZECC (2000) Irrigation long term trigger levels irrigation (0.02 mg/L)
Zinc (Filtered)	0.008	0.04	0.02	4	ANZECC (2000) 95% Fresh water (0.008 mg/L)

Other organic compounds

Five samples (ID46-BH03, ID46-BH05, ID46-BH08, ID46-BH10 and ID46-GWBH05) were analysed for organic compounds including TRH, BTEX, PAH, phenols, OC OP pesticides and other volatile organic compounds.

Detectable concentrations of phenol (4.1 µg/L) were reported in groundwater samples obtained in ID46-BH01 which is located in the vicinity of a Groundwater Restricted Use Zone at [redacted].

Detectable concentrations of TRH fraction C6-C10 (40 µg/L), TPH C6-C9 (40 µg/L), toluene (25 µg/L), 3-&4-methylphenol (41 µg/L), phenols (45 µg/L), total phenolics (340 µg/L), and acetone (14 µg/L) were reported in groundwater samples obtained in ID46-BH03 which is located in the vicinity of a commercial/industrial area (including a furniture manufacturer).

Detectable concentrations of phenols (5 µg/L), acetone (8 µg/L), idomethane (4 µg/L) were reported in groundwater samples obtained in ID46-BH05 which is located in the vicinity of the rail corridor.

Detectable concentrations of phenols (1.6 µg/L) were reported in groundwater samples obtained in ID46-BH06 which is located in the vicinity of the rail corridor.

Detectable concentrations of acetone (1 µg/L) and idomethane (4 µg/L) were reported in groundwater samples obtained in ID46-BH10 which is located in the vicinity of the rail corridor.

All other analytes were reported below laboratory limit of reporting.

Assessment of beneficial uses

Maintenance of ecosystems

All concentrations reported in filtered samples were found to be within ANZECC (2000) Maintenance of Ecosystems FW 95% guidelines for slightly to moderately modified aquatic ecosystems with the exception of:

- Ammonia as N (ID46-BH08, ID46-BH10 and ID46-GWBH05), aluminium (ID46-BH08 and ID46-BH10), chromium (III+VI) (ID46-BH08, ID46-BH10 and ID46-GWBH05), copper (ID46-BH10), lead (ID46-BH10), nickel (ID46-BH10 and ID46-GWBH05) and zinc (ID46-BH08, ID46-BH10 and ID46GWBH05) concentrations in the Quaternary aquifer
- Ammonia as N (ID46-BH01, ID46-BH03, ID46-BH05, ID46-BH06, ID46-GWBH01, ID46-GWBH03 and ID46-GWBH06), aluminium (ID46-BH01, ID46-BH03, ID46-BH05 and ID46-GWBH01), chromium (III+VI) (ID46-BH05, ID46-BH06 and ID46GWBH01), copper (ID46-BH05 and ID46-BH06), lead (ID46-BH06), nickel (ID46-BH03, ID46-BH05 and ID46-BH06), selenium (ID46-BH03 and ID46-BH05) and zinc (ID46-BH03, ID46-BH05, ID46-BH06 and ID46-GWBH01) concentrations in the Upper Tertiary aquifer.

Potable water supply

All concentrations reported in filtered samples were found to be within ADWG (2015) Health guidelines, with the exception of:

- Nickel (ID46-BH10 and ID46-GWBH05) concentrations in the Quaternary aquifer
- Arsenic (ID46-BH03, ID46-BH05) and nickel (ID46-BH03, ID46-GWBH03 and ID46-GWBH06) concentrations in the Upper Tertiary aquifer

All concentrations reported in filtered samples were found to be within ADWG (2015) Aesthetic guidelines, with the exception of:

- Total dissolved solids (ID46-BH08 and ID46-BH10), aluminium (ID46-BH08 and ID46-BH10), iron (ID46-BH08) concentrations in the Quaternary aquifer
- Total dissolved solids (ID46-BH03, ID46-BH05, ID46-BH06, ID46-GWBH01, ID46-GWBH03 and ID46-GWBH06), sodium (ID46-BH03, ID46-GWBH01, ID46-GWBH03 and ID46-GWBH06), chloride (ID46-BH03, ID46-BH06, ID46-GWBH01, ID46-GWBH03 and ID46-GWBH06), sulphate (ID46-GWBH03), aluminium (ID46-BH03 and ID46-BH05), iron (ID46-GWBH03 and ID46-GWBH06) concentrations in the Upper Tertiary aquifer

Agriculture, parks & gardens

All concentrations reported in filtered samples were found to be within ANZECC (2000) Irrigation – Long-term Trigger Values guidelines, with the exception of:

- Fluoride (ID46-BH08), phosphorus (total) (ID46-BH08), aluminium (ID46-BH08, ID46-BH10), iron (ID46-BH08, ID46-GWBH04 and ID46-GWBH05) and molybdenum (ID46-BH08) concentrations in the Quaternary aquifer
- Fluoride (ID46-BH05), nitrogen (total) (ID46-BH06), phosphorus (total) (ID46-BH03, ID46-BH05), iron (ID46-BH01, ID46-BH03, ID46-GWBH03 ID46-GWBH06) and selenium (ID46-BH03) concentrations in the Upper Tertiary aquifer

All concentrations reported in filtered samples were found to be within ANZECC (2000) Irrigation – Short-term Trigger Values guidelines.

Stock watering

All concentrations reported in filtered samples were found to be within ANZECC (2000) Stock Watering guidelines, with the exception of:

- Total dissolved solids (ID46-GWBH06) concentrations in the Upper Tertiary aquifer

Primary contact recreation

All concentrations reported in filtered samples were found to be within the adopted NHMRC 2008 guidelines for recreational waters (health).

Buildings and structures

As specified in the SEPP GoV, contamination must not cause groundwater to become corrosive or adversely affect the structural integrity or building materials or structures.

A summary of existing conditions at the Bonbeach project area is provided in Section 6.2.

6 Summary of existing conditions

6.1 Edithvale

6.1.1 Presence of CASS

The review of the available information and the data collected during the soil and groundwater assessment discussed in Section 5.2 has indicated the nature and extent of CASS at Edithvale as having a 'high risk' of CASS being present in the project area:

- The Stage B soil assessment concluded:
  - Presence of AASS in 10 samples ranging from 0.02 %S to 0.14 %S in the sandy to silty clay layer (5 -10 mbgs)
  - Presence of PASS was confirmed in approximately 71% of samples collected across the entire soil profile, ranging from 0.005 %S to 1.58 %S
  - Net Acidity exceeded the criteria in approximate 33% samples collected from the central silty clay to sandy silt layer (4 -15 mbgs) with maximum acidity of 1.58 %S
  - Based on the analytical results and lithology observations from current and historical bores, the potential risk of encountering CASS at deeper layers ranging between 22 to 23 mbgs is marginal.
- A review of the groundwater field and analytical results (Stage C) noted:
  - The SWL of the groundwater for shallow 'Quaternary Aquifer' ranged between 0.68 mAHD and 1.30m AHD which equates to as shallow as 1.03 mbgs and deep as 5.73 mbgs, and the SWL for deeper '*Upper Tertiary Aquifer'* was measured ranging between 0.56 mAHD and 1.07 mAHD which equates to 1.31 mbgs to 5.85 mbgs respectively.
  - The groundwater chemistry was different for both the aquifers with the shallow groundwater being slightly acidic to neutral (pH ranging from 5.01 to 7.36) and fresh (Electrical conductivity values ranging from 307 µS/cm to 731 µS/cm) as compared to the alkalinity (pH ranging from 7 to 8.52) and salinity (Electrical conductivity values ranging from 2544 µS/cm to 21,653 µS/cm) noted in the deeper aquifer.
  - Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS were noted for the shallow aquifer. The chloride to sulfate ratio did not indicate presence of actual acidity for the deeper aquifer. The pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.
- Based on the CASS Stage B results and the estimate of soil to be disturbed, the Stage D hazard assessment as per DSE 2010 indicates that the hazard associated with disturbance of CASS at Edithvale is 'High'. For projects with 'High' hazard rating, it is recommended to avoid disturbance of CASS (if possible). Alternatively, an Acid Sulfate Soils Management Plan (ASSMP) needs to be developed in accordance with the BPMG (DSE, 2010) prior to construction. Additionally, a CASS risk assessment needs to be undertaken to effectively understand the risk and impacts of CASS disturbance to human health and environment. The project specific CASS risk assessment is presented in Section 8.

6.1.2 Potential sources of contamination

A summary of the potential sources of contamination, their location in relation to the Edithvale project area, how the potential contamination could be interacted with (impact pathway) and the associated potential contaminants of concern is presented in Table 41. The locations of potential sources of contamination in the project area are illustrated in Figure 10.

Table 41 Edithvale project area – potential source of contamination

Potential source of contamination	Location[4]	Impact pathway	Potential contaminants of concern
Geological unit			
Fill material – uncontrolled material used	Within project area	Excavation of soil	Metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, fertilisers, pesticides, herbicides, asbestos and aesthetics such as building rubble.
Quaternary Sands – naturally occurring disseminated pyrite	Within project area	Excavation of soil	Acidity, metals, salinity.
Land use			
Rail corridor – use of fill, illegal dumping, leaks and spills	Project area	Excavation of soil and groundwater	Oil, fuel and ash: petroleum hydrocarbons, PAHs, brake liners, engine and rail-car insulation: asbestos, weed spraying: arsenic, potentially lead and organochlorine pesticides (typically restricted to the track formation), illegal dumping of asbestos containing materials (particularly asbestos sheeting), illegal dumping of contaminated soil (various contaminants, including metals, PAHs), historical filling activities (various contaminants, including heavy metals and PAHs), illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard).
Service station – leaks and spills of fuels from filling vehicles and storing fuels	Both up and down hydrogeological gradient outside project area	Excavation of soil and groundwater	Aliphatic hydrocarbons, BTEX, PAH, phenols, lead.
Dry cleaners – leaks and spills from use and storage of chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Alkalis, bactericides, bleaches, brighteners, detergents, enzymes, fungicides, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), surfactants, turpentine, ammonia, waterproofing.
Commercial/industrial areas – use of fill, illegal dumping, leaks and spills from use and storage of chemicals and/or fuels	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Heavy metals, BTEX, TPH, PAHs, Asbestos

[4] Groundwater elevation contours were developed based on groundwater level measurements collected in July 2017 (Refer to EES Technical Report A *Groundwater*). These inferred contours indicated a west to south-westerly groundwater flow direction at Edithvale, ultimately towards Port Phillip Bay.

Potential source of contamination	Location[4]	Impact pathway	Potential contaminants of concern
Fire station – leaks and spills from use and storage of PFAS and/or oils and fuels	Up hydrogeological gradient outside project area	Excavation of soil and groundwater	Per- and Polyfluoroalkyl substances (PFAS), Aliphatic hydrocarbons, BTEX, PAH, phenols, lead.
Mower sales/service centre - leaks and spills from use and/or storage of chemicals and fuels	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals (lead), PAHs, petroleum fuels (BTEX, total recoverable hydrocarbons, phenolics), acids, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
Boat storage - leaks and spills from use and storage of fuels and/or chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals (aluminium, cadmium, chromium, copper, lead, , nickel, tin, zinc), Tributyltin (TBT), polycyclic aromatic hydrocarbons, petroleum fuels (benzene, toluene, xylene, ethylbenzene, total recoverable hydrocarbons, phenolics), acids, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
Former car dealer - leaks and spills from use and storage of fuels and/or chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Heavy metals, BTEX, TPH, waste oils, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), cyanides, polychlorinated byphenyls, PAHs, Asbestos
Upholsterer - leaks and spills from use and storage of chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	PFAS, alcohols, ammonia, ethylene glycol, sulfuric acid, benzene, toluene, ethylbenzene, xylenes, chloroform, chlorinated benzenes, dioxane, hydrogen chloride, acetates, solvents, heavy metals, phenols.
Mechanics - leaks and spills from use and storage of fuels and/or chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals (lead), PAHs, petroleum fuels (BTEX, total recoverable hydrocarbons, phenolics), acids, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), asbestos from brake replacement activities, alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
Audit Statements 70603-1, 36865-1, 54038-1, 64068-1 – residual contamination	Both up and down hydrogeological gradient outside project area	Excavation of soil and groundwater	Heavy metals, TPH and BTEX, nitrate and ammonia, pH

[redacted]

Figure 10 Edithvale project area – Potential sites of concern (Page 1 of 3)

[redacted]

Figure 10 Edithvale project area – Potential sites of concern (Page 2 of 3)

[redacted]

Figure 10 Edithvale project area – Potential sites of concern (Page 3 of 3)

6.1.3 Results of indicative contamination investigation

The following conclusions were made as a result of the indicative contamination investigation at the Edithvale project area:

- The intrusive soil investigation confirmed:
  - the presence of fill material, ranging from surface to 0.7 mbgs. The fill material included silt, sand, gravel, clay and asphalt.
  - detectable concentrations of PFHxS, PFOA and PFOS were reported in soil samples ID18-CASS05_1.5, ID18-CASS06_1 and ID18-CASS06_1.5 obtained in the vicinity for the former Edithvale fire station located at [redacted].
  - results from soil samples ID18-CASS02_0.1 and ID18-CASS16_0.3 collected from anthropogenic fill material exceeded the maximum concentrations allowed to be disposed of as Fill material and has the potential to be classified as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.
- The groundwater investigation confirmed:
  - concentrations of selected metals (aluminium, arsenic, chromium (III + IV), iron, manganese, nickel, and zinc), total dissolved solids, ammonia as N, nitrogen, phosphorous (total) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens beneficial uses in the Quaternary aquifer
  - concentrations of selected metals (aluminium, boron, iron, nickel and zinc), total dissolved solids, ammonia as N, sulphate, sulphate as S, phosphorous (total), fluoride exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens and stock watering beneficial uses in the Upper Tertiary aquifer
  - concentrations of PFHxS+PFOS and PFOS were reported above the PFAS NEMP 2017 freshwater ecosystem or the PFAS NEMP 2017 Drinking water (health) in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at [redacted].
  - detectable concentrations of PFHxS, 6:2 FTS, PFOA and PFHxA were reported in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at [redacted].
  - detectable concentrations of 3&4 methylphenol and phenol were reported in one groundwater sample obtained in the vicinity for the former boat storage facility located at [redacted]

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Edithvale level crossing removal construction footprint may be contaminated to some degree with metals, polycyclic aromatic hydrocarbons (PAH) and PFAS.

An indication of the volumes and characteristics of the spoil expected to be generated during the Edithvale level crossing removal is provided in 7.1.

6.1.4 Conceptual site model

Conceptual site models (CSMs) based on the Edithvale existing conditions are shown in Figure 11 and Figure 12.

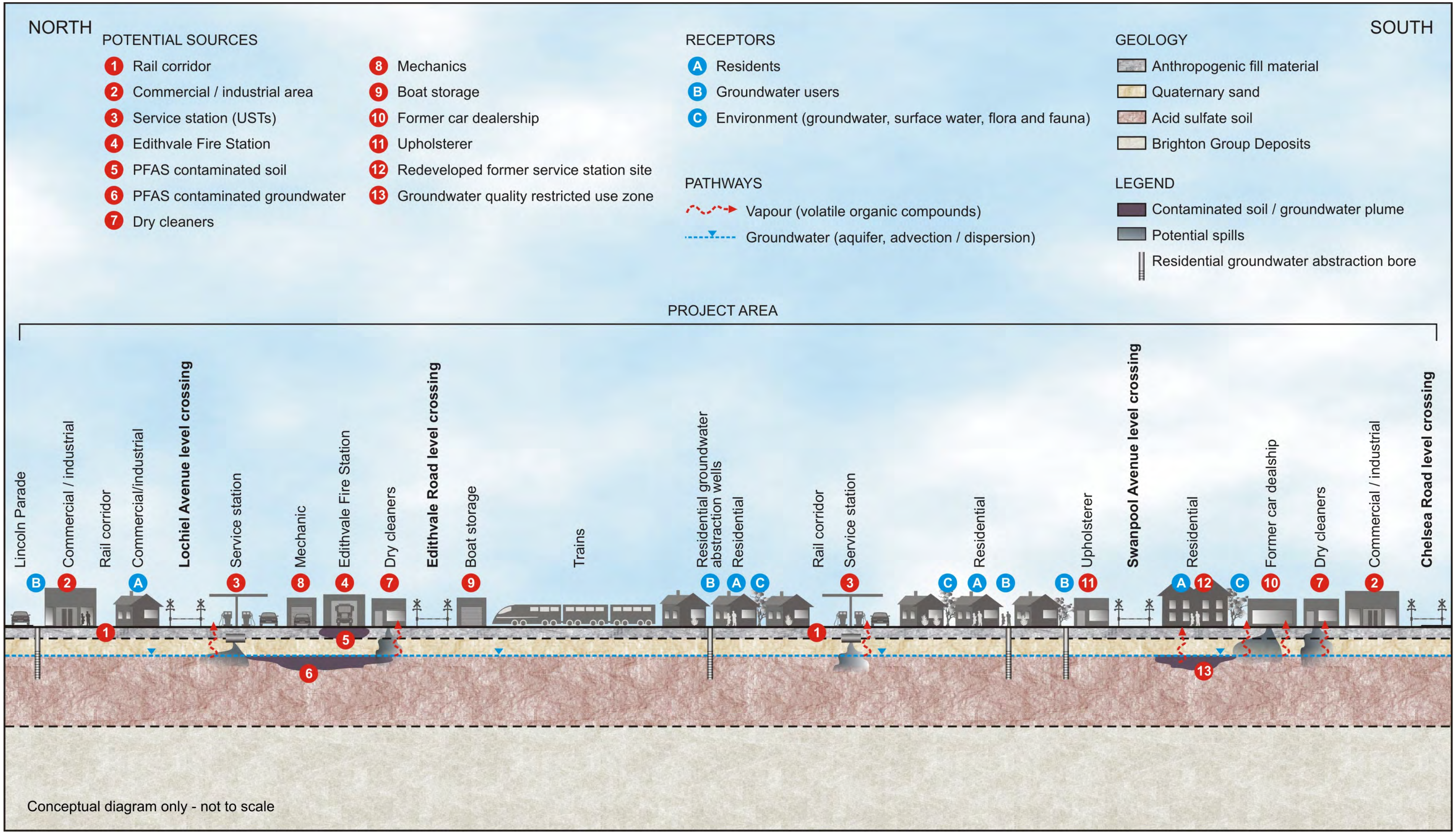


Figure 11 Edithvale project area conceptual site model (north-south)

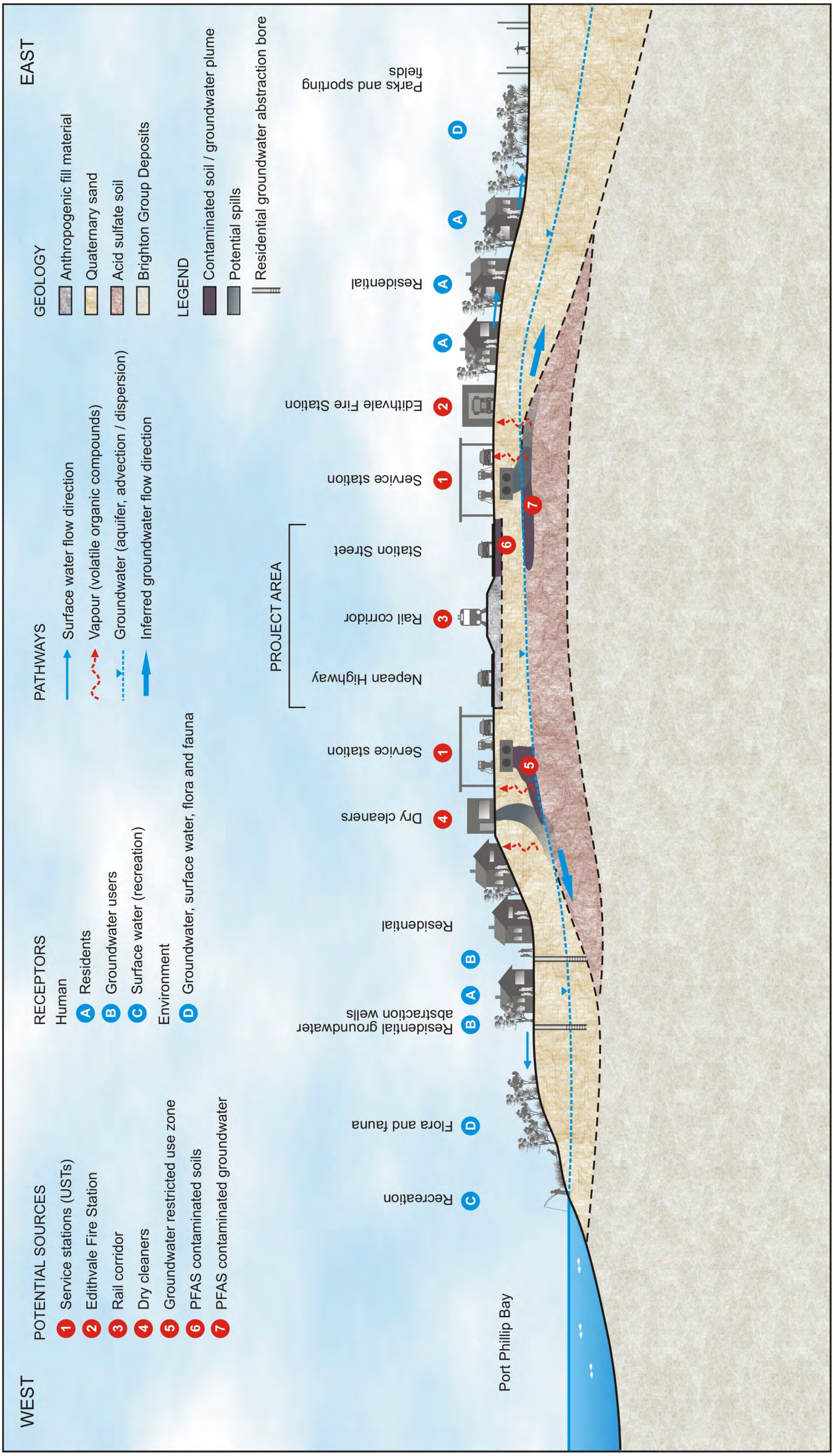


Figure 12 Edithvale project area conceptual site model (east - west)

6.2 Bonbeach

6.2.1 Presence of CASS

The review of the available information and the data collected during the soil and groundwater assessment as detailed in Section 5.3 concluded that there is 'high risk' of CASS being present in the project area.

- The Stage B soils assessment concluded:
  - Presence of AASS in four samples ranging from 0.02 %S to 0.07 %S in the fill sand (0.1 to 1 mbgs) and the deeper sandy to silty clay layer (15-16 mbgs)
  - Presence of PASS was confirmed in approximately 73% of samples collected across the entire soil profile, ranging from 0.005 %S to 1.01 %S.
  - Net Acidity exceeded the criteria in approximate 39% samples collected from the sandy silt to silty clay layer (3.5 to16 mbgs) with maximum acidity of 1.01 %S.
  - Based on the analytical results and lithology observations from current and historical bores, the potential risk of encountering CASS at deeper layers ranging between 22 to 23 mbgs is marginal.
- A review of the groundwater field and analytical results (Stage C) noted:
  - The SWL of the groundwater for shallow 'Quaternary Aquifer' ranged between 0.05 mAHD and 0.91 mAHD which equates to as shallow as 3.08 mbgs and as deep as 5.92 mbgs. The SWL for deeper 'Upper Tertiary Aquifer' was between below sea level -0.23m AHD and 1.06 mAHD which equates to 1.64 mbgs to 5.47 mbgs respectively.
  - The groundwater chemistry for the shallow aquifer was observed to be neutral to alkaline (pH ranging from 7.61 to 9.67) and fresh water (EC values ranging from 521 to 883 µS/cm). Comparatively the deeper groundwater was observed to be neutral to highly alkaline (pH ranging from 7.21 to 12.74) and fresh to saline (EC values ranging from 543 to 9447 µS/cm) in nature.
  - Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS were noted for both the shallow and the deeper aquifer. However the pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.

Based on the Stage B results and the estimate of soil to be disturbed, the Stage D hazard assessment as per DSE 2010 indicates that the hazard associated with disturbance of CASS at Bonbeach is 'High'. This implies that an ASSMP need to be developed in accordance with the BPMG (DSE, 2010) prior to the construction. The project specific risk assessment is presented in Section 8 (Table 45).

6.2.2 Potential sources of contamination

A summary of the potential sources of contamination and their location in relation to the Bonbeach project area is presented in Table 42. The locations of potential sources of contamination in the project area are illustrated in Figure 13.

Table 42 Bonbeach project area – Potential source of contamination

Potential source of contamination	Location[5]	Impact pathway	Potential contaminants of concern
Geological unit			
Fill material - uncontrolled material used	Within project area	Excavation of soil and groundwater	Metals, PAHs, petroleum hydrocarbons, fertilisers, pesticides, herbicides, asbestos and aesthetics such as building rubble.
Quaternary Sands – naturally occurring disseminated pyrite	Within project area	Excavation of soil	Acidity, metals, salinity.
Quaternary Swamp Deposits – naturally occurring	Within project area	Excavation of soil	Disseminated pyrite
Land use			
Rail corridor – use of fill, illegal dumping, leaks and spills	Project area	Excavation of soil and groundwater	Oil, fuel and ash: petroleum hydrocarbons, PAHs, brake liners, engine and rail-car insulation: asbestos, weed spraying: arsenic, potentially lead and organochlorine pesticides (typically restricted to the track formation), illegal dumping of asbestos containing materials (particularly asbestos sheeting), illegal dumping of contaminated soil (various contaminants, including metals, PAHs), historical filling activities (various contaminants, including heavy metals and PAHs), illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard).
Electrical sub-station – leaks and spills from use and/or storage of transformer oil	Project area	Excavation of soil and groundwater	Transformer oil that includes contaminants of concern such as chlorinated naphthalenes, chlorodiphenyls, polychlorinated biphenyls, PAHs.

[5] Groundwater elevation contours were developed based on groundwater level measurements collected in July 2017 (Refer to EES Technical Report A *Groundwater*). These inferred contours indicated a south to south-westerly groundwater flow direction, towards both Port Phillip Bay and Patterson River.

Potential source of contamination	Location[5]	Impact pathway	Potential contaminants of concern
Demolition of buildings – uncontrolled demolition	Project area	Excavation of soil and groundwater	Asbestos containing materials, metals and aesthetics such as building rubble.
Panel beaters – leaks and spills from use and/or storage of chemicals and fuels	Up hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals, PAHs, petroleum hydrocarbons, pesticides, volatile organic compounds, acids, alkalis, glycols
Telstra exchange – uncontrolled dumping, use of hazardous materials	Up hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals, PAHs, petroleum hydrocarbons, fertilisers, pesticides, herbicides, polychlorinated biphenyls, asbestos
Furniture manufacturer - leaks and spills from use and/or storage of chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Acids, alkalis, solvents, metals, total recoverable hydrocarbons.
Mower sales/service centre - leaks and spills from use and/or storage of chemicals and fuels	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Metals (lead), PAHs, petroleum fuels (BTEX, total recoverable hydrocarbons, phenolics), acids, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
Commercial/industrial areas – use of fill, illegal dumping, leaks and spills from use and storage of chemicals and/or fuels	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Heavy metals, BTEX, TPH, waste oils, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), cyanides, polychlorinated byphenyls, PAHs, Asbestos

Potential source of contamination	Location[5]	Impact pathway	Potential contaminants of concern
Service station – leaks and spills of fuels from filling vehicles and storing fuels	Both up and down hydrogeological gradient outside project area	Excavation of soil and groundwater	Aliphatic hydrocarbons, BTEX, PAHs, phenols, lead
Laundromat – leaks and spills of chemicals	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Alkalis, bactericides, bleaches, brighteners, detergents, enzymes, fungicides, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), surfactants, turpentine, ammonia, waterproofing.
Audit Statements [redacted] – residual contamination	Down hydrogeological gradient outside project area	Excavation of soil and groundwater	Heavy metals, TPHs and BTEX.

[redacted]

Figure 13 Bonbeach project area - Potential sites of concern (Page 1 of 3)

[redacted]

Figure 13 Bonbeach project area - Potential sites of concern (Page 2 of 3)

[redacted]

Figure 13   Bonbeach project area - Potential sites of concern (Page 3 of 3)

6.2.3 Results of indicative contamination investigation

The following conclusions were made as a result of the indicative contamination investigation at the Bonbeach project area:

- The intrusive soil investigation confirmed:
  - the presence of fill material, ranging from surface to 0.3 mbgs. The fill material included silt, silty sand, sand, gravel and sandy gravel.
  - results from soil samples ID46-CASS01_0.1, ID46-CASS02_0.1, ID46-CASS02_0.3, ID46-CASS10_0.5 and ID46-CASS_0.1 collected from anthropogenic fill material exceeded the maximum concentrations allowed to be disposed of as Fill material and has the potential to classify as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.
- The groundwater investigation confirmed:
  - concentrations of selected metals (aluminium, arsenic, chromium (III + IV), copper, lead, iron, manganese, , molybdenum, nickel and zinc), total dissolved solids, ammonia as N, nitrogen, fluoride, phosphorous (total) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens, and stock watering beneficial uses in the Quaternary aquifer
  - concentrations of selected metals (aluminium, chromium (III + IV), copper, lead, iron, nickel, selenium and zinc), total dissolved solids, ammonia as N, nitrogen (total), sodium, chloride, sulphate, phosphorous (total) and fluoride exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, and agriculture, parks and gardens beneficial uses in the Upper Tertiary aquifer
  - detectable concentrations of phenol (4.1 µg/L) were reported in a groundwater sample obtained from ID46-BH01 which is located in the vicinity of a Groundwater Restricted Use Zone at [redacted].
  - detectable concentrations of TRH fraction C6-C10 (40 µg/L), TPH C6-C9 (40 µg/L), toluene (25 µg/L), 3-&4-methylphenol (41 µg/L), phenols (45 µg/L), total phenolics (340 µg/L), and acetone (14 µg/L) were reported in a groundwater sample obtained from ID46-BH03 which is located in the vicinity of a commercial/industrial area (including a furniture manufacturer).
  - detectable concentrations of phenols (5 µg/L), acetone (8 µg/L), idomethane (4 µg/L) were reported in a groundwater sample obtained from ID46-BH05 which is located in the vicinity of the rail corridor.
  - detectable concentrations of phenols (1.6 µg/L) were reported in a groundwater sample obtained from ID46-BH06 which is located in the vicinity of the rail corridor.
  - detectable concentrations of acetone (1 µg/L) and idomethane (4 µg/L) were reported in a groundwater sample obtained from ID46-BH10 which is located in the vicinity of the rail corridor.

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Bonbeach level crossing removal construction footprint may be contaminated to some degree with metals, phenols, total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOCs).

An indication of the volumes and characteristics of the spoil expected to be generated during the Bonbeach level crossing removal is provided in 7.1.

6.2.4 Conceptual site model

Conceptual site models (CSMs) based on the Bonbeach existing conditions are shown in Figure 14 and Figure 15.

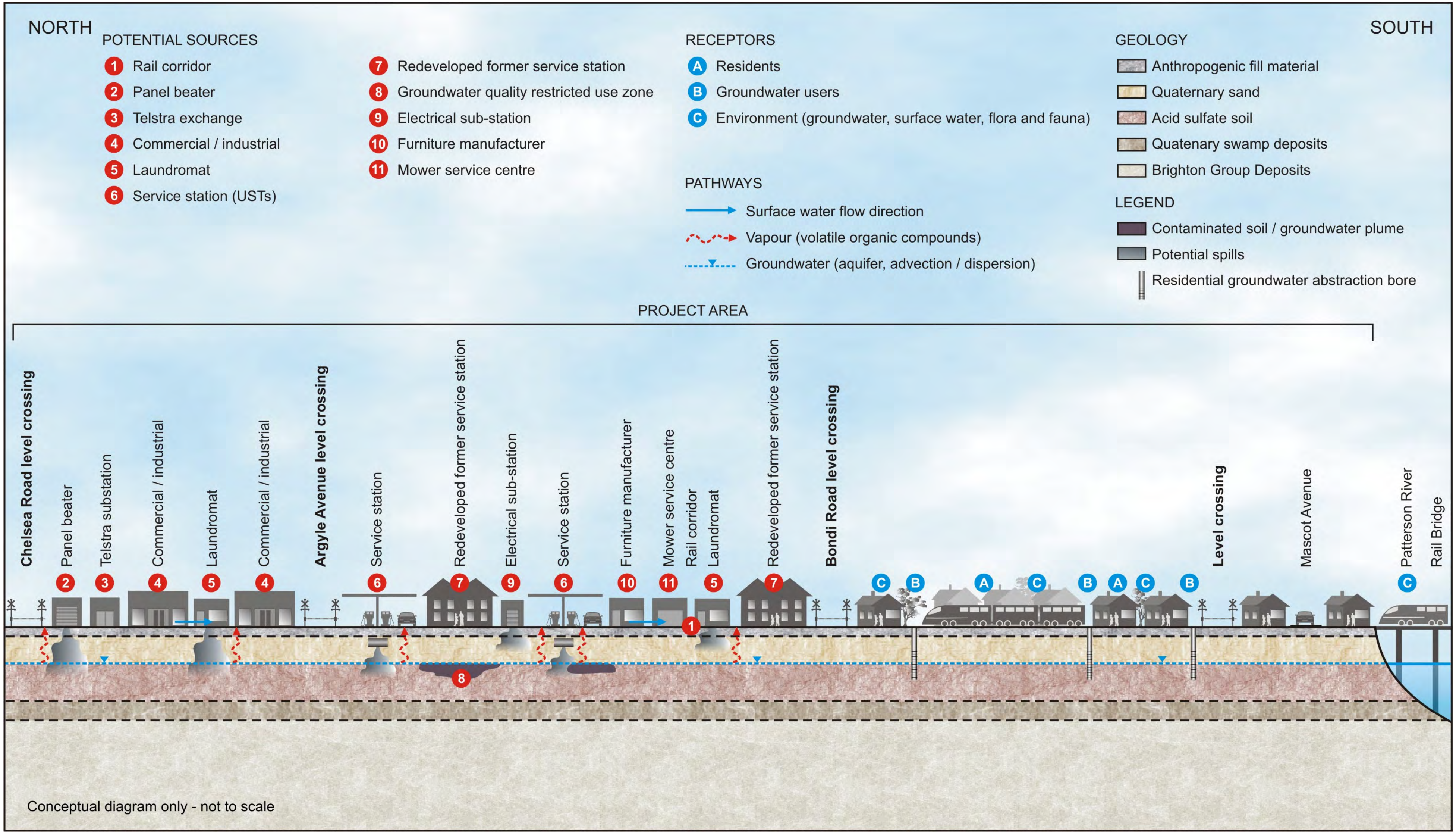


Figure 14 Bonbeach project area conceptual site model (north-south)

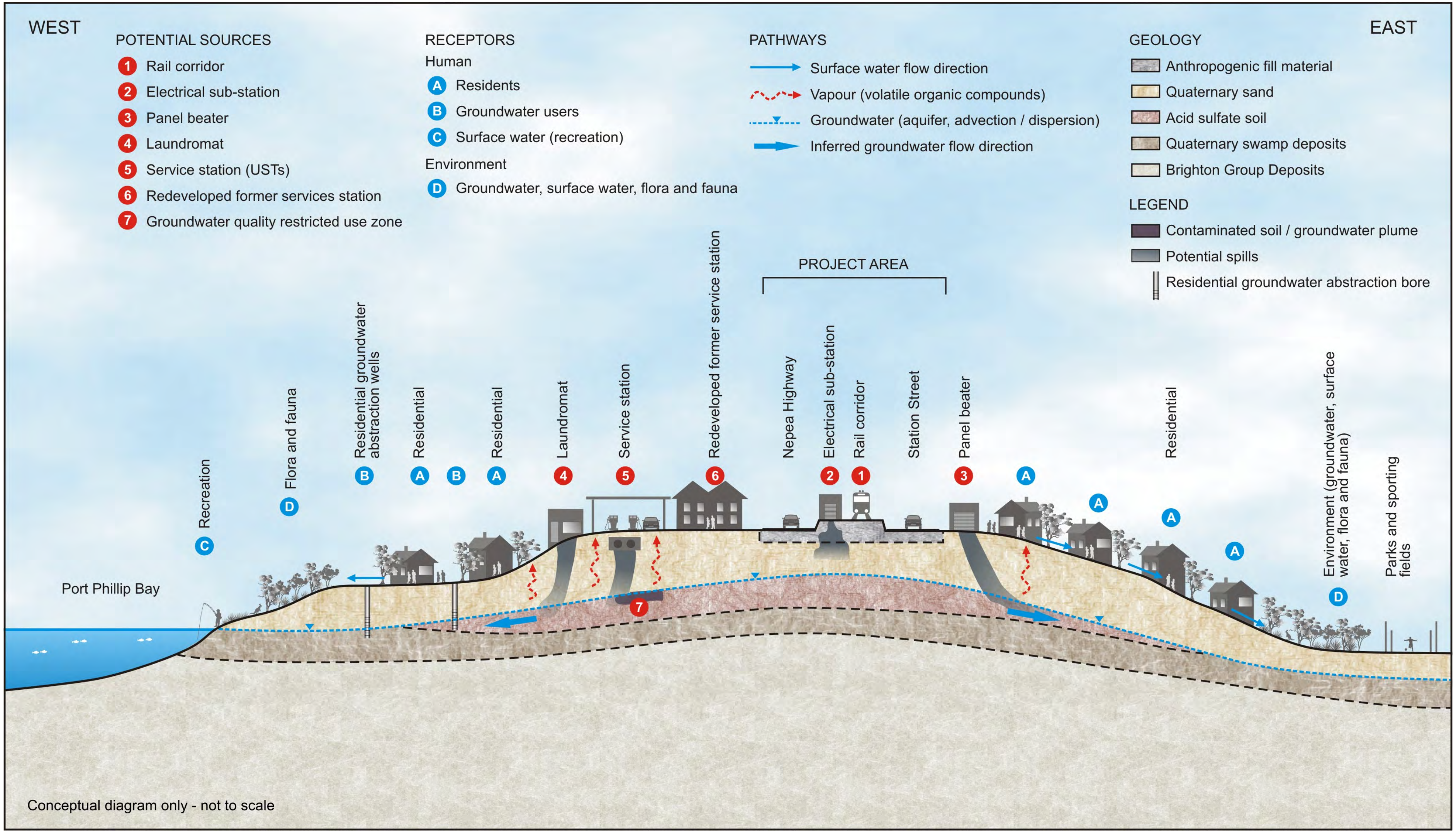


Figure 15 Bonbeach project area conceptual site model (east - west)

7 Spoil assessment

Spoil is waste soil or rock produced during the course of excavation and construction activities. Approximately 358,094 cubic metres (ex-situ) of excess spoil is expected to be produced during the excavation and construction works for the Edithvale and Bonbeach projects. Spoil would be generated during the following construction activities:

- site establishment
  - stripping and clearing within the project area
  - establishment of site fencing, staff facilities and temporary construction areas
  - installation of access roads
- protection and/or relocation of utility services
- excavation for piling, foundations and the rail trench
- on site waste management
- transport of spoil, excavated material and groundwater offsite
- removal of existing level crossing infrastructure.

7.1 Volumes and characteristics of excavated spoil

Indicative in-situ spoil category volumes from the Edithvale and Bonbeach level crossing removal projects were calculated using modelling software Leapfrog Geo and the inputs and assumptions detailed in Appendix K. Indicative ex-situ spoil volumes for each of the project areas are provided Table 43. A bulking factor of 1.3 was used to calculate ex-situ volumes.

Table 43 Indicative ex-situ spoil volume estimates

Spoil category	Edithvale level crossing removal (m3 ex-situ)	Bonbeach level crossing removal (m3 ex-situ)
Fill material	120,341	145,639
Solid inert waste	0	0
Contaminated spoil – Prescribed industrial waste		
Category A	0	50
Category B	0	50
Category C	11,440	28,704
Waste acid sulfate soil	43,355	8,515
Total	**175,136**	**182,958**

7.1.1 Spoil management options

Spoil generated during the construction activities for the Edithvale and Bonbeach projects should be managed in accordance with the EPA Victoria waste management hierarchy as defined in the EP Act 1970, which prioritises management of waste in the following order of preference:

- avoidance

- reuse
- recycling
- recovery of energy
- treatment
- containment
- disposal.

An assessment of the potential spoil management options during the Edithvale and Bonbeach level crossing removal is provided below.

Avoidance

The Edithvale and Bonbeach level crossing removals will involve:

- lowering the Frankston railway line into a trench under Edithvale Road whilst maintaining Edithvale Road at the current road level
- lowering the Frankston railway line into a trench under Bondi Road while maintaining Bondi Road at the current road level.

As such, the avoidance of spoil generation during the construction works at both project areas is not possible based on the current project description.

Reuse on site

The trench to be excavated during both the Edithvale and Bonbeach level crossing removal projects would occupy the entire construction sites. Therefore, there are minimal opportunities to reuse the spoil within the project areas however consideration could be given to the use in the construction of embankments, landscaping mounds, or similar structures.

Reuse off site Contaminated spoil generated during the construction activities for the Edithvale and Bonbeach projects could potentially be reused off site. EPA has developed an interim tool to enable spoil management and reuse for major infrastructure projects which expands on the use of the existing waste classifications. Classifications for prescribed industrial wastes (PIW) may be issued by EPA in accordance with Clause 11 of the Environment Protection (Industrial Waste Resource) Regulations 2009. Classifications can specify spoil management options through conditions such as requirements on auditing, tracking, treatment, storing or monitoring. Application for a Major Infrastructure spoil management classification and reuse can be made by contacting EPA’s Development Assessment Unit.

Recycling

Asphalt that is removed during the construction activities could be recycled and reused during the reinstatement of both Edithvale Road and Bondi Road at their existing levels. Other materials such as concrete and steel could be recycled offsite at an appropriately licenced recycling facility. Reuse of spoil should be in accordance with EPA Publication 1624 Industrial Waste.

Recovery of energy

The spoil to be excavated during the Edithvale and Bonbeach level crossing removals would likely include a mixture of rail ballast, anthropogenic fill material, potential acid sulfate soils (quaternary sands) and possibly some soils that could be classified as either Category C, B or A Contaminated Soil. It is unlikely that energy could be recovered from these materials.

Treatment

Options for treatment of contaminated spoil include:

- chemical immobilisation and solidification for the treatment of both inorganic and organic contaminants
- bioremediation for the treatment of organic contaminants, including petroleum hydrocarbons
- soil washing for the treatment of heavy metals, petroleum hydrocarbons, some VOCs, PCBs, PAHs, acids, pesticides, herbicides and cyanides
- thermal desorption for the treatment of VOCs, SVOCs, PCBs, dioxins and furans.

The application of these treatment technologies for the treatment of spoil would be applied to reduce contaminant concentrations and/or leachability and allow for Category A and B soils to be reclassified as either Category C soil or fill material post treatment. Reclassification of material would require additional testing and application to EPA Victoria. Treatment and subsequent reclassification by EPA Victoria would require stockpiling of the material pending EPA Victoria determination.

Treatment and disposal of PFAS contaminated soil

There are currently no waste disposal guidelines for PFAS in soil, water or solid (non-soil) waste streams. At the time of reporting EPA was working to understand the risks associated with landfill disposal of PFAS-impacted wastes as PFAS are very soluble and mobile, and current landfill leachate management practices may not provide adequate environmental protection. As such, landfill disposal is not permitted. This may change in the future. An outline of EPA's knowledge regarding PFAS and approach for the assessment and management of PFAS contaminated soil is provided in EPA Publication 1669.1 Interim position statement on PFAS. It is noted in Section 5.2.14 that detectable concentrations of PFAS have been reported in shallow soils in the vicinity of the fire station at 206 Station Street, Edithvale.

In effect, this means that waste containing PFAS has limited options with respect to disposal and may require treatment prior to disposal. Potential treatment options include:

- excavation and Ex Situ Thermal Desorption - desorption and/or destruction of organic contaminants in excavated soil by heating, usually by direct heating thermal unit. There are currently no facilities licensed specifically to treat PFAS-impacted wastes in Victoria. One facility (Renex in Lyndhurst) currently has approval from EPA Victoria to undertake a trial for research, development and demonstration purposes to treat PFAS impacted soils and liquids. Under this approval, they are authorised to accept a limited amount of soil and liquid.
- physical containment/capping - containment or capping of contaminated PFAS material to prevent or significantly reduce contaminant migration and to prevent human and environmental exposure. This is a feasible option, particularly if soil is required for filling purposes. This option will not remove or destroy contamination, and shallow groundwater may limit containment volume. Ongoing risk to groundwater from PFAS within soil would need be considered and managed appropriately.
- excavation and off-site disposal - disposal to landfill. As noted above, landfill disposal is not permitted. This may change in the future.
- stabilisation - chemically binds contaminants within a stabilised mass and chemically reduces the hazard potential of a waste by converting the contaminants into less soluble, mobile, or toxic forms. Most commonly undertaken ex-situ (either on-site or off-site).

- soil washing - soil is excavated and “washed” such that the contaminant is leached from the soil, collected and subsequently bound onto a substrate which can then be destroyed by a separate method. Technology has not been attempted on a large scale in Australia although bench trials have been successful. PFAS impacted substrate still requires treatment or disposal.

It is anticipated that EPA Victoria will eventually determine waste disposal guidelines for PFAS, and therefore at some point in the future disposal to landfill as Category B or C contaminated waste may be possible. The likely timing of such a decision is not known. As such, it is recommended that PFAS impacted solid wastes be minimised wherever possible. Reducing the volume of PFAS impacted soiled wastes could include:

- minimise PFAS impacted wastes by not mixing with any other material that might not be contaminated
- undertake a high degree of delineation so that the location and volume of contaminated material is fully known
- store wastes onsite in such a way that the risk of mobilising PFAS is minimised as far as practicable to prevent environmental impact (such as through limiting exposure to rain or surface water run-off, as PFAS is very water soluble)
- where PFAS-impacted leachate is generated, collect and manage the leachate
- if no waste disposal or treatment option is available at the time of construction, periodic review (at least annually) will be required to understand what options are available to adequately dispose of PFAS impacted wastes.

Treatment and offsite disposal of acid sulfate soils/rock

Offsite disposal of waste acid sulfate soil and rock can only occur to a premise that is either:

- licenced to accept waste acid sulfate soil and rock in accordance with the Environment Protection Act 1970, or
- has an Environment Management Plan (EMP) approved by EPA Victoria.

Removal of bonded asbestos

Bonded asbestos (that is fragments of asbestos cement sheeting) in soils can be treated (or abated) by physically removing (hand picking) asbestos fragments from soils and subsequently have the soil certified by an independent competent person as being ‘visually free’ (Worksafe Guidance 2010 – Asbestos Contaminated Soils). The abated soils would be required to be categorised as fill material using EPA Publication IWRG 621 Soil hazard categorisation and management prior to disposal offsite to a landfill licenced to accept abated fill material. The receiving facility must be notified that the material previously contained asbestos. If the abated fill material is found to contain asbestos during disposal then it must be managed as asbestos-containing material in accordance with WorkSafe’s OHS regulations and EPA’s Asbestos transport and disposal (EPA Publication IWRG611.2 Asbestos transport and disposal). This process would require space for spreading the soils and appropriate Occupational Health and Safety measures would be required.

Disposal

Due to the limited space within the construction boundary, spoil generated during the Edithvale and Bonbeach level crossing removal projects will likely require disposal offsite. Waste spoil taken off site for disposal must be classified in order to determine EPA Victoria requirements and to choose an appropriate disposal or re-use option. According to the Gazette S195, contaminated soil means ‘soil or a mixture of soils that can be classified as Category A, B or C

Contaminated Soil as provided for under the Regulations and defined in the Industrial Waste Guidelines (published in Special Gazette No. S177 on 9 June 2009).' The guidelines set the framework for the categorisation of wastes and define criteria used for the categorisation of waste soil in Victoria. The Soil Hazard Categories in accordance with the EPA Victoria Publication IWRG 621 Industrial Waste Resource Guidelines: Soil Hazard Categorisation and Management are:

- **Fill** – soil, gravel and rock of naturally occurring materials, often referred to as 'clean fill' by industry, with concentrations less than the upper limits specified for 'fill'. EPA Victoria does not regulate the use of fill material and re-use of this soil does not require EPA Victoria approval, however other authorities such as local councils, may have individual requirements. Use of fill material on any site must take into account general obligations (under the EP Act) to prevent adverse impacts on the environment and human health.
- **Category C** – contaminated soil with concentrations exceeding the limits for 'fill' but not exceeding the limits for 'Category C'. This is the lower level of contaminated soil classification for disposal and is accepted at a number of licensed landfills in Victoria, once the landfill has reviewed analytical results and agreed to accept the soil. Category C contaminated soils must be transported by an appropriately licensed EPA Victoria vehicle (unless exception issued) and accompanied by Waste Transport Certificates.
- **Category B** – contaminated soil with concentrations exceeding the limits set out for 'Category C' but not exceeding the limits for 'Category B'. This is the higher level of contaminated soil classification for disposal, and is accepted at only one licensed landfill (SUEZ landfill in Taylors Road, Lyndhurst) and/or a limited number of treatment facilities in Victoria. Category B waste is regulated by EPA Victoria and is subject to the same landfill acceptance, transport and certificate requirements as Category C waste soils.
- **Category A** – contaminated soil with concentrations exceeding the limits set out for 'Category B'. Category A soils are regulated by EPA Victoria are subject to the same transport regulations as Category B or C soils, however soils with this higher level of contamination cannot be disposed of to landfill. The soils must be treated either on or off site, or stored pending availability of an appropriate treatment technology. Once treated (or partially treated) the soils may be reclassified and, if appropriate, retained on site or disposed of to a licensed facility.

Provision of stockpiling area

Due to the limited space within the project area boundaries, an offsite stockpiling (and potential treatment) area may be required for spoil excavated during the projects. Any stockpile area would need to be identified in consultation with EPA's Development Assessment Unit and other stakeholders including The City of Kingston and landowners as appropriate. The stockpile area would need to be large enough to accommodate any spoil management strategy (that is treatment and reclassification prior to offsite disposal).

Containment

The trenches to be excavated during the Edithvale and Bonbeach level crossing removal projects would occupy the entire construction sites. Therefore, there will be limited opportunities to contain the spoil within the project areas.

Transport of spoil for off-site disposal

EPA Victoria regulates the storage, transport and disposal of waste in Victoria. Contaminated soil is required to be transported using a vehicle with an EPA Victoria permit accompanied by a waste transport certificate. The transported contaminated soil may only be accepted by a licenced facility unless exempted from the process by EPA Victoria. Haulage routes for transport of spoil would be informed by the construction methodology; however key routes are expected to be on higher order roads. This is further discussed in EES Technical Report G *Traffic*.

Off-site disposal options and capacity assessment

Approximately 358,094 cubic metres (ex-situ) of excess spoil is expected to be produced during the excavation works for the Edithvale and Bonbeach projects. As detailed above, there will be limited opportunities to reuse the excess spoil within the project areas. As such, the excess spoil will need to be disposed of or re-used off-site.

The West Gate Tunnel Technical Report B - Impact Assessment Contaminated Soil and Spoil Management (Golder, 2017) includes an assessment of the capacity of existing facilities to the north and west of Melbourne, including EPA licensed landfills and former extractive industry sites (quarries). Golder concluded that that there was sufficient capacity within the existing facilities to the north and west of Melbourne to accommodate the estimated 2,743,000 cubic metres (in-situ) of spoil to be generated during the construction of the West Gate Tunnel that would likely require off-site disposal. A project specific landfill capacity assessment is currently underway. The results of the landfill capacity assessment will be incorporated into the EES when available.

Taking the Golder capacity assessment completed for the West Gate Tunnel Project and the relatively small volume of spoil expected the generated during the Edithvale and Bonbeach projects into account, it is considered that there should be sufficient capacity within the existing facilities to dispose of the approximately 358,094 cubic metres (ex-situ) of excess spoil expected to be generated during the Edithvale and Bonbeach level crossing removal projects. It is noted that spoil requiring off-site disposal must be managed off-site in accordance EPA Publication 1624 Industrial waste. Further, if detectable concentrations of PFAS are reported in soils, the soils will be classified as a Prescribed Industrial Waste and will need to be managed in accordance with EPA Publication 1669.1 Interim position statement on PFAS.

An assessment of the cumulative impacts of constructing the Edithvale and Bonbeach level crossing removal projects concurrently with other major infrastructure projects, including the West Gate Tunnel and Melbourne Metro Rail Tunnel Project, and the demands on landfill space is discussed further in Section 7.1.2.

7.1.2 Spoil cumulative impacts

The disposal of excess spoil to landfill and the capacity of the existing landfills to accept the spoil generated during the Edithvale and Bonbeach level crossing removals may be impacted by other major infrastructure projects being developed concurrently.

Other major infrastructure projects currently proceeding within the Melbourne region that would require significant landfill space include the Melbourne Metro Rail Tunnel Project and the Westgate Tunnel Project. It is noted that the estimated quantity of spoil requiring management during the Edithvale and Bonbeach level crossing removals only makes up six percent of the total spoil estimated to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail Tunnel and West Gate Tunnel infrastructure projects.

Excess spoil expected to be generated during the Edithvale and Bonbeach level removal projects has been assessed in Sections 7.1 and 7.1.1. A comparison of the indicative estimate of spoil volumes requiring disposal from the four projects is provided in Table 44. A bulking factor of 1.3 has been used to calculated ex-situ indicative estimate volumes.

Table 44 Indicative estimate of excess spoil volumes

Spoil category	Edithvale level crossing removals (m^3 ex-situ)	Bonbeach level crossing removals (m^3 ex-situ)	Melbourne Metropolitan Rail Tunnel (m^3 ex-situ)[6]	West Gate Tunnel (m^3 ex-situ)[7]
Fill material	120,341	145,639	1,754,090	2,150,200
Solid inert waste	-	-	-	257,400
	Contaminated spoil – Prescribed industrial waste			
Category A	-	50	20,410	3,900
Category B	-	50	33,930	18,200
Category C	11,440	28,704	118,820	202,800
Waste acid sulfate soil	43,355	8,515	716,300	110,500
Total	**175,136**	**182,958**	**2,643,550**	**2,743,000**

The indicative estimate of ex-situ quantities of spoil categories requiring disposal offsite from the Edithvale, Bonbeach, Melbourne Metropolitan Rail Tunnel and West Gate Tunnel infrastructure projects indicates that:

- 73% is estimated to be categorised as Fill material
- 15% is estimated to be categorised as Waste Acid Sulfate Soil
- 1% is estimated to be categorised as Category B contaminated soil
- 6% is estimated to be categorised as Category C contaminated soil.

The remainder of the material is expected to comprise of Category A soils (which cannot be disposed of to landfill) or solid inert waste.

EPA Victoria does not regulate the use of Fill material and re-use of this soil does not require EPA Victoria approval. As the use of Fill material off-site is not regulated and is not required to be disposed to an EPA licenced landfill, it is considered that there is sufficient capacity to reuse or dispose to landfill the combined estimated volume of Fill expected to be generated.

Category C contaminated soil is accepted at a number of licensed landfills in Victoria. There is considered to be sufficient capacity within EPA licenced landfills to accommodate the approximately 361,764 cubic metres (ex-situ) of Category C contaminated soils to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects. The application of treatment technologies for the treatment of spoil could potentially be applied to reduce contaminant concentrations and/or leachability allowed for Category C soils to be reclassified as Fill material post treatment. Further, Category A and B soils can also potentially be reclassified as Category C soil post treatment. Reclassification of material would require additional testing and application to EPA Victoria. Treatment is required to be undertaken at a facility licensed to receive and treat the particular material.

[6] Estimated spoil volumes sourced from the Melbourne Metro Rail Project Contaminated land and Spoil Management Impact Assessment (AJM JV, 2016)

[7] Estimated spoil volumes sourced from the West Gate Tunnel Technical Report B - Impact Assessment Contaminated Soil and Spoil Management (Golder, 2017)

Offsite disposal of waste acid sulfate soil and rock can only occur to a premise that is either licenced to accept waste acid sulfate soil and rock in accordance with the Environment Protection Act 1970, or has an Environment Management Plan (EMP) approved by EPA Victoria. There is considered to be sufficient capacity within EPA licenced and/or approved facilities to accommodate the approximately 878,670 cubic metres (ex-situ) of waste acid sulfate soil to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects.

7.2 Other key waste streams

Other key waste streams that would require management and disposal during the construction activities include:

- groundwater encountered during the excavation works
- surface water that comes into contact with excavated areas and contaminated spoil stockpiles.
- Groundwater management is discussed in Section 8 of the EES Technical Report A *Groundwater* and surface water is discussed in Section 8 of the EES Technical Report E *Surface Water*.

A Trade Waste Agreement (TWA) with the relevant utility authority may be an option to dispose of treated water off-site to sewer. If a TWA is not granted for disposal of treated water to sewer, alternative options for managing intercepted groundwater and surface water include:

- storing the water onsite, characterising the water, and determining appropriate treatment and discharge via stormwater, as per EPA Publication 1287 Guidelines for risk assessment of wastewater discharges to waterways, which considers TDS in the discharge. It should also consider the stormwater quality standards as per the Urban stormwater best practice environmental management guidelines
- storing the water onsite, characterising the water, determining appropriate treatment and reuse on site (for example for use in dust suppression). It is the responsibility of the proponent to ensure the water is appropriate for its intended reuse
- storing the water onsite, characterising the water, determining appropriate treatment and managed aquifer recharge (reinjection) in accordance with the appropriate water authority guidelines, SEPP Groundwaters of Victoria (which includes references to the Alternative Urban Water Supplies Regulatory Review (MAR) Technical Report, 28th August 2006, A Framework for Alternative Urban Water Supplies: MAR, December 2006) and EPA Publication 1290 Guidelines for Managed Aquifer Recharge with approval/further information to be sought from the relevant water authority as appropriate
- store the water onsite, characterise the water and determine appropriate disposal via a tanker and liquid waste disposal guidance in accordance with *Environment Protection Act 1970* and *Water Act 1989*.

Other solid inert, liquid and organic wastes, such as packaging, chemicals and food scraps should be managed in accordance with the Environment Management Framework developed for the projects.

8 Risk assessment

An assessment of risks to Beneficial Uses of land and groundwater (as specified in the SEPP *Prevention and Management of Contamination of Land* and the SEPP *Groundwaters of Victoria)* posed by the projects was undertaken in accordance with the method described in Section 4.2.

The initial and residual CASS and contamination risks associated with the projects are listed in Table 45. The likelihood and consequence ratings applied during the risk assessment process are provided in Appendix L.

Where relevant, the risks are separated by project area (Edithvale and Bonbeach) where the consequence or likelihood of the risk occurring is different. Risks were assessed for the construction and design/operation phases (where relevant). For further details refer to the EES Attachment II *Environmental Risk Report*.

Activation of CASS has the potential to impact the air environment. The following risk is further discussed in EES Technical Report I *Air Quality* and summarised in Section 9.

Table 45 CASS and contamination risks

Risk ID	Risk name	Risk pathway	Initial EPR ID	Initial risk level	Final EPR ID	Residual risk level
Edithvale and Bonbeach construction risks						
CL50	CASS/contaminated soil (physical environment)	Disturbance, handling, storage or disposal of CASS/contaminated soil (including asbestos) results in adverse health and environmental impacts to land.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil management sub-plan	Negligible	As initial EPR	Negligible
CL51	CASS/contaminated soil (odour)	Disturbance, handling, storage or disposal of CASS/contaminated soil leads to the generation of odorous material and results in a loss of amenity.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil management sub-plan EPR SC1 – Community and Stakeholder Engagement Management Plan	Negligible	As initial EPR	Negligible
CL52	Contaminated groundwater	Disturbance, handling, storage or disposal of acidic and/or contaminated groundwater results in adverse health and environmental impacts.	EPR CL4 – Acidic and/or contaminated groundwater (construction)	Negligible	As initial EPR	Negligible
CL53	Unknown contamination	Unknown contamination encountered during construction results in environmental, health or amenity impacts.	EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Negligible	As initial EPR	Negligible
CL54	Spill	Fuel/chemical spill results in adverse health or environmental impact.	EPR CL3 – Waste management	Negligible	As initial EPR	Negligible

Risk ID	Risk name	Risk pathway	Initial EPR ID	Initial risk level	Final EPR ID	Residual risk level
CL55	Other waste streams	Management of other waste (solid inert, liquid, organic, packaging and food scraps) results in environmental impact.	EPR CL1 – SMP EPR CL3 – Waste management	Negligible	As initial EPR	Negligible
CL56	Non-compliance (waste transport / disposal)	Transport or disposal of CASS and/or contaminated soil is not in compliance with EPA Victoria permit/licence and results in an environmental impact.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan	Negligible	As initial EPR	Negligible
CL57*	Contamination (vapour) - EV	Intersection of contaminated soil and/or groundwater resulting in vapour impacts on human health.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan EPR CL4 – Acidic and/or contaminated groundwater (construction) EPR GW4 – Groundwater Management Plan	Negligible	As initial EPR	Negligible

Risk ID	Risk name	Risk pathway	Initial EPR ID	Initial risk level	Final EPR ID	Residual risk level
Groundwater associated risks (operation phase)						
GW60	CASS activation - EV	Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses of land and groundwater.	EPR GW1 - Rail trench design EPR GW3 – Groundwater Management and Monitoring Plan	Moderate	EPR GW1 - Rail trench design EPR GW2 - Groundwater performance outcomes EPR GW3 – Groundwater Management and Monitoring Plan EPR CL5 – Acidic and/or contaminated groundwater (operation)	Negligible
GW62	Contaminant migration - EV	Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses for land and groundwater.	EPR GW1 - Rail trench design EPR GW3 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Moderate	EPR GW1 - Rail trench design EPR GW2 - Groundwater performance outcomes EPR GW3 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction) EPR CL5 – Acidic and/or contaminated groundwater (operation)	Minor

Risk ID	Risk name	Risk pathway	Initial EPR ID	Initial risk level	Final EPR ID	Residual risk level
GW67	CASS activation - BB	Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses of land and groundwater.	EPR GW1 - Rail trench design (Edithvale and Bonbeach) EPR GW3 – Groundwater Management and Monitoring Plan	Minor	EPR GW1 - Rail trench design (Edithvale and Bonbeach) EPR GW2 - Groundwater performance outcomes EPR GW3 – Groundwater Management and Monitoring Plan EPR CL5 – Acidic and/or contaminated groundwater (operation)	Minor
GW69	Contaminant migration - BB	Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses of land and groundwater.	EPR GW1 - Rail trench design (Edithvale and Bonbeach) EPR GW3 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Negligible	EPR GW1 - Rail trench design (Edithvale and Bonbeach) EPR GW2 - Groundwater performance outcomes EPR GW3 – Groundwater Management and Monitoring Plan EPR CL1 – CEMP EPR CL4 – Acidic and/or contaminated groundwater (construction) EPR CL5 – Acidic and/or contaminated groundwater (operation)	Negligible

**Risk CL56 only applies to the project at Edithvale.*

Table 46 Air quality risks

Risk ID	Risk name	Risk pathway	EPR ID	Risk level	Reference to relevant technical report
AQ12	Air quality-odour	Odour from contaminated soils (including acid sulfate soils) resulting in amenity impacts	EPR CL2 Acid Sulfate Soils management sub-plan	Negligible	EES Technical Report I *Air Quality*

9 Impact assessment

9.1 Impact pathways

Construction of the projects has the potential to cause the following impacts:

- Disturbance, handling, storage or disposal of CASS/contaminated soil (including asbestos) results in adverse health and environmental impacts.
- Disturbance, handling, storage or disposal of CASS/contaminated soil leads to the generation of odorous material and results in a loss of amenity.
- Disturbance, handling, storage or disposal of acidic and/or contaminated groundwater results in adverse health and environmental impacts.
- Unknown contamination encountered during construction results in environmental, health or amenity impacts.
- Fuel/chemical spill results in adverse health or environmental impact.
- Management of other waste (solid inert, liquid, organic, packaging and food scraps) results in environmental impact.
- Transport or disposal of CASS and/or contaminated soil is not in compliance with EPA Victoria permit/licence and results in an environmental impact.
- Intersection of contaminated soil and/or groundwater resulting in vapour impacts on human health.

Construction and ongoing operation of the projects has the potential to cause impacts that could result from the projects relate to:

- Drawdown on the down gradient side and mounding of groundwater on up-gradient side of trench could result in changes to regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses.
- Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses.

The following section outlines the impacts for those risks considered during the risk assessment. The impacts are discussed together in Section 9.2 (where the magnitude, extent or duration of the impact is the same for each project area) and separately in Section 9.3 for Edithvale and Bonbeach (where the magnitude, extent or duration of the impact differs).

9.2 Construction impacts applicable at Edithvale and Bonbeach

The combined impacts, applicable to both Edithvale and Bonbeach during the construction stage, relevant to this assessment include:

9.2.1 CASS/Contaminated soil (residents) (Risk CL50)

Construction of the level crossing removals will involve the excavation of an estimated 358,094 m^3 (ex-situ) of spoil across both projects. The types and volume of spoil that would be generated are summarised below.

Coastal Acid Sulfate Soils

As discussed earlier (Section 1.2), when exposed to the air (either by excavation or lowering of groundwater table), acid sulfate soils can produce sulfuric acid. The oxidation of acid sulfate soils can result in the generation, mobilisation and migration of acidity which can liberate contaminants (e.g. nutrients and metals) and potentially impact the environment, engineered structures and human health. Once released from the soil profile, sulfuric acid and its subsequent impacts (discussed further below) can persist in the environment for as long as the sulfuric acid is being generated.

The disturbance of acid sulfate soils by excavation is likely to have a negligible risk of impact on human health and the surrounding environment. This is because the likely occurrence of PASS in the area to be excavated has been established by undertaking a detailed sampling program in accordance with the IWMP (2009) including EPA publication 655.1 (2009) and CASS BPMG (DSE, 2010). This sampling is sufficient to develop an appropriate management plan including disposal to minimise impacts during construction works.

The assessment shows that acid sulfate soils are present at various locations between 4 mbgs and 15 mbgs at Edithvale and 3.5 mbgs and 16 mbgs at Bonbeach. The spoil calculation data shows that approximately 51,870 m^3 (ex-situ) of acid sulfate soils may require management from the project areas. This estimate is based on regional geology as well as the CASS sampling program results (Section 5.2.12 and Section 5.3.12) and is considered to be indicative of what is likely to be encountered.

There are two key activities that have the potential to encounter or activate acid sulfate soils– when the piles are installed and when the trenches are excavated.

1. Pile installation

Spoil generated by the pile installation would likely contain some acid sulfate soil when it is brought to the surface. Also, in situ PASS may be exposed during the piling activities. However, the pile installation process will have minimal time (unlikely to be more than 8 hours) between the spoil being excavated and the pile being installed, and therefore is considered unlikely to activate acid sulfate soils in-situ. A maximum of 18 hours exposure to air without treatment is considered an acceptable timeframe for course acid sulfate soils (Dear et al, 2014) such as those within the project area.

There is expected to be approximately 65,787 m^3 (ex-situ) of spoil excavated from piling activities in both project areas. Approximately 48% of this volume is estimated to be waste acid sulfate soils.

Given the constrained sites and the need to construct the trenches within the existing rail alignment there is no opportunity to move the locations of the piled walls of the trench to minimise the amount of PASS encountered.

Acid sulfate soil excavated during the piling activity will be managed in accordance with the Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils.

The primary proposed management measure would be to remove soil predicted to be acid sulfate soils from site immediately and transport it to a facility licensed to receive such soils.

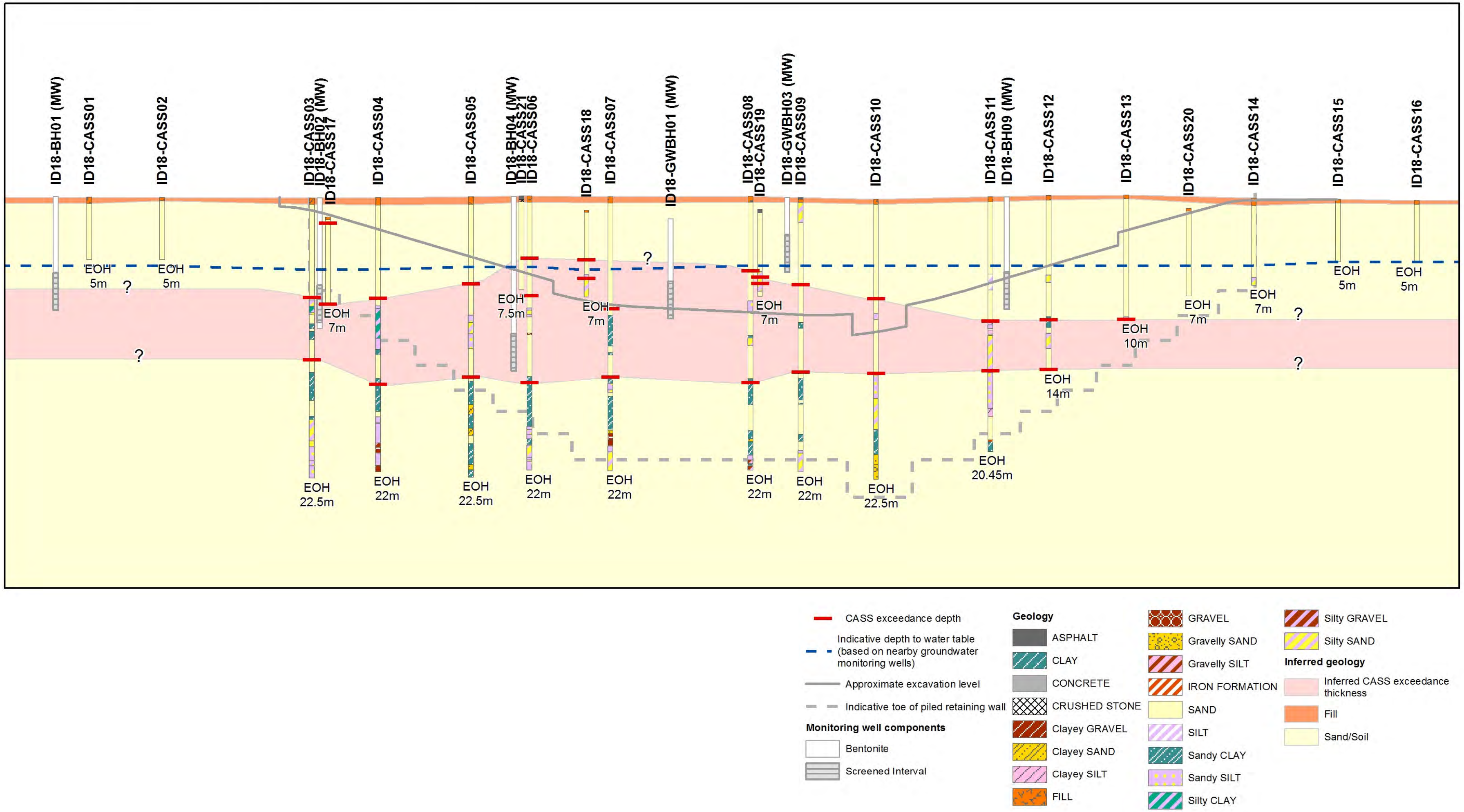
2. Excavation of the trenches

Excavation of the trenches is likely to activate potentially acid sulfate soils generally at 4 mbgs at Edithvale and 3.5 mbgs at Bonbeach. Figure 16 and Figure 17 shows a schematic section of the proposed excavation and the depths where it is expected to intersect with PASS at Edithvale and Bonbeach respectively. At Edithvale, there is a high potential of intercepting the PASS layer during excavation of the rail trench and associated infrastructure. The approximate volume of PASS likely to be generated at Edithvale is 43,355 m^3 (ex-situ). At Bonbeach (Figure 17) the depths where samples exceeded the DSE 2010 CASS management criteria are located below the depth of the excavation. As such, at Bonbeach there is limited potential of intercepting potential acid sulfate soil - approximately 2,000 cubic metres is expected to be generated during excavation of the water storage structure and the associated deeper sections of the trench.

The pile walls on either side of the trench will be constructed prior to excavation of the trench itself. This will prevent any ground or surface water in the trench area from mobilising into the surrounding groundwater environment. This will effectively prevent acidic water (generated by contact between water and exposed acid sulfate soils, for example rain water) from contaminating existing groundwater or adjacent soils. The pile walls will extend several metres below the deepest excavation point which will also prevent the potential for contamination as a result of the activation of acid sulfate soils.

The preferred management of excavated acid sulfate soils would be to transport them off site directly to a licenced facility.

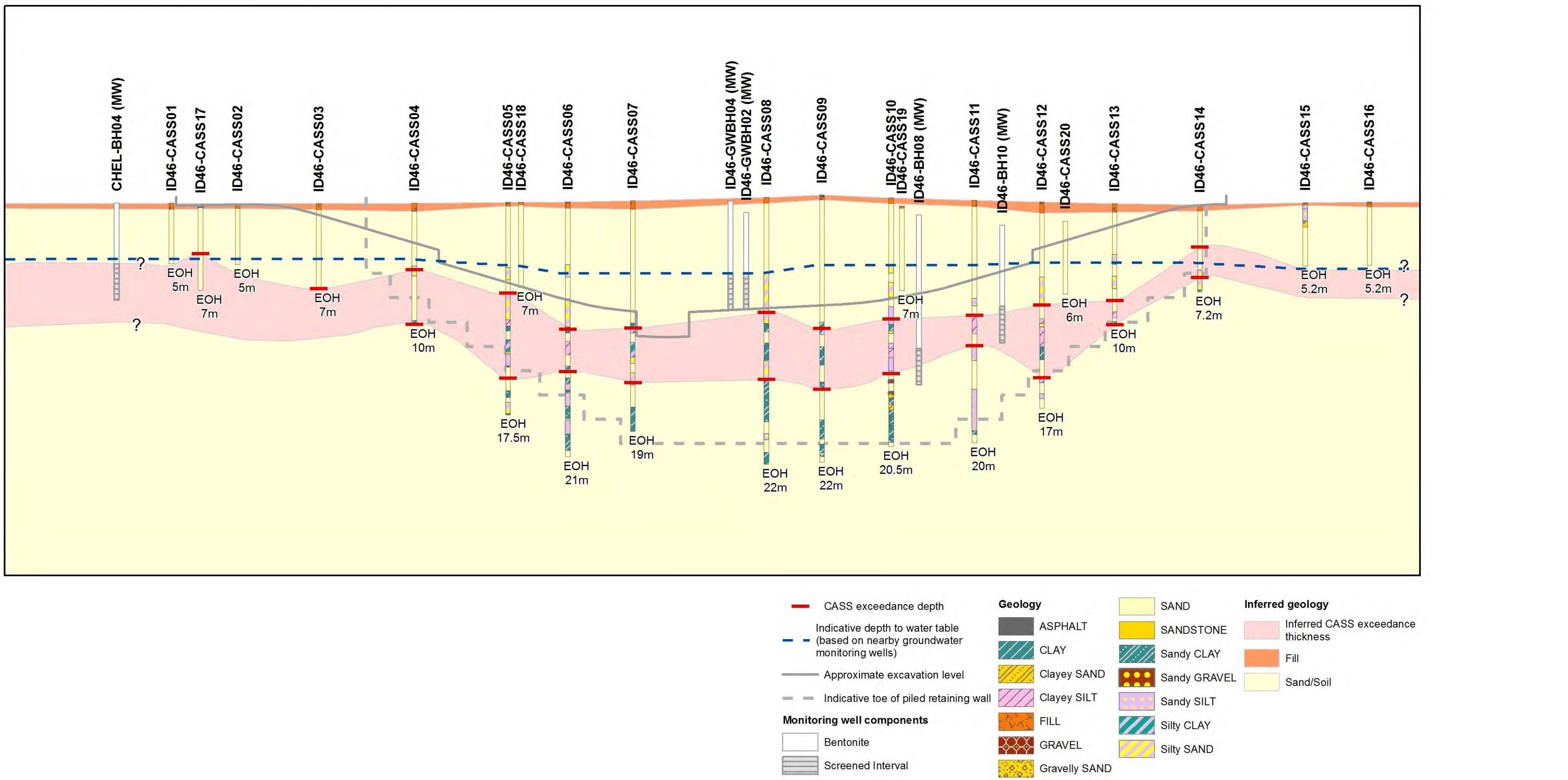
SECTION VIEW (15X VERTICAL EXAGGERATION) - EDITHVALE



Graphics showing inferred fill/CASS exceedance/sand/soil are indicative only

Figure 16 Schematic representation of Longitudinal sections of Boreholes and extent of trench - Edithvale

SECTION VIEW (15X VERTICAL EXAGGERATION) - BONBEACH



Graphics showing inferred fill/CASS exceedance/sand/soil are indicative only

Figure 17 Schematic representation of Longitudinal sections of Boreholes and extent of trench – Bonbeach

Contaminated soil

Based on the desktop and field investigations undertaken it is expected that some of the excavated soil will be contaminated as a result of existing and historical land uses, such as the use of fill material in the rail corridor and adjacent land uses such as a fire station, service stations and drycleaners. Typical contaminants are considered to be metals, hydrocarbons, asbestos and other industrial chemicals. A limited intrusive investigation was undertaken adjacent to the proposed rail trench to investigate the potential for contamination whilst minimising disruption to rail operations and protect the safety of personnel undertaking the field investigation. The results of the investigation are considered to be indicative of the contamination profile of the shallow soils (to a depth of approximately 2 mbgs) to be excavated.

Approximately 40,144 m^3 (ex-situ) or 11% of the total spoil to be excavated is expected to be categorised as Category C contaminated soil. It has been assumed that approximately 100 m^3 of soils beneath the substation in the Bonbeach project area will be contaminated by PCBs and categorised as either Category A or Category B contaminated soil.

Category B and C contaminated soil can be disposed of at appropriately licensed landfills and/or treatment facilities within Victoria. Category A soils require treatment and reclassification prior to transport and disposal to landfill.

Soil samples obtained in the vicinity of the fire station adjacent to the Edithvale sites reported detectable concentrations of PFAS. There are currently no waste disposal guidelines for PFAS in soil, water or solid (non-soil) waste streams. At the time of reporting EPA had released a statement that it was working to understand the risks associated with landfill disposal of PFAS-impacted wastes and was not approving landfill disposal (excluding common consumer products). Therefore, management and disposal of soil contaminated by PFAS would need to be managed in consultation with EPA and in the context of an evolving regulatory environment. Treatment and destruction of PFAS contaminated material is the EPA preferred management solution, followed by on-site encapsulation (unlikely to be feasible due to spatial constraints at the project sites). If these options are not feasible, landfill disposal for low concentration and low volumes of contaminated material will be considered by the EPA. An outline of EPA's knowledge regarding PFAS and current interim approach for the assessment and management of PFAS contaminated soil is provided in EPA Publication 1669.1 Interim position statement on PFAS (issued November 2017).

The trench to be excavated during both the Edithvale and Bonbeach level crossing removal projects would occupy the entire construction sites. As such, there is no opportunity to re-use the spoil from the excavation, or encapsulate on site, therefore disposal at an appropriate facility is considered the primary option to manage spoil.

The scoping requirements for the EES require the identification and evaluation of the effects of waste acid sulfate soil and contaminated soil on environmental and human health values during construction (section 4.2). The following risks have been identified to assist in addressing this requirement. This section includes an assessment of the likelihood and consequence of the risk occurring.

The disturbance of contaminated soil is considered to have a negligible risk of impact on human health and the environment. Due to the land use history of the project areas and their surrounds, and elevated concentrations of contaminants of concern identified in shallow soils adjacent to the construction areas, it is expected that contaminated soils will be encountered during the excavation works. Soil material to be excavated will be categorised in situ prior to the excavation works in accordance with EPA Victoria Industrial Waste Resource Guidelines (IWRG) and Australian Standards, to inform the management solutions for the contaminated spoil material. The preferred option is disposal to a licenced landfill or treatment facility. Due to the limited space within the construction boundary, there will be no opportunity to re-use or for stockpiling of the excavated soils and as such, all soils will be transported directly off-site, minimising the risk of adverse health and environmental impacts to the community.

Mitigation of CASS/Contaminated soil (residents) (Risk CL50)

The following management measures would be embedded in the environmental performance requirements (**EPR_CL1** and **EPR_CL2**) to manage risk of the disturbance, handling, storage or disposal of CASS/contaminated soil resulting in adverse health and environmental impacts to the community:

- **EPR_CL1**: develop and implement a spoil management plan that includes but it is not limited to:
  - Applicable regulatory requirements
  - Identifying nature and extent of spoil (clean fill and contaminated spoil) across the construction areas
  - Roles and responsibilities
  - Identification of management measures for storage, handling and transport of spoil for the protection of health and the environment
  - Identification, design and development of specific management measures for temporary stockpile areas
  - Identifying potential sites for management or disposal of any spoil
  - Monitoring and reporting requirements
  - Identifying locations and extent of any prescribed industrial waste (PIW) (including asbestos) and characterising PIW prior to excavation
  - Identifying suitable sites for disposal of PIW

The spoil management plan shall include sub-plans as appropriate, including an Acid Sulfate Soil Management Plan (refer to **EPR_CL2**).

- **EPR_CL2**: An Acid Sulfate Soil Management Plan would be prepared prior to construction of the project in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999, EPA Publication 655.1 Acid Sulfate Soil and Rock. The plan would also be in accordance with EPA regulations, standards and best practice guidance and be prepared in consultation with the EPA. This plan will include:
  - Identify locations and extent of potential acid sulfate soils.
  - Assess potential impact for human health, odour and environment
  - Identify and implement measures to prevent oxidation of acid sulfate soil wherever possible
  - Identify suitable sites for management or disposal of acid sulfate soil.

9.2.2 CASS/contaminated soil odours (Risk CL51)

Odorous material can be generated when soils containing sulfides are exposed to air and hydrogen sulphide is produced (also known as rotten egg gas) or contaminated soil containing odorous wastes (such as petroleum hydrocarbon impacted soils) are excavated and exposed to air. While such soils are exposed, either by excavation, in stockpiles or on the side of a trench, they can continue to emit odour that could be considered unpleasant by construction workers and surrounding users. The odour can also be spread outside of the project area as material is transported off-site or during prevailing winds. This can lead to a loss in amenity (for instance people not wanting to be in the vicinity) for the surrounding area (Risk ID CL46). Given the potential presence of CASS and contaminated soils has been identified in the construction area, it is considered likely that the spoil excavation process will expose odorous material. However, the risk that it will result in a loss of amenity is considered negligible. This is because the material will be managed to minimise odours and the duration that odorous material will be exposed is during the excavation period which will be short term (a maximum of six weeks) and temporary.

Mitigation of CASS/Contaminated soil odours (Risk CL51)

Management of spoil as described above will also minimise the impacts of odour on surrounding amenity. There are additional measures that would be undertaken to minimise odour impacts (**EPR_CL1** and **EPR_CL2**) during the excavation and transportation including but not limited to:

- periodic monitoring of the aesthetics of the material excavated and proposed for transportation
- if odorous material is identified, it must be segregated and odour emissions assessed with the appropriate gas monitoring equipment
- if the trigger levels are exceeded, implementing appropriate occupational health and safety measures
- odour mitigation measures must be put in place prior to transporting the identified odorous material off site for treatment and/or disposal. This may include spraying the material with an odour neutralising agent.

In addition to the measures described above, a communications plan (**EPR_SC1**) will be used to let surrounding users know of the potential impacts associated with the construction occupation period, including odour.

9.2.3 Contaminated groundwater (Risk CL52)

Due to the historic land uses within the project areas and their surrounds, and elevated concentrations of contaminants of concern identified in groundwater adjacent to the construction areas, it is expected that contaminated groundwater will be encountered during the excavation works. Also, groundwater was found to be slightly acidic to neutral in the shallow aquifer during the groundwater investigation completed (refer to Sections 5.2.13 and 5.3.13).

Groundwater impacted by the projects will be limited because the deep pile walls that support the sides of the proposed trench would be inserted prior to the excavation of the trench. The pile walls would prevent groundwater entering the excavated area. This means that only groundwater located between the two pile walls would need to be removed from the trench as a result of construction. A conservative estimate (based on spoil volumes to be excavated and groundwater flow rates) of the volumes of groundwater expected to be removed from the excavations is 20.8 mega litres at Edithvale and 21.7 mega litres at Bonbeach.

Adverse environmental impacts would result if contaminated or acidic groundwater was released into the environment resulting in changes to groundwater chemistry (contamination) which precluded the beneficial uses of groundwater (as defined in the SEPP Groundwaters of Victoria) i.e. by being allowed to soak back into the ground or discharged untreated to stormwater or a surface water body. Adverse human health impacts would result if dermal contact or ingestion was made with contaminated or acidic groundwater.

The disturbance of acidic and/or contaminated groundwater is considered likely to have a negligible risk of impact on human health and the environment, as these risks will be managed by completing a baseline groundwater assessment (**EPR_CL4**) to understand the groundwater condition including contaminants of concern and concentrations. This would assist with the management, treatment and disposal of groundwater generated during the construction phase. The most likely option for disposing of this water would be a Trade Waste Agreement with the relevant utility authority to dispose of treated water off-site to sewer. Treatment and monitoring of impacted groundwater would occur prior to disposal to sewer in accordance with the Trade Waste Agreement. The disturbance of acidic and/or contaminated groundwater is considered likely to have a negligible risk of impact on human health and the environment

These actions are included in the management measures (**EPR_CL4)** developed to manage acidic and /or contaminated groundwater during construction, to EPA Victoria requirements, including:

- a baseline groundwater quality assessment (taking into account site history) at least three to six months prior to commencement of trench excavation
- implementing a system to manage and/or dispose of intercepted groundwater (if required) which may be a trade waste agreement (TWA) with relevant utility authority or other measures in accordance with relevant guidelines and legislation (if a TWA is not granted)collection, treatment, disposal and handling of contaminated groundwater and/or slurries including vapours
- monitoring of intercepted groundwater quality
- implementing contamination plume management (if required)
- treating and monitoring impacted groundwater (including vapours) prior to disposal in accordance with licence and/or agreement.

There is expected to be minimal opportunity to interact with groundwater outside the construction footprint during construction. The current construction technique will include the installation of a cut off wall prior to the commencement of excavation to prevent the ingress or egress of groundwater in to or from the construction zone.

9.2.4 Unknown contamination (Risk CL53)

Encountering unknown contamination during construction is possible although the risk to environment, health or amenity is considered to be negligible. This is because the potential for unknown contamination to be encountered during construction will be minimised by the completion of an in situ intrusive soil investigation in accordance with EPA Victoria IWRG and Australian Standards for sampling, and a baseline groundwater assessment to understand the groundwater condition including contaminants of concern and concentrations prior to excavation works commencing. These management measures outlined above would be embedded in EPRs to manage this risk (**EPR_CL1**) and (**EPR_CL4**).

9.2.5 Fuel/chemical spills (Risk CL54)

During construction vehicles, plant and machinery will be operating within the construction zone. There is a possibility that spills may occur during the refuelling of vehicles, plant and machinery or the use of chemicals required as part of the construction process.

The risk of such a spill being extensive enough to result in a significant adverse health or environmental impact is assessed as being negligible. This is because the following management measures included in a Construction Environmental Management Plan (CEMP) (**EPR_CL3**) would be in place:

- refuelling of vehicles in designated areas only and management of the areas to contain any spill.
- minimising volumes of fuel and other chemicals stored on site

- provision of spill kits with apparatus to contain any spill at the construction site and fuel storage areas to enable rapid management of spills
- training of staff in spill containment and in using the spill kits provided
- use of well-maintained plant to minimise the potential for spills to occur
- development of procedures to remove, treat and/or dispose soil that becomes contaminated due to a fuel or chemical spill.

9.2.6 Management of other waste streams (solid inert, liquid, organic, packaging and food scraps) (Risk CL55)

Waste other than soil and groundwater would be generated by the projects. These wastes are expected to be generated by daily activities such as material deliveries, ablutions, meal times and other such activities. If these wastes are not appropriately contained, they could be released to the environment resulting in adverse impacts (as described above). The risk of other waste being discharged to environment and resulting in a significant adverse impact is considered negligible. This is because the following mitigation measures would be in place:

- development and implementation of a CEMP (**EPR_CL3**) including the following measures to specifically mitigate this risk:
  - application of the waste management hierarchy in assessing waste management options
  - contamination and waste management requirements (e.g. use of waste and recycling facilities, maintenance of a clean site policy)
  - designated vehicle refuelling area
  - chemical management procedures, such as minimising use and storage of chemicals on site, bunded storage facilities to ensure spills, washing residues, slurries or other contaminated water can be contained, and are managed/disposed of appropriately
  - location and type of spill kits required
  - staff training and competence requirements
  - use of well-maintained plant to minimise the potential for spills to occur
  - procedures to remove, treat and/or dispose soil that becomes contaminated due to a fuel or chemical spill
  - storage of litter in bins from which it cannot escape (temporary fencing may be used as a secondary containment measure for litter).

9.2.7 Non-compliance (waste transport/disposal) (Risk CL56)

In accordance with the spoil assessment completed as part of this report (Section 7), there is estimated to be 358,094 m^3 (ex-situ) of spoil generated by the projects. Spoil excavated from the site (including contaminated soil and acid sulfate soil) will require transport and disposal to an appropriately licensed facility.

A preliminary assessment of the spoil breakdown (refer to Section 7) has indicated there is sufficient capacity available in landfills in Victoria to accept the type of spoil generated (fill material, acid sulfate soils and Category A, B and C contaminated soils). The risk of non-compliance with EPA Victoria guidelines resulting in a significant adverse impact to the environment is considered negligible. This is because the following mitigation measures would be in place:

- development and implementation of a spoil management plan **(EPR_CL1** and **EPR_CL2)** including the following measures to specifically mitigate this risk:
  - sampling and analysing soil material to be excavated prior to excavation in accordance with EPA Victoria Industrial Waste Resource Guidelines (IWRG) and Australian Standards for sampling, and determining transport and treatment requirements, if any, prior to disposal or reuse
  - identifying soil containing asbestos fibre to enable appropriate handling and transport
  - identifying suitably licenced facilities for the disposal of soil material generated
  - management of contaminated soil within the project area to ensure material is segregated according to its transport and disposal requirements
  - a tracking system that allows verification of the suitability of soil movement from the site to a licensed landfill or treatment facility
  - specification of the type of vehicles to be used for waste movements
  - measures to ensure transport certificates/records are completed and maintained on file.

9.2.8 Contamination (vapour) (Risk CL57)

Vapours associated with contaminated soil and/or contaminated groundwater that could be encountered during the trench excavation have the potential to impact human health. This is considered to be a negligible risk because there would be minimal opportunity for the general public to interact with vapours from contaminated soil or contaminated groundwater. Volatile contaminants (such as those generated by a petroleum hydrocarbon plume in groundwater) may be present in the soil and/or groundwater due to existing contamination. Depending on the contaminant concentration and depth, the contaminants associated with existing contamination may not be present at the surface. Excavation of surface soils during construction has the potential to expose volatile contamination at depth creating a pathway for gases and vapours to migrate from a subsurface source of vapour forming chemicals (volatile organic compounds i.e. petroleum hydrocarbons in soil and/or groundwater) into buildings or other enclosed spaces via cracks in the foundation and/or openings for utility lines. The desktop contamination assessment undertaken as part of this EES has identified possible sources of vapour forming chemicals in the vicinity of the project area i.e. services stations. Exposure to soils vapours can have an adverse impact to human health through the generation of odour, inhalation or flammability.

As the construction methodology is likely to be an open trench, vapours released during the excavation will readily dissipate, minimising the potential for human health impacts to the general public.

To further understand the potential for the project to generate a vapour risk, a targeted soil and groundwater investigation (**EPR_CL4**) would be undertaken prior to excavation commencing. In the areas that have been identified as potential sources for vapours (i.e. adjacent to service stations), the results will indicate the level of volatile organic compounds present in the soil and/or groundwater. This would guide the requirement for further assessment (i.e. a vapour assessment) which would also assess the risk of impacts to human health. Based on the current understanding of the potential sources of vapour forming chemicals and the construction methodology, the likelihood of adverse impacts is considered negligible. Undertaking further targeted assessment would provide greater certainty around the potential for adverse human health maintaining the risk level at negligible.

Therefore, the following mitigation measures would be included in the soil management plan and groundwater management plan:

- development and implementation of a spoil management plan (**EPR_CL1** and **EPR_CL2**) including (but not limited to) the following measures to specifically mitigate this risk:
  - a targeted soil assessment to identify if volatile contaminants are present in soils to be excavated
  - identification of management measures for storage, handling and transport of spoil for the protection of health, amenity and the environment.
- development and implementation of a groundwater management plan (**EPR_CL4**) including (but not limited to) the following measures to specifically mitigate this risk:
  - a targeted baseline groundwater assessment to identify if volatile contaminants are present in groundwater to be intercepted during construction
  - collection, treatment, disposal and handling of contaminated water and/or slurries including vapours
  - treating and monitoring impacted groundwater (including vapours) prior to disposal to sewer and/or groundwater in accordance with licence and/or agreement.

9.3 Project area specific impacts from changes to groundwater

The construction of cut off walls on both sides of the trench at each site has the potential to change the hydrogeological conditions. Groundwater modelling undertaken as part of EES Technical Assessment A – *Groundwater* shows that the effect of the cut-off walls on groundwater would be:

- levels would rise (mounding) to the east of the rail trench
- levels would fall (drawdown) to the west of the rail trench
- groundwater flowing toward Port Phillip Bay would be diverted the north or south by the rail trench.

Impacts would commence within months of installation of the cut-off walls (during construction) and result in permanent changes to the groundwater levels either side of the trench and permanent diversion of groundwater flow. The risks related to CASS and contamination with respect to the impact from the installation of the cut-off wall are discussed below.

9.3.1 CASS activation at Edithvale (GW60)

The recent CASS assessment undertaken in accordance with EPA 655.1 has identified select locations at both Edithvale and Bonbeach which are underlain by PASS in the vicinity of existing groundwater levels. The decrease in groundwater level, in these areas has the potential to oxidise the sulfide minerals present in these soils and leach acidity, metals and other nutrients into groundwater. This may cause contamination and/or acidification of groundwater precluding the beneficial uses (as defined in the SEPP Groundwaters of Victoria). Additionally, the discharge of acidic contaminated groundwater to the Port Phillip Bay could adversely affect the health of the aquatic ecosystem and may also make it unsuitable for recreational use.

The risk of PASS oxidisation impacting beneficial uses of groundwater (following the installation of the cut-off walls), described in Section 8, was initially assessed as a **Moderate** risk. Groundwater modelling predicted a maximum groundwater drawdown of up to 1.4 metres within 50 metres of the rail trench on the western side and groundwater mounding of up to 0.9 metres within 50 metres of the rail trench at the Edithvale site.

At Edithvale, the majority of PASS has been identified below the sea level except for the area located between Denman Avenue and Bank Road (approximately 300 linear meters) presented in Figure 18a. Groundwater levels cannot drop below sea level, as such any CASS located below sea level can only be activated by excavation only. The risk of activation of CASS due to lowering of groundwater level is only at the select locations. This area is located within the zone of predicted groundwater change and it is almost certain it would be affected by the groundwater drawdown. It is almost certain that the PASS would be activated in this area where PASS is located close to existing groundwater levels as a result of the decreasing groundwater levels. If PASS was oxidised it would result in a temporary and reversible loss of one or more beneficial uses of the environment.

At Edithvale, the existing acidity (actual acid sulfate soils) exceeding the management criteria was only encountered in an area of approximately 100 linear meters near Vincent Lane at depth 10 meters below ground surface and area of approximately 200 linear meters near the northern road at depth of five and 10 meters below ground surface These depths are below the existing groundwater level, so the risk of dissolution of exiting acidity due to mounding of groundwater on the up-gradient side of the trench due to increase of groundwater level is negligible.

The identified areas of PASS layers, and predicted groundwater changes at the Edithvale project area is shown in .

An EPR was developed to ensure the design of the project does not result in degradation to groundwater quality that would preclude beneficial use of groundwater (salinity, contaminants, and acid sulfate soils) (**EPR_GW2**). In order to achieve this performance requirement the design would need to limit the maximum hydraulic head difference (i.e. water pressure difference upstream and downstream of the rail trench) to reduce the magnitude and extent of groundwater level change at Edithvale. This would be achieved by the installation of sub-surface infrastructure (such as a passive horizontal drain) to equalise groundwater.

A description of the groundwater engineering solution and the results of the groundwater modelling which validate the effectiveness of the solution are summarised in Section 7.2.1.3(Summary of model predictions) of Technical Report A *Groundwater* and included in full in Appendix H of the same report.

The implementation of an EPR (**EPR_GW2**) to reduce mounding and drawdown impacts at Edithvale consequently reduced the risks associated with PASS activation and acidification.

Modelling the effectiveness of an engineering solution (a passive horizontal drain) demonstrated a significant reduction in the potential for drawdown and mounding during both construction and operation. The maximum groundwater drawdown predicted is approximately up to 0.2 metres within 80 metres of the rail trench, and groundwater mounding to be up to 0.2 metres within 50 metres of the rail trench. Comparatively, the 'no mitigation' scenario predicted groundwater drawdown of up to 1.4 metres within 50 metres of the rail trench, and groundwater mounding of up to 0.9 metres within 50 metres of the rail trench.

Groundwater levels naturally vary within 0.4 metres. This level of mounding is well within that range of natural variation. Implementing and achieving EPR_GW2 would reduce both the magnitude of groundwater level change (from drawdown or mounding) and the extent of the area affected. As a result it is considered very unlikely that PASS would be activated from groundwater being lowered below naturally occurring levels. As illustrated in Figure 18b, based on these controls, impacts to beneficial uses of groundwater caused by activation of PASS have been reduced to a '**Negligible'** risk.

If PASS activation and groundwater acidification were to occur, the implementation of the management measures provided in the groundwater monitoring plan (**EPR_GW3**) would provide early detection of impacts as a result of PASS activation and groundwater acidification (for example increased acidity of groundwater).

The following mitigation measures would be included in the groundwater management plan:

- development and implementation of a groundwater management and monitoring plan **(EPR GW3)** including (but not limited to) the following measures to specifically mitigate this risk:
  - detailed monitoring parameters including timing, location of monitoring bores
  - duration of the monitoring program
  - clear trigger levels for changes in groundwater level and quality that require mitigation plans to be implemented.

Additionally, **EPR_CL5** requires the development of a Groundwater Quality Mitigation Plan which must include:

- measures to maintain or manage the beneficial uses of groundwater affected by acidification.
- measures to monitor and manage the beneficial uses of groundwater affected by contaminated groundwater plume migration attributable to the project(s)
- measures to maintain or manage impacts on beneficial uses as a result of changes to salinity in groundwater that is attributed to the project(s).

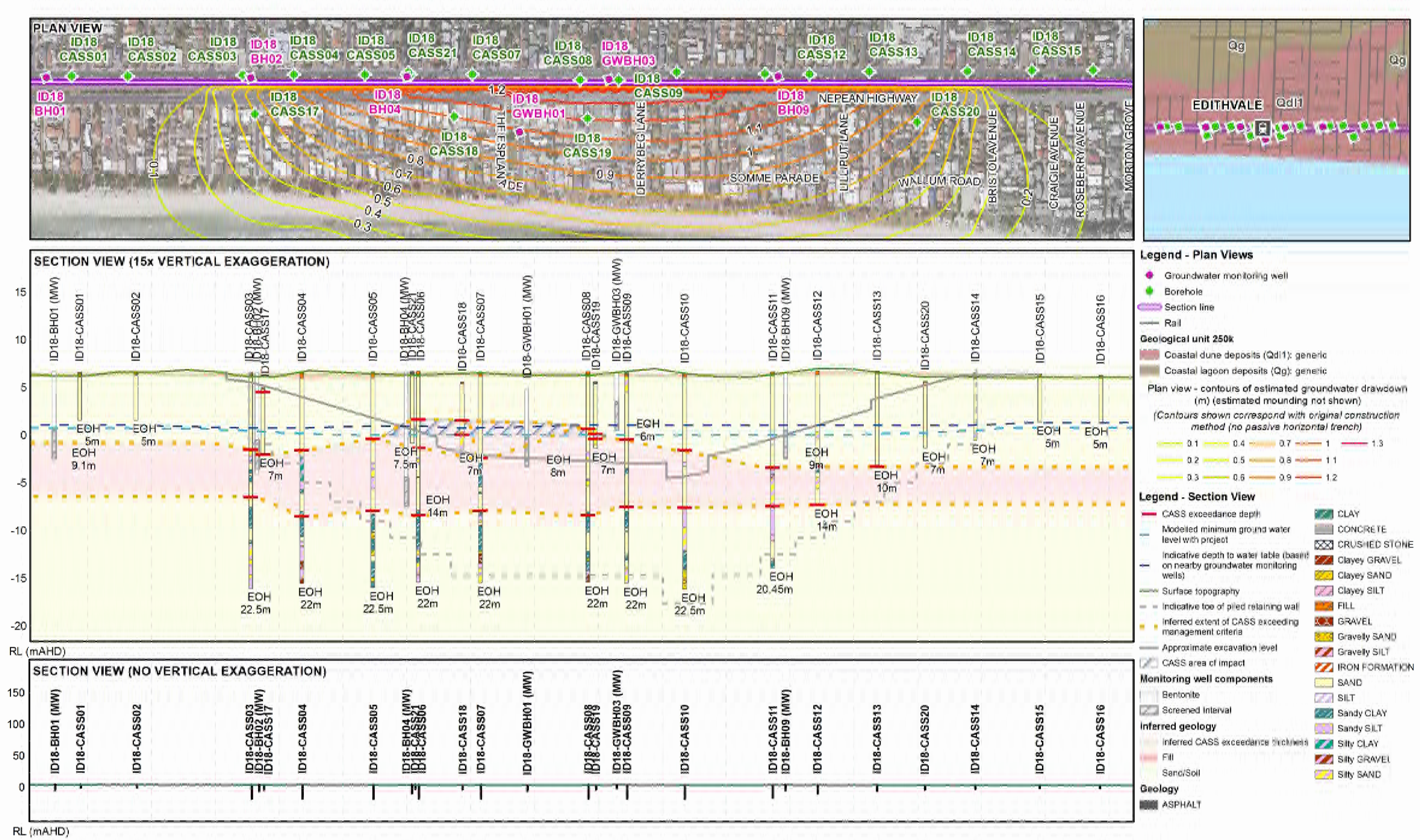


Figure 18a Cross section showing presence of PASS layers and predicted groundwater mounding/drawdown - Edithvale

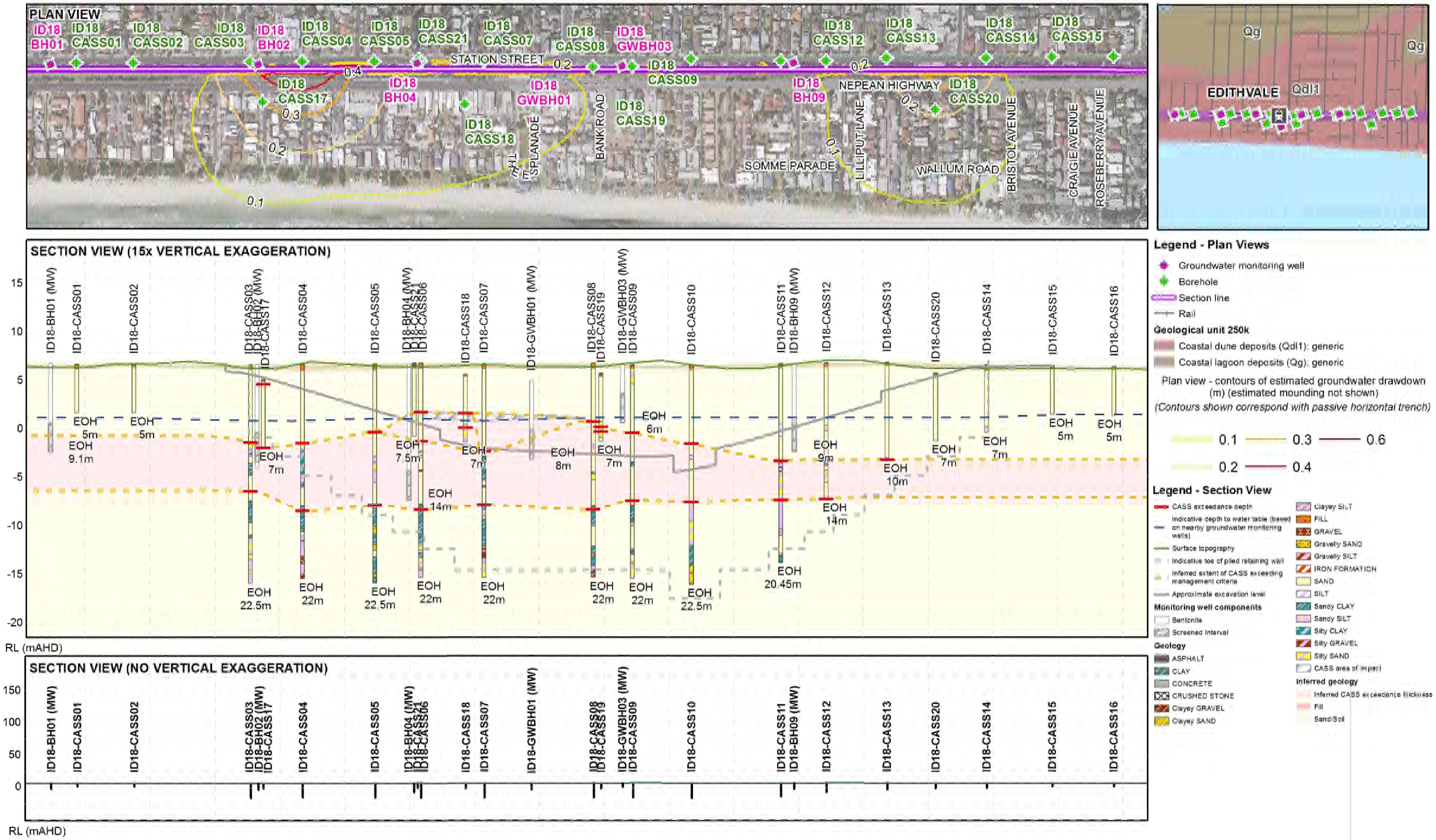


Figure 18b Cross section showing presence of PASS layers and predicted groundwater mounding/drawdown after groundwater equalisation - Edithvale

9.3.2 CASS activation at Bonbeach (GW67)

At Bonbeach, the groundwater modelling predicted a maximum groundwater drawdown of up to 1.0 metres within 50 metres of the rail trench on the western side. Similar to Edithvale, the majority of the PASS has been identified below the sea level except for the two areas: onearea approximately 100 linear meters located at Wimborne Avenue on the north and the other area approximately 200 linear meters located opposite Breeze Street in the south (presented in Figure 19).

These two areas are located within the zone of predicted groundwater change and would be affected by the groundwater drawdown.

It is almost certain that the PASS would be activated as a result of the decreasing groundwater levels in these areas where PASS is located close to existing groundwater levels. The distribution of PASS in the zone of predicted groundwater change is limited in its extent (refer to Figure 19) and if PASS is activated by the lowering of groundwater levels the impacts would also be localised to the area. The overall risk of PASS oxidisation impacting beneficial uses of groundwater (following the installation of the sheet pile walls - described in Section 8) was assessed as having a **'Minor'** risk level. The PASS identified at these locations was moderately aggressive and, if activated, would result in a localised, temporary and reversible loss of one or more beneficial uses of the environment.

At Bonbeach, the existing acidity exceeding the management criteria was only encountered opposite waterfront place (approximately 50 linear m) at depth of 1 m below ground. The predicted groundwater levels would not reach this depth so the risk of dissolution of exiting acidity due to increase of groundwater level is negligible.

The identified areas of PASS layers, and predicted groundwater drawdown at the Bonbeach site is shown in Figure 19.

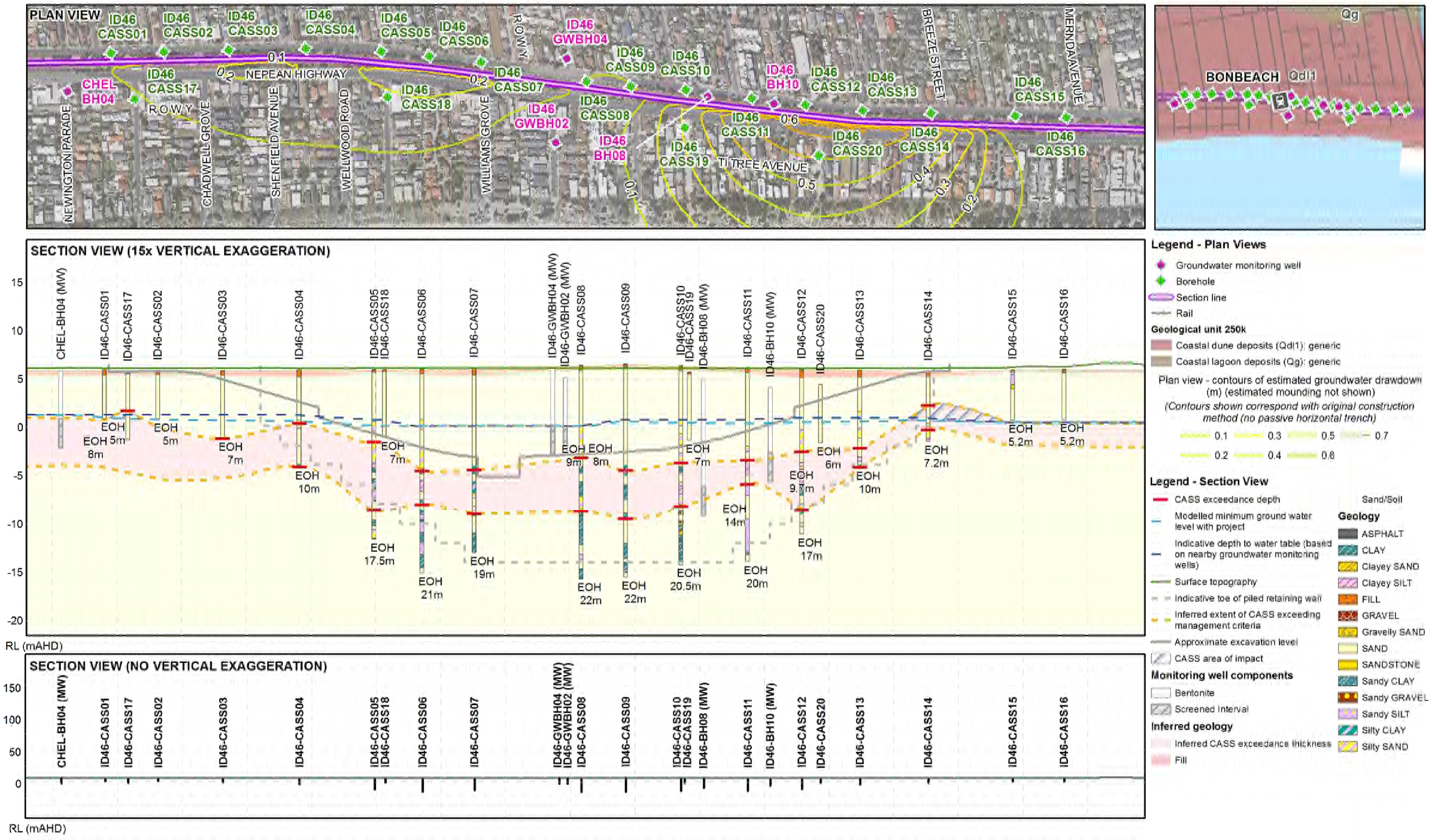


Figure 19 Cross section showing presence of PASS layers and predicted groundwater mounding/drawdown - Bonbeach

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If PASS activation and groundwater acidification were to occur, the implementation of the management measures provided in the groundwater monitoring, management and mitigation plans (**EPR_GW3** and **EPR_CL5**) would provide early detection of impacts as a result of PASS activation and groundwater acidification (for example increased acidity of groundwater) and develop appropriate mitigation measures (as outlined above).

9.3.3 Contaminant migration at Edithvale (Risk GW62)

Changes to groundwater level and the diversion of groundwater could result in the migration of existing contaminant plumes associated with potential sources of contamination (PSOCs) into previously non-impacted areas of groundwater. Migration of contaminant plumes could result in adverse changes to groundwater chemistry (contamination) precluding the beneficial uses of groundwater (as defined in the SEPP Groundwaters of Victoria) and/or land (as defined in the SEPP Prevention and Management of Contamination of Land). The relevant beneficial uses to be protected at the project areas are detailed in Section 4.3. All of the relevant beneficial uses could be affected by contaminant migration.

The risk of contaminant migration impacting beneficial uses of groundwater (following the installation of the cut-off walls described in Section 1.3) was initially assessed as having a **moderate** risk level. The groundwater modelling predicted that flow paths at the Edithvale site would be altered after the installation of the cut-off wall with groundwater drawdown of up to 1.4 metres within 50 metres of the rail trench, and groundwater mounding of up to 0.9 metres within 50 metres of the rail trench. Groundwater flowing towards Port Phillip Bay would also be diverted to the north or south by the sheet pile wall.

Within the area of predicted groundwater change there are a number of PSOCs, including one former and two operating service stations, a mechanics, a dry cleaners, a mower sales/service centre, a former boat storage facility, an upholsterer and the Edithvale fire station. PFAS contaminated groundwater was also identified in the vicinity of the fire station, which is up hydraulic gradient of the where the cut-off wall will be installed. Due to the presence of PFAS contaminated groundwater up gradient of the cut-off wall, and the diversion of groundwater that will occur once the cut-off wall is installed, it was considered almost certain that contaminant migration could occur as a result of the altered groundwater flow paths, which would result in a localised, temporary and reversible loss of one or more beneficial uses of the environment.

The identified PSOCs and predicted groundwater drawdown/mounding at the Edithvale site is shown in Figure 20.

[redacted]

Figure 20 Edithvale PSOCs and predicted groundwater mounding/drawdown (Page 1 of 3)

[redacted]

Figure 20 Edithvale PSOCs and predicted groundwater mounding/drawdown (Page 2 of 3)

[redacted]

Figure 20 Edithvale PSOCs and predicted groundwater mounding/drawdown (Page 3 of 3)

In order to reduce the risks associated with groundwater drawdown and mounding at Edithvale an EPR was developed to ensure the design of the project does not result in changes to groundwater level and quality that would preclude beneficial uses of groundwater (**EPR_GW2**). In order to achieve this performance requirement the design would need to limit the maximum hydraulic head difference (i.e water pressure difference upstream and downstream of the rail trench) to reduce the magnitude and extent of groundwater level change at Edithvale. This would be achieved by the installation of sub-surface infrastructure (such as a passive horizontal drain) to minimise changes to groundwater levels.

The implementation of an EPR to reduce drawdown and mounding impacts at Edithvale consequently reduced the risks associated with contaminant plume migration (**risk GW62**).

A description of an engineering solution and the results of the groundwater modelling which validate the effectiveness of the system are summarised in section 7.2.2 of EES Technical report A *Groundwater* and included in full in Appendix H of the same report.

Based on these controls, impacts to the protected beneficial uses of groundwater caused by contaminant plume migration (**GW62**) have been reduced to a **Minor** risk.

Groundwater modelling with the installation of sub-surface infrastructure predicted a significant reduction in the magnitude of drawdown and mounding during both construction and operation. Groundwater modelling with the installation of sub-surface infrastructure predicted a maximum groundwater drawdown of up to 0.2 metres within 80 metres of the rail trench, and groundwater mounding to be up to 0.2 metres within 50 metres of the rail trench. Comparatively, the ‘no mitigation’ scenario predicted groundwater drawdown of up to 1.4 metres within 50 metres of the rail trench, and groundwater mounding of up to 0.9 metres within 50 metres of the rail trench.

The sub-surface infrastructure would reduce both the magnitude of groundwater level change (from drawdown or mounding) and the extent of the area affected (Figure 21). It would not mitigate changes as a result of the diversion of groundwater along the cut-off wall. The PSOCs within the reduced area of groundwater change would include two operating service stations, a mechanics, a dry cleaners, a mower sales/service centre and the Edithvale fire station, and the identified PFAS contaminated groundwater in the vicinity of the Edithvale fire station. As such, the combination of the reduction in the extent of drawdown and mounding, as well as the reduction in the number of PSOCs within the area of impact, results in the likelihood of contaminant migration reducing from almost certain to highly probable. If contaminant plume migration were to occur, the implementation of groundwater monitoring, management and mitigation plans (**EPR_GW3, EPR_CL4** and **EPR_CL5**) would provide early detection of impacts as a result of contamination plume migration and develop appropriate mitigation measures.

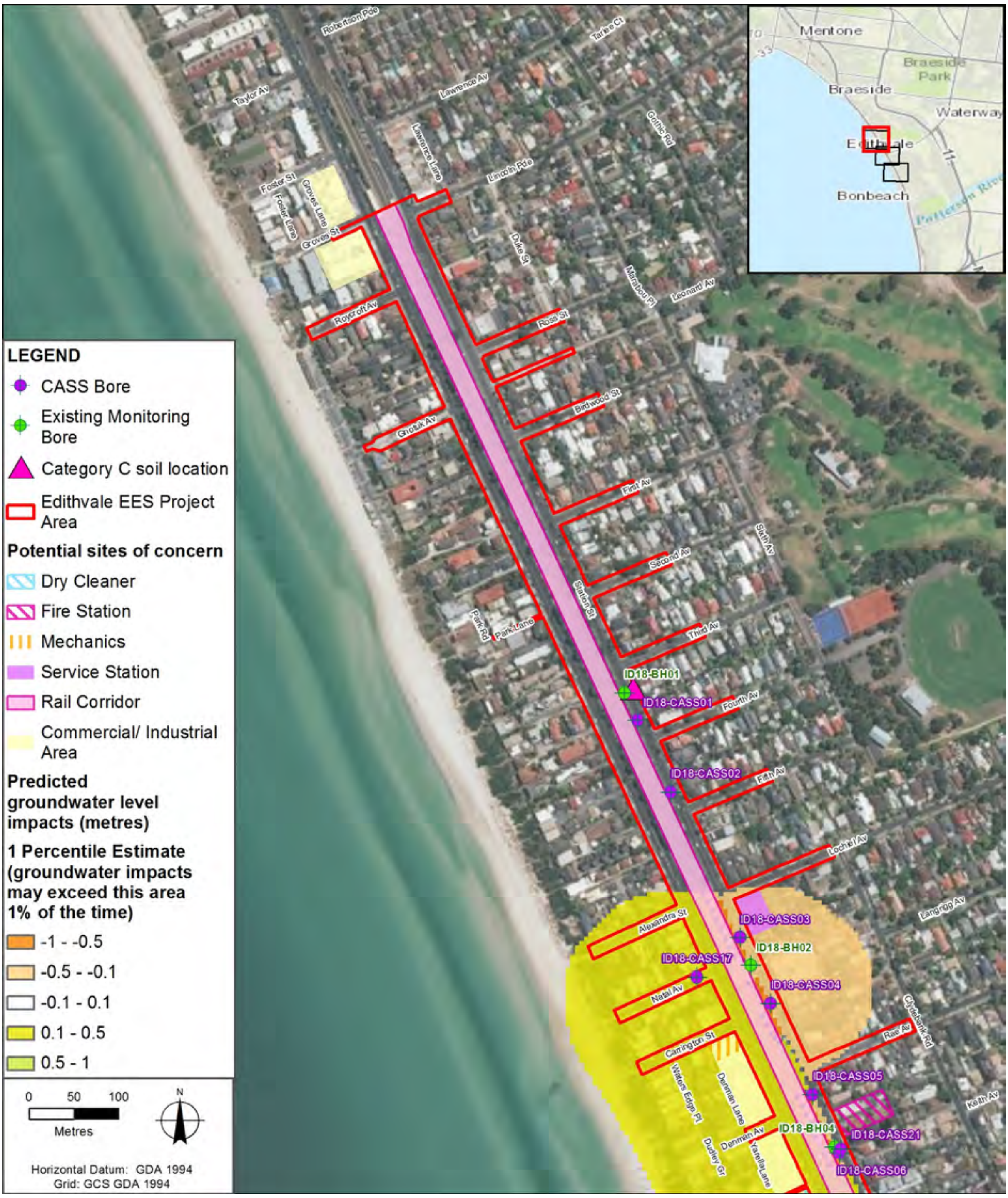

Figure 21 PSOCs and predicted groundwater mounding/drawdown after installation of passive horizontal trench (Page 1 of 3)

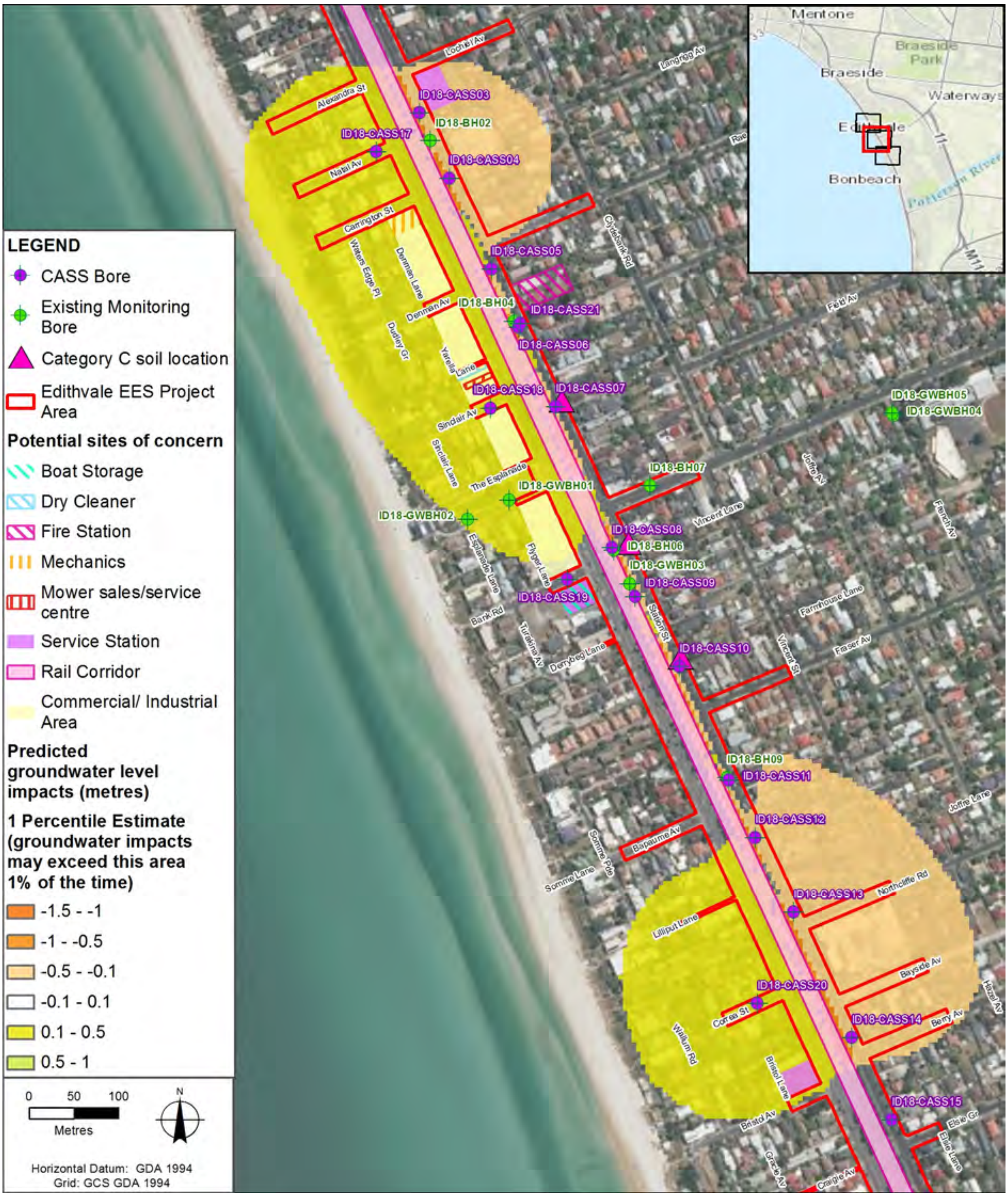

Figure 21 PSOCs and predicted groundwater mounding/drawdown after installation of passive horizontal trench (Page 2 of 3)

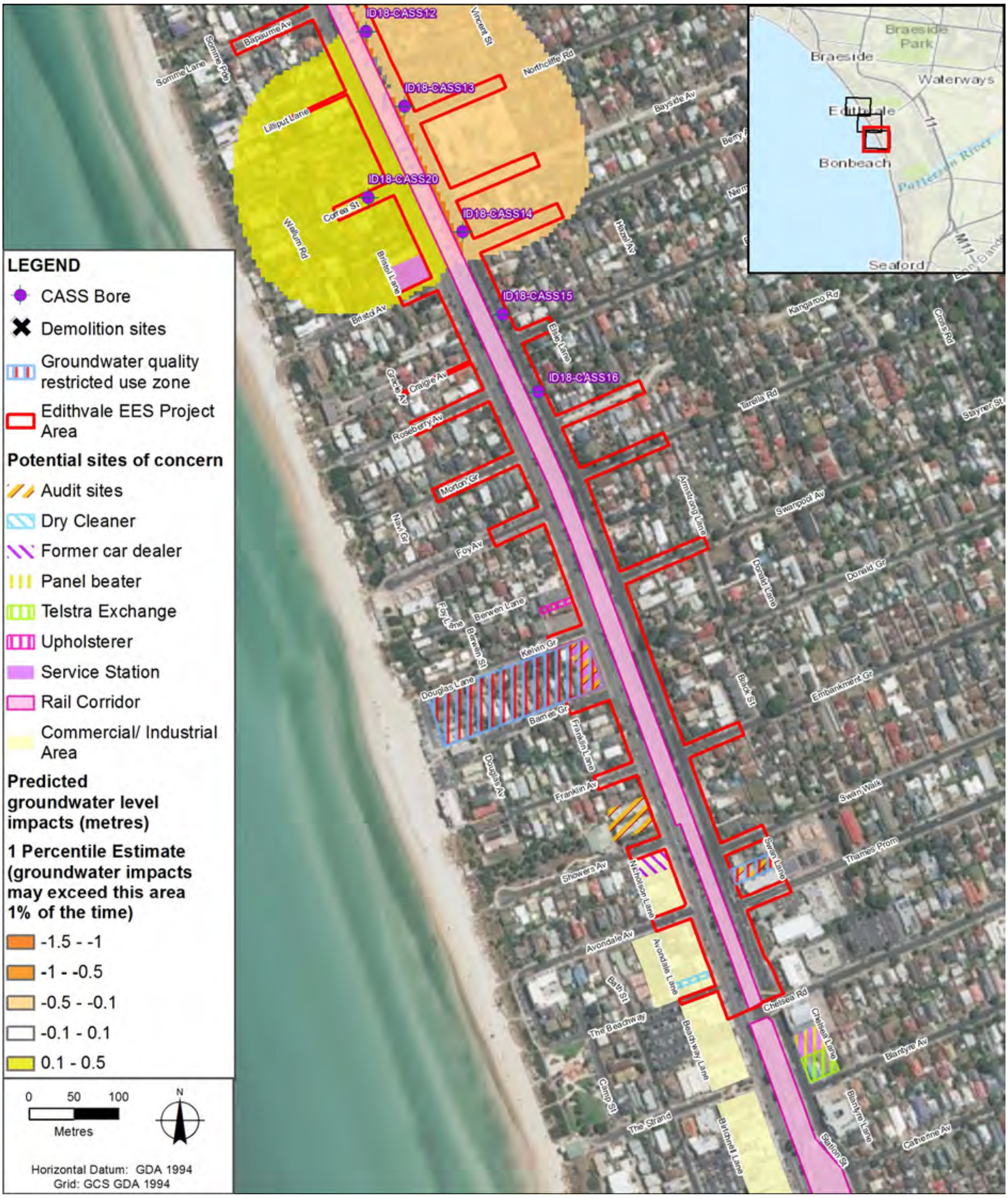

Figure 21 PSOCs and predicted groundwater mounding/drawdown after installation of passive horizontal trench (Page 3 of 3)

9.3.4 Contaminant migration at Bonbeach (Risk GW69)

The risk of contaminant migration as a result of drawdown, mounding and physical diversion of the groundwater at Bonbeach from the installation of cut-off walls was assessed as a **negligible** risk level. In order to reduce the risks associated with groundwater drawdown and mounding at Bonbeach an EPR was developed to ensure the design of the project does not result in changes to groundwater level and quality that would preclude beneficial uses of groundwater (**EPR_GW2**). The groundwater modelling predicted that flow paths at the Bonbeach site would be altered after the installation of the cut-off wall with groundwater mounding of up to +0.4 metres within 50 metres of the rail trench, and groundwater drawdown of up to -0.7 metres within 50 metres of the rail trench. Groundwater flowing toward Port Phillip Bay The Bay would also be diverted the north or south by the rail trench.

Within the area of predicted groundwater change there are three identified PSOCs, including a furniture manufacturer, a mower sales/service centre and a laundromat. All three identified PSOCs are down hydraulic gradient of the cut-off wall, and located where groundwater drawdown is only predicted to be -0.15 metres, which is within the range of natural variability for groundwater level changes. Due to the limited extent of predicted change to groundwater at the location of the identified PSOCs, as well as the PSOCs being located down hydraulic gradient of the cut-off wall, it was considered unlikely that contaminant migration could occur as a result of the altered groundwater flow paths. If contaminant plume migration were to occur, the implementation of groundwater monitoring, management and mitigation plans (**EPR_GW3, EPR_CL4** and **EPR_CL5**) would provide early detection of impacts as a result of contamination plume migration and the application of appropriate mitigation measures.

The identified PSOCs and predicted groundwater drawdown/mounding at the Bonbeach site is shown in Figure 21.

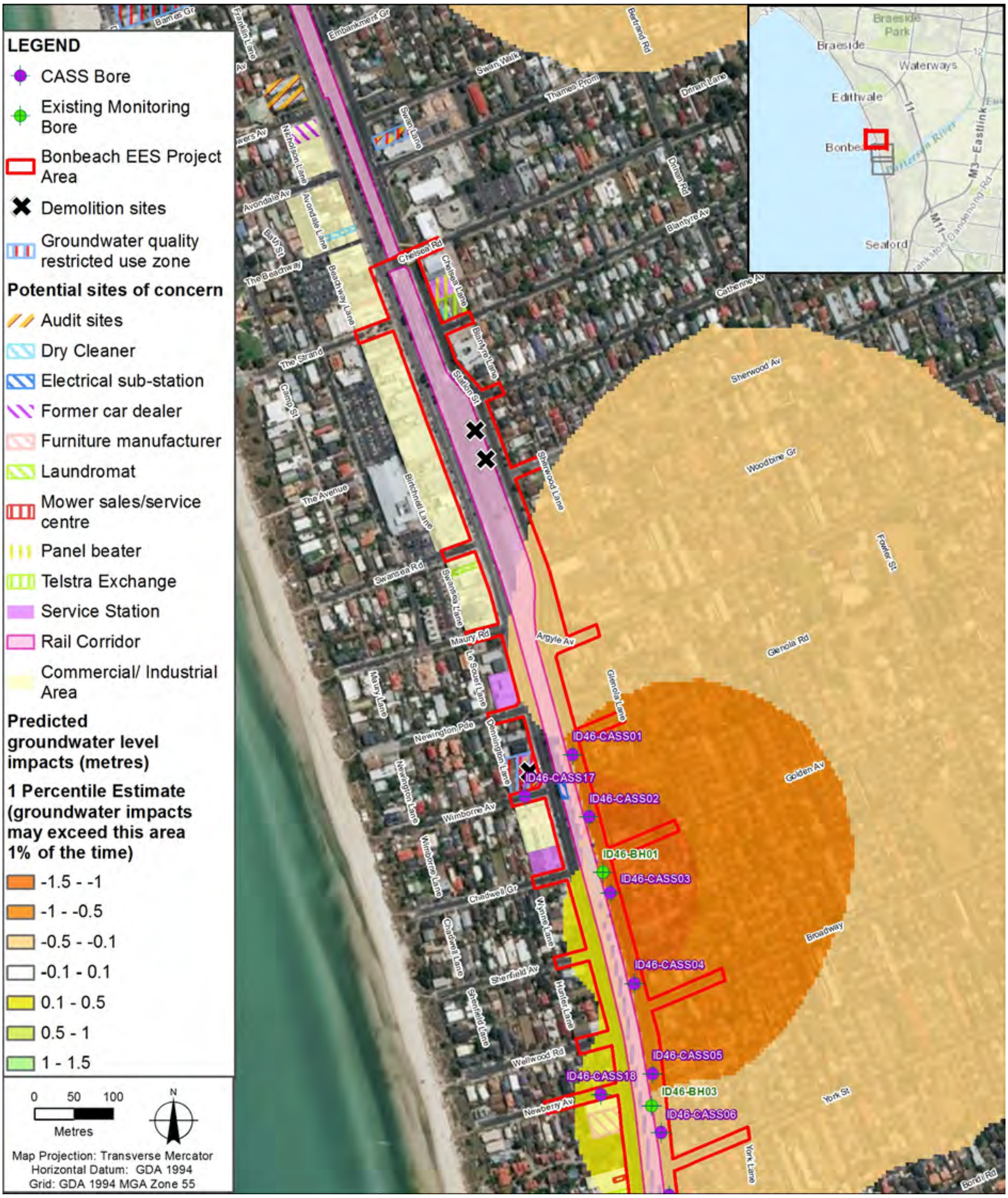

Figure 22 Bonbeach PSOCs and predicted groundwater mounding/drawdown (Page 1 of 3)

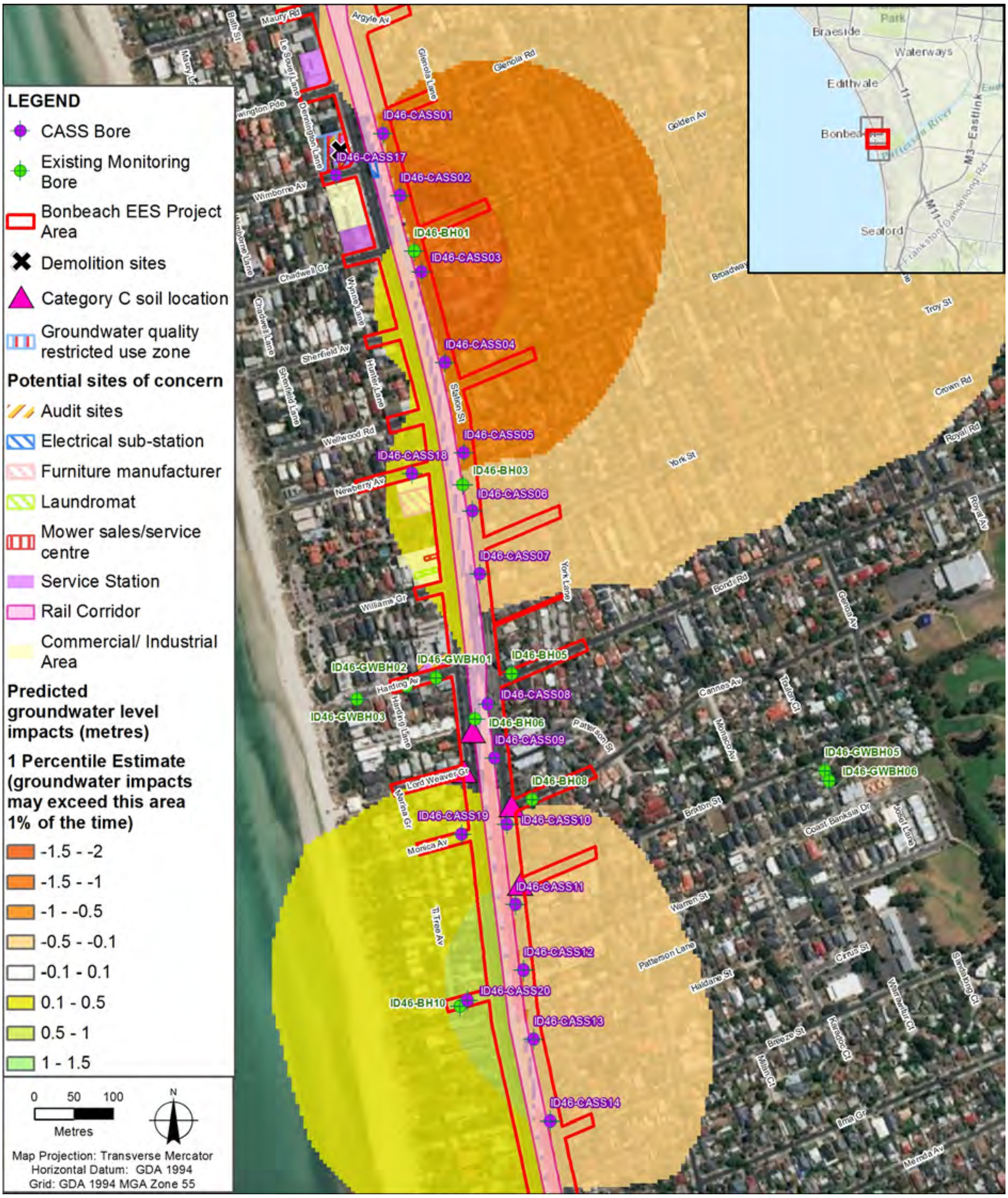

Figure 22 Bonbeach PSOCs and predicted groundwater mounding/drawdown (Page **2** of 3)

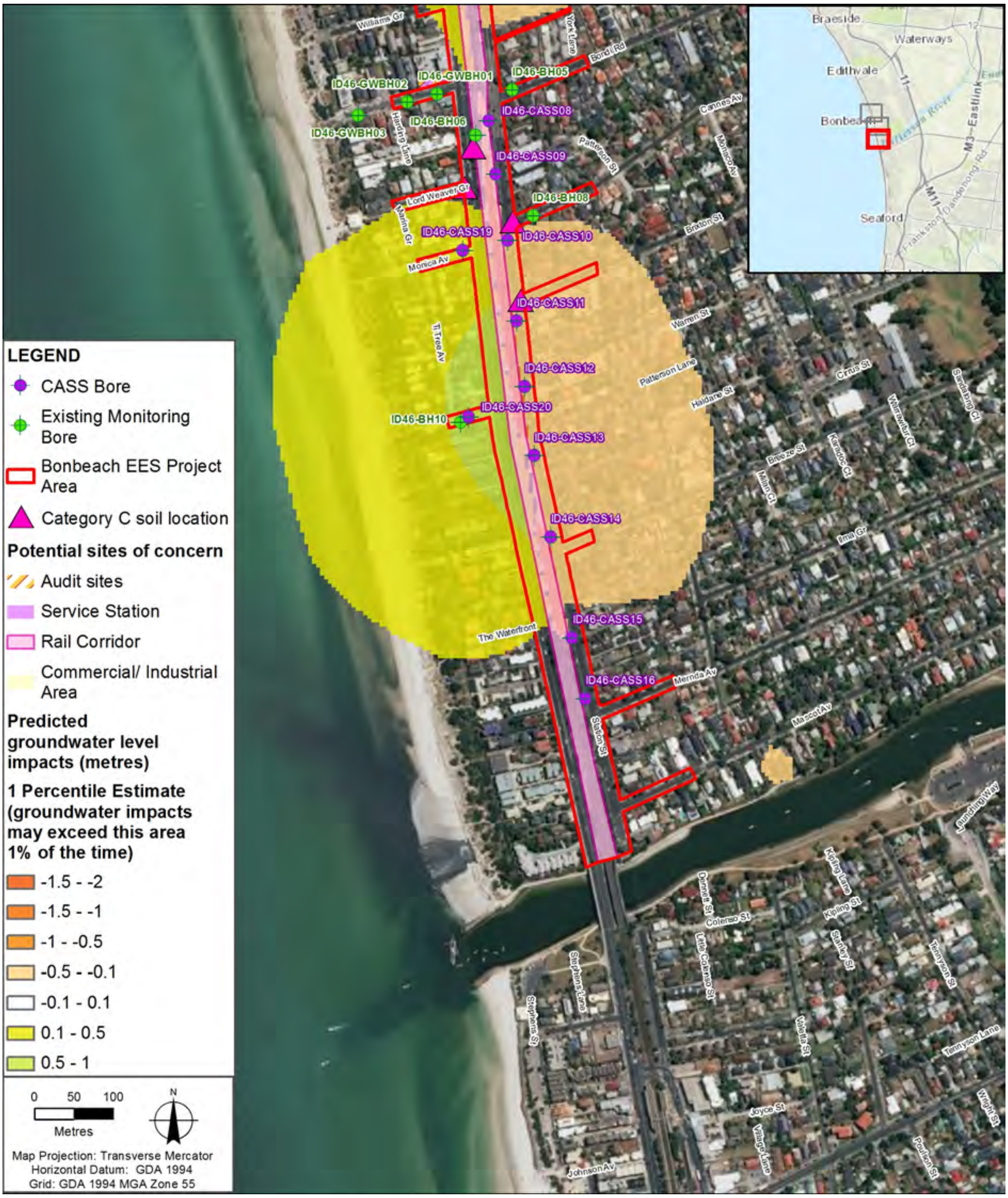

Figure 22 Bonbeach PSOCs and predicted groundwater mounding/drawdown (Page **3** of 3)

10 Environmental Performance Requirements

The EPRs required for the projects are summarised in the table below. The EPRs are applicable to the final design and construction approach and provide certainty regarding the environmental performance of the projects.

Table 47   Edithvale and Bonbeach Environmental Performance Requirements

EPR #	Environmental Performance Requirement	Phase
EPR CL1	**Spoil Management Plan** Prior to construction (excluding preparatory works), prepare and implement a Spoil Management Plan(s) in accordance with relevant regulations, standards or best practice guidelines. The plan must be developed in consultation with the EPA. The plan shall be prepared prior to the commencement of construction (excluding preparatory) and include: a. applicable regulatory requirements b. identifying nature and extent of spoil (clean fill and contaminated spoil) across the construction areas c. roles and responsibilities. d. identification of management measures for storage, handling and transport of spoil for the protection of health, amenity and the environment e. identification, design and development of specific management measures for temporary stockpile areas f. identifying potential sites for management for disposal of any spoil g. monitoring and reporting requirements h. identifying locations and extent of any prescribed industrial waste (including asbestos) and characterising prescribed industrial waste prior to excavation i. identifying suitable sites for disposal of prescribed industrial waste The Spoil Management Plan shall include an Acid Sulfate Soil Management Plan (refer to EPR reference CL2).	Construction
EPR CL2	**Acid Sulfate Soil Management Plan** Prepare and implement an Acid Sulfate Soil Management Plan prior to construction of the project to the satisfaction of the EPA 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 in consultation with the EPA. This plan will include: a. identify locations and extent of potential acid sulfate	Construction

EPR #	Environmental Performance Requirement	Phase
	soils. b. assess potential impact for human health, odour and environment c. identify and implement measures to prevent oxidation of acid sulfate soils wherever possible d. identify suitable sites for management, reuse or disposal of acid sulfate soils.	
EPR CL3	**Waste management** Manage wastes during the construction of the projects through development and implementation of a Construction Environmental Management Plan in accordance with the EPA Publication 480 *Environmental Guidelines for Major Construction Sites*, EPA Publication 347.1 *Bunding*, Australian Standard AS1940 *Storage and Handling of Flammable and Combustible Liquids*, and relevant EPA and Victorian WorkCover Authority regulations, standards and best practice guidance that includes: a. application of the waste management hierarchy in assessing waste management options b. contamination and waste management requirements (e.g. use of waste and recycling facilities, maintenance of a clean site policy) c. designated vehicle refuelling area d. chemical management procedures, such as minimising use and storage of chemicals on site, bunded storage facilities to ensure spills, washing residues, slurries or other contaminated water can be contained, and are managed/disposed of appropriately e. location and type of spill kits required f. staff training and competence requirements g. use of well-maintained plant to minimise the potential for spills to occur h. procedures to remove, treat and/or dispose soil that becomes contaminated due to a fuel or chemical spill i. storage of litter in bins from which it cannot escape (temporary fencing may be used as a secondary containment measure for litter).	Construction
EPR CL4	**Acidic and/or contaminated groundwater (construction)** Develop and implement measures to manage acidic and/or contaminated groundwater, in accordance with the State Environment Protection Policy Groundwaters of Victoria 1997, State Environment Protection Policy Waters of Victoria 2004, State Environment Protection Policy Prevention and Management of Contamination of Land 2002, Water Industry Regulations 2006, and relevant EPA regulations, standards	Construction

EPR #	Environmental Performance Requirement	Phase
	and best practice guidance, which must include: a. a baseline groundwater quality assessment (taking into account site history) at least three months prior to commencement of construction works, where applicable b. implementing a system to manage and/or dispose of intercepted groundwater (if required) which may be a trade waste agreement with relevant utility authority or other measures in accordance with relevant guidelines and legislation (if a trade waste agreement is not granted) c. collection, treatment, disposal and handling of contaminated groundwater and/or slurries including vapours d. monitoring of intercepted groundwater quality monitoring during construction and water quality monitoring at run-off containment areas e. implementing contamination plume management (if required) f. treating and monitoring impacted groundwater (including vapours) prior to disposal in accordance with licence and/or agreement.	
EPR CL5	**Acidic and/or contaminated groundwater (operation)** Prepare and fund the implementation of a Groundwater Quality Mitigation Plan in consultation with the land manager of any affected land parcels to manage and mitigate any impacts from changes to groundwater quality and/or levels as a result of the projects. The plan must include: a. measures to maintain or manage the beneficial use of groundwater affected by acidification b. measures to monitor and manage the beneficial uses of groundwater affected by contaminated groundwater plume migration attributable to the project(s) c. measures to maintain or manage impacts on beneficial uses as a result of changes to salinity in groundwater that is attributed to the project(s).	Detailed design Operation
EPR GW1	**Rail trench design** The projects will be designed as rail trenches to meet applicable design standards and comply with the EPRs developed for the projects.	Detailed design Construction Operation
EPR GW2	**Groundwater performance outcomes** The tanked rail trenches at Edithvale and Bonbeach must be designed to ensure that changes to ground water levels as a result of the projects do not result in: a. groundwater mounding that increase water logging at	Detailed design Construction Operation

EPR #	Environmental Performance Requirement	Phase
	ground level b. groundwater drawdown that could cause ground subsidence and adverse impact to subsurface structures c. degradation to groundwater quality that would preclude protected beneficial uses of groundwater (salinity, contaminants, coastal acid sulfate soils) d. changes to groundwater that would have significant impacts on groundwater dependent ecosystems. The performance of the installed rail trench will be monitored to confirm it is not having any impacts on groundwater levels and quality beyond those set out above (EPR reference GW3). Further monitoring and mitigation measures would be implemented if a change to groundwater level or quality that is not in accordance with this EPR is observed (EPR references FF7, FF8, CL5).	
EPR GW3	**Groundwater Management and Monitoring Plan** Prepare and fund the implementation of a Groundwater Management and Monitoring Plan to the satisfaction of the EPA and relevant water authorities to manage predicted and potential impacts to groundwater following construction of the piled trench walls. The Groundwater Management and Monitoring Plan must be prepared prior to the construction of the pile walls and must include: a. detailed monitoring parameters including timing, location of monitoring bores b. duration of the monitoring program c. clear trigger levels for changes in groundwater level and quality that require mitigation plans to be implemented. The following plans for the monitoring and mitigation of impacts to specific environmental assets must be prepared prior to handover of the constructed asset to the rail infrastructure asset manager: a. Groundwater Dependent Ecosystem Monitoring and Mitigation Plan (Foreshore Native Vegetation) (EPR FF7) b. Groundwater Dependent Ecosystem Monitoring and Mitigation Plan (Edithvale Wetland) (EPR FF8) c. Groundwater Quality Monitoring and Mitigation Plan (EPR CL5) The plans would be implemented if trigger levels for changes to groundwater level and quality were identified by the groundwater monitoring program. The Groundwater Management and Monitoring Plan must include a program of monitoring for at least 10 years. At the completion of this time an assessment would be made to	Detailed Design Construction Operation

EPR #	Environmental Performance Requirement	Phase
	consider the need for continued monitoring, rationalisation of the approach or a cessation of monitoring.	
EPR GW4	**Independent peer review** Prior to construction of the trench, independent peer reviews by an appropriately qualified specialist must be undertaken of the following: a. the proposed design of the Edithvale project to confirm that the proposed design is capable of achieving EPR GW2. b. The Groundwater Management and Monitoring Plan (EPR GW3).	Design Construction
EPR SC1	**Community and Stakeholder Engagement Management Plan** Prior to construction (excluding preparatory works), prepare and implement a Community and Stakeholder Engagement Management Plan in consultation with Kingston City Council that includes the following: a. Identifies all Project activities that potentially impact on community and business operations, and provides for a well-coordinated communication and engagement processes. b. Consults with and addresses needs of vulnerable groups that would be impacted by the project such as the elderly, socio-economically disadvantaged groups and children. c. Consults with and addresses needs of community facilities impacted by the project such as schools, child care, aged care, and caravan parks. d. Sets out processes and measures to provide advanced notice to key stakeholders and other potentially affected stakeholders of construction activities (including any staged works, early works, main works, or out of hours works), significant milestones, changed traffic conditions, interruptions to utility services, changed access and parking conditions, periods of predicted high noise and vibration activities, including contact details for enquiries/complaints. e. Provides for any interested stakeholder to register their contact details to ensure they are automatically advised of planned construction activities, project progress, mitigation measures and intended reinstatement measures where applicable. f. Documents a complaints management process (including processes and measures for registering, managing and resolving complaints) consistent with Australian Standard AS/NZS 10002: 2014 Guidelines for Complaint Management in Organisations.	Design Construction

11 Conclusion

An acid sulfate soils and contamination impact assessment has been undertaken for the Edithvale and Bonbeach level crossing removal projects to determine the impacts of acid sulfate soils and contamination impacts as a result of the project. Management and mitigation options in order to reduce these impacts have also been identified.

Existing conditions

The Edithvale and Bonbeach project areas and temporary construction areas are located within a modified, urban environment. The project areas are underlain by Quaternary age aeolian and swamp deposits, which in turn overlie the Pliocene age Baxter Sandstone or Brighton Group sediments. A variable thickness of anthropogenic fill material overlies the natural geological materials associated with the construction of the local transport and residential/commercial infrastructure.

Edithvale

The review of the available information and the data collected during this investigation has indicated the nature and extent of CASS and contamination at Edithvale as:

- The Stage A investigation identified a 'high risk' of CASS being present in the project area
- The Stage B investigation identified PASS ranging from 4 mbgs to15 mbgs that requires management if disturbed as per Victorian EPA guidelines
- The Stage C investigation indicated the SWL of the groundwater for shallow '*Quaternary Aquife*r' was measured ranging between 0.05 mAHD and 0.91 mAHD which equates to as shallow as 3.08 mbgs and as deep as 5.92 mbgs. The SWL for deeper '*Upper Tertiary Aquifer'* was measured ranging between below sea level -0.23m AHD and 1.06 mAHD which are similar to 1.64 mbgs to 5.47 mbgs respectively.
    - The groundwater chemistry for the shallow aquifer was observed to be neutral to alkaline (pH ranging from 7.61 to 9.67) and fresh water (EC values ranging from 521 to 883 µS/cm). Comparatively the deeper groundwater was observed to be neutral to highly alkaline (pH ranging from 7.21 to 12.74) and fresh to saline (EC values ranging from 543 to 9447 µS/cm).
    - Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS were noted for the shallow aquifer. The chloride to sulfate ratio did not indicate presence of actual acidity for the deeper aquifer. The pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.
- The Stage D hazard assessment as per DSE 2010 indicates that the hazard associated with disturbance of CASS at Edithvale is 'High'. This implies that an Acid Sulfate Soils Management Plan (ASSMP) need to be developed in accordance with the BPMG (DSE, 2010) prior to the construction.
- The identified potential land uses identified during the desktop investigation that may be sources of contamination are summarised in Table 48.

Table 48 Edithvale – Potential sources of contamination

Location	Potential source of contamination	Potential contaminants of concern
Within project area	Uncontrolled Fill, Rail corridor	Metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, fertilisers, pesticides, herbicides, asbestos, illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard) and aesthetics such as building rubble.
	Quaternary Sands – naturally occurring disseminated pyrite	Acidity, metals, salinity
Outside project area	Service station, Dry cleaners, Commercial/industrial areas, Boat storage, Mower sales/service centre, Former car dealer, upholsterer, mechanics, Audit Statements [redacted]	Aliphatic hydrocarbons, heavy metals, total recoverable hydrocarbons, BTEX, PAH, phenols, Per- and Polyfluoroalkyl substances (PFAS), cyanides, polychlorinated byphenyls, bactericides, bleaches, brighteners, detergents, enzymes, fungicides, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene), surfactants, turpentine, ammonia, waterproofing, alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol).
	Fire station – leaks and spills from use and storage of PFAS and/or oils and fuels	Per- and Polyfluoroalkyl substances (PFAS), Aliphatic hydrocarbons, BTEX, PAH, phenols, lead.

The intrusive soil investigation confirmed:

- the presence of fill material, ranging from surface to 0.7 mbgs. The fill material included silt, sand, gravel, clay and asphalt.
- detectable concentrations of PFHxS, PFOA and PFOS were reported in soil samples ID18-CASS05_1.5, ID18-CASS06_1 and ID18-CASS06_1.5 obtained in the vicinity for the former Edithvale fire station located at [redacted].
- soil samples ID18-CASS02_0.1 and ID18-CASS16_0.3 collected from anthropogenic fill material exceed the maximum concentrations allowed to be disposed of as Fill Material and has the potential to classify as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.

The groundwater investigation confirmed:

- concentrations of selected metals (aluminium, arsenic, chromium (III + IV), iron, manganese, nickel, and zinc), total dissolved solids, ammonia as N, nitrogen, phosphorous (total) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens beneficial uses in the Quaternary aquifer
- concentrations of selected metals (aluminium, boron, iron, nickel and zinc), total dissolved solids, ammonia as N, sulphate, sulphate as S, phosphorous (total), fluoride exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens and stock watering beneficial uses in the Upper Tertiary aquifer

- concentrations of PFHxS+PFOS and PFOS were reported above the PFAS NEMP 2017 freshwater ecosystem or the PFAS NEMP 2017 Drinking water (health) in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at 206 Station Street, Edithvale.
- detectable concentrations of PFHxS, 6:2 FTS, PFOA and PFHxA were reported in groundwater samples ID18-BH02 and ID18-BH04 obtained in the vicinity for the former Edithvale fire station located at [redacted].
- detectable concentrations of 3&4 methylphenol and phenol were reported in groundwater sample ID18-BH09.

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Edithvale level crossing removal construction footprint may be contaminated to some degree with metals, polycyclic aromatic hydrocarbons (PAH) and PFAS. Further detailed testing to understand soil and groundwater contamination is required during detailed design as per the Environmental Performance Requirements detailed in Section 10.

Bonbeach

The review of the available information and the data collected during this investigation has indicated the nature and extent of CASS and contamination at Bonbeach as:

- The Stage A investigation identified a ‘high risk’ of CASS being present in the project area
- The Stage B investigation identified PASS ranging from 3.5 mbgs to16 mbgs that requires management if disturbed as per Victorian EPA guidelines
- The Stage C investigation indicated the SWL of the groundwater for shallow ‘*Quaternary Aquife*r’ was measured ranging between 0.02 mAHD and 0.91 mAHD which equates to as shallow as1.64 mbgs and as deep as 5.92 mbgs. The SWL for deeper ‘*Upper Tertiary Aquifer’* was measured ranging between below sea level (-0.23m AHD) and 1.06 mAHD which is similar to 4.32 mbgs to 5.47 mbgs respectively.
- The groundwater chemistry was almost similar for both the aquifers with both the shallow and deeper groundwater being neutral to alkaline (pH ranging from 7.21 to 9.67 and 7.37 to 12.74 respectively) and fresh to saline (EC values ranging from 521 to 8401 µS/cm and 543 to 9447 µS/cm respectively).
- Increased levels of sulfate relative to chloride and alkalinity, indicative of the oxidation of PASS were noted for both the shallow and the deeper aquifer. However the pH of the samples (>5) and the measured buffering capacity (>60 mg/L) indicated that the groundwater for both the shallow and deep aquifers has sufficient buffering capacity to neutralise any acidity being produced.
- The Stage D hazard assessment as per DSE 2010 indicates that the hazard associated with disturbance of CASS at Bonbeach is ‘High’. This implies that an Acid Sulfate Soils Management Plan (ASSMP) need to be developed in accordance with the BPMG (DSE, 2010) prior to the construction.

The identified potential land uses identified during the desktop investigation that may be sources of contamination are summarised in Table 49.

Table 49 Bonbeach - Potential contamination sources

Location	Potential source of contamination	Potential contaminants of concern
Within project area	Fill material, Rail corridor, Electrical sub-station	Metals, PAHs, petroleum hydrocarbons, chlorinated naphthalenes, chlorodiphenyls, polychlorinated biphenyls fertilisers, pesticides, herbicides, asbestos, illegal dumping of non-hazardous hard and household rubbish, discarded syringes (biological and physical hazard) and aesthetics such as building rubble.
	Quaternary Sands – naturally occurring disseminated pyrite	Acidity, metals, salinity
Outside project area	Panel beaters, Telstra exchange, Furniture manufacturer, Mower sales/service centre, Commercial/industrial areas, Service station, Laundromat, Audit Statements [redacted]	Metals, PAHs, petroleum hydrocarbons, fertilisers, pesticides, herbicides, polychlorinated biphenyls, asbestos volatile organic compounds, acids, alkalis, glycols, Acids, alkalis, solvents, metals, total recoverable hydrocarbons, solvents (dichlorobenzene, perchloroethene, trichloroethane, trichlorethene, et cetera), alkalis and antifreeze (ethyl-alcohol, ethylene glycol, isopropyl alcohol, methyl alcohol)

The intrusive soil investigation confirmed:

- the presence of fill material, ranging from surface to 0.3 mbgs. The fill material included silt, silty sand, sand, gravel and sandy gravel.
- soil samples ID46-CASS01_0.1, ID46-CASS02_0.1, ID46CASS02_0.3, ID46-CASS10_0.5 and ID46-CASS_0.1 collected from anthropogenic fill material exceed the maximum concentrations allowed to be disposed of as Fill Material and has the potential to classify as Category C contaminated soil in accordance with EPA Victoria Publication IWRG 621.

The groundwater investigation confirmed:

- concentrations of selected metals (aluminium, arsenic, chromium (III + IV), copper, lead, iron, manganese, , molybdenum, nickel and zinc), total dissolved solids, ammonia as N, nitrogen, fluoride, phosphorous (total) exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, agriculture, parks and gardens, and stock watering beneficial uses in the Quaternary aquifer
- concentrations of selected metals (aluminium, chromium (III + IV), copper, lead, iron, nickel, selenium and zinc), total dissolved solids, ammonia as N, nitrogen (total), sodium, chloride, sulphate, phosphorous (total) and fluoride exceeded the adopted investigation levels which are considered to be protective of maintenance of ecosystems, potable water supply, and agriculture, parks and gardens beneficial uses in the Upper Tertiary aquifer
- detectable concentrations of phenol were reported in a groundwater sample obtained from ID46-BH01 which is located in the vicinity of a Groundwater Restricted Use Zone at [redacted].
- detectable concentrations of TRH fraction C6-C10, TPH C6-C9, toluene, 3-&4-methylphenol, phenols, total phenolics, and acetone were reported in groundwater a

sample obtained from ID46-BH03 which is located in the vicinity of a commercial/industrial area (including a furniture manufacturer).

- detectable concentrations of phenols, acetone, idomethane were reported in groundwater samples obtained in ID46-BH05 which is located in the vicinity of the rail corridor.
- detectable concentrations of phenols were reported in a groundwater sample obtained from ID46-BH06 which is located in the vicinity of the rail corridor.
- detectable concentrations of acetone and idomethane were reported in a groundwater sample obtained from ID46-BH10 which is located in the vicinity of the rail corridor.

Based on the indicative contamination investigation, it is considered that soil and groundwater within the Bonbeach level crossing removal construction footprint may be contaminated to some degree with metals, phenols, total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOCs). Further detailed testing to understand soil and groundwater contamination is required during detailed design as per the Environmental Performance Requirements detailed in Section 10.

Spoil volumes

The estimated ex-situ spoil volumes based on the desktop and indicative soil contamination investigations are given below:

- Fill Material – 120,341 m^3 and 145,639 m^3 for Edithvale and Bonbeach respectively
- Category A and B – assumed only at Bonbeach, approximately 100m^3
- Category C – 11,440 m^3 and 28,704 m^3 for Edithvale and Bonbeach respectively
- Waste acid sulfate soils – 43,355 m^3 and 8,515 m^3 for Edithvale and Bonbeach respectively. It is noted that waste acid sulfate soils requiring management would not be generated during excavation of the trench at Bonbeach

The cumulative spoil disposal assessment summarised the following key findings:

- The disposal of excess spoil to landfill and the capacity of the existing landfills to accept the spoil generated during the Edithvale and Bonbeach level crossing removals may be impacted by other major concurrent infrastructure projects (e.g. the Melbourne Metro Rail Tunnel Project and the Westgate Tunnel Project). It is noted that the estimated quantity of spoil requiring management during the Edithvale and Bonbeach level crossing removals only makes up 6% of the total spoil estimated to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail Tunnel and West Gate Tunnel infrastructure projects.
- For the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects, 73% of spoil is estimated to be categorised as Fill material. As the use of Fill material off-site is not regulated and is not required to be disposed to an EPA licenced landfill, it is considered that there is sufficient capacity to reuse or dispose to landfill the combined estimated volume of Fill expected to be generated.
- There is considered to be sufficient capacity within EPA licenced landfills to accommodate the approximately 361,764 cubic metres (ex-situ) of Category C contaminated soils to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects. This could be further reduced by application of treatment technologies to reduce contaminant concentrations and/or leachability to allow for Category C soils to be reclassified as Fill material post treatment. Further, Category A and B soils can also potentially be reclassified as Category C soil post treatment. Reclassification of material would require additional testing and

application to EPA Victoria. Treatment is required to be undertaken at a facility licensed to receive and treat the particular material.

- Offsite disposal of waste acid sulfate soil can only occur to a premise that is either licenced to accept waste acid sulfate soil in accordance with the EPA 1970, or has an Environment Management Plan (EMP) approved by EPA Victoria. There is considered to be sufficient capacity within EPA licenced and/or approved facilities to accommodate the approximately 878,670 cubic metres (ex-situ) of waste acid sulfate soil to be generated during the Edithvale, Bonbeach, Melbourne Metropolitan Rail and West Gate Tunnel projects.

Risk and impact assessment

An assessment of risks to Beneficial Uses of land and groundwater (as specified in the SEPP *Prevention and Management of Contamination of Land* and the SEPP *Groundwaters of Victoria)* posed by the projects was undertaken in accordance with AS/NZS ISO 31000:2009 Risk Management Process. Based on the desktop and field assessments undertaken, the key risks related to CASS and contamination and their risk rating with respect to the construction and operation of the projects are listed below:

Edithvale and Bonbeach

- Disturbance, handling, storage or disposal of CASS/contaminated (including asbestos) soil resulting in adverse health and environmental impacts was assessed as a **Negligible** risk level
- Disturbance, handling, storage or disposal of CASS/contaminated soil leads to the generation of odorous material and results in a loss of amenity was assessed as a **Negligible** risk level
- Disturbance, handling, storage or disposal of acidic and/or contaminated groundwater results in adverse health and environmental impacts was assessed as a **Negligible** risk level
- Unknown contamination encountered during construction results in environmental, health or amenity impacts was assessed as a **Negligible** risk level
- Fuel/chemical spill results in adverse health or environmental impact was assessed as a **Negligible** risk level
- Management of other waste (solid inert, liquid, organic, packaging and food scraps) results in environmental impact was assessed as a **Negligible** risk level
- Transport or disposal of CASS and/or contaminated soil is not in compliance with EPA Victoria permit/licence and results in an environmental impact was assessed as a **Negligible** risk level
- Intersection of contaminated soil and/or groundwater resulting in vapour impacts on human health was assessed as a **Negligible** risk level

Edithvale

Risks associated with changes to groundwater flow paths during construction and ongoing operation of the Edithvale level crossing removal, taking in to consideration the Environmental Performance Requirements developed to mitigate the associated impacts, are:

- Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses. This risk was assessed to have **Negligible** residual risk

- Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses. This risk was assessed to have **Minor** residual risk

Bonbeach

Risks associated with changes to groundwater flow paths during construction and ongoing operation of the Bonbeach level crossing removal, taking in to consideration the Environmental Performance Requirements developed to mitigate the associated impacts, are:

- Drawdown on the down gradient side of trench could result in lowering of regional groundwater levels, which could give rise to activation of CASS and groundwater acidification affecting beneficial uses. This risk was assessed to have **Minor** residual risk
- Mounding on the up gradient side of trench, drawdown on down gradient side of trench, and groundwater physically diverted either to the north or south along the up gradient side of the trench could alter contamination plume migration adversely impacting on beneficial uses. This risk was assessed to have **Negligible** residual risk

Environmental Performance Requirements (EPRs)

Nine EPRs related to acid sulfate soils and contamination were developed to achieve the acceptable environmental outcomes that are required for the projects. The EPRs are applicable to the final design, construction and operation approach and provide certainty regarding the environmental performance of the projects.

The management of known or unexpected PASS and/or contamination during the construction and operation phases would be controlled by developing and implementing the following:

- a spoil management plan(s) in accordance with relevant regulations, standards or best practice guidelines to the satisfaction of EPA
- an Acid Sulfate Soil Management Plan prior to construction of the project 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 to the satisfaction of EPA
- a Construction Environmental Management Plan including procedures to manage waste
- measures to manage acidic and/or contaminated groundwater during construction
- development of a Groundwater Quality Mitigation Plan to monitor and manage impacts during operation
- rail trenches designed within the limits defined in the incorporated document
- the tanked rail trench design at Edithvale and Bonbeach must be designed to ensure that groundwater level changes (as a result of the projects) do not result in:
    - groundwater mounding that increases waterlogging at ground level
    - groundwater drawdown that could cause ground subsidence and adverse impact to subsurface structures
    - degradation to groundwater quality that would preclude beneficial use of groundwater (salinity, contaminants, CASS)

- a Groundwater Management and Monitoring Plan to the satisfaction of the EPA and relevant water authorities to manage predicted and potential impacts to groundwater following construction of the piles trench walls
- a Community and Stakeholder Engagement Management Plan in consultation with the City of Kingston.

The effectiveness of the implemented control measures requires frequent monitoring and adjustment given that construction sites constantly change.

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Appendix A – Relevant legislation

Appendix A – Legislation, policy and guidelines

Table 1 Key legislation and policies

Legislation / policy	Purpose
Environment Protection Act 1970 (EP Act)	The EP Act provides a framework for preventing and controlling air, land and water pollution as well as noise, increasing resource efficiency, reducing waste and improving environmental performance. The EP Act established EPA Victoria and made provisions with respect to the powers, duties and functions of EPA Victoria and the protection of the environment. Key aims of the EP Act include sustainable use and holistic management of the environment, ensuring consultative processes are adopted so that community input is a key driver of environment protection goals and programs, and encouraging a cooperative approach to environment protection. The EP Act also provides the basis for the various State Environment Protection Policies (SEPPs) which provide the framework for the assessment and management of the environmental quality of land, surface waters and groundwater in Victoria.
SEPP (Prevention and Management of Contamination of Land)	The SEPP (Prevention and Management of Contamination of Land) sets out policies to control and reduce environmental pollution and provide acceptable environmental quality standards and conditions for discharging wastes and identification of beneficial uses of the environment. The SEPP (Prevention and Management of Contamination of Land) establishes a range of general uses of land in Victoria and is the main guidance document for the management of contaminated land in Victoria. The SEPP (Prevention and Management of Contamination of Land) outlines the process for establishing land contamination and management and remediation of impacted sites. The SEPP (Prevention and Management of Contamination of Land) identifies a range of land use categories and protected beneficial uses for each of these categories. EPA Victoria considers that land (soil) is polluted where current and/or future protected beneficial uses for the relevant land use categories are precluded. The beneficial uses of land with respect to specific land use categories are defined in Clause 9(1) as follows: **Sensitive uses** – consisting of land used for residential use, a childcare centre, pre-school or primary school. A sensitive use may occur in an area of high density (where development makes maximum use of available land space and there is minimal access to soil) or in other low density areas (where there is generally substantial access to soil) **Agricultural** – consisting of rural areas involved in agricultural or horticultural practices **Parks and gardens** – consisting of parks and forested area as defined in any Victorian or Commonwealth legislation or subordinate legislation, or any regions designated by the Authority or the Department of Environment and Primary Industries (DEPI)

Legislation / policy	Purpose
	Recreation / open space – consisting of general open space and public recreation areas **Commercial** – consisting of a range of commercial and business activities **Industrial** – consisting of utilities and a range of industrial activities.
SEPP (Groundwaters of Victoria)	SEPP (Groundwaters of Victoria) establishes a range of general uses of groundwater and is the main guidance document for the management of groundwater in Victoria. SEPP (Groundwaters of Victoria) provides quality objectives for groundwater protection in Victoria. The policy provides that groundwater is categorised into segments with each segment having particular identified uses. It also requires that occupational health and safety (OH&S) and odour and amenity be considered, due to the fact that vapours sourced from impacted groundwater may present a potential risk to workers, and that odours or discolouration may result in degradation of overall beneficial use.
SEPP (Waters of Victoria)	SEPP (Waters of Victoria) establishes a range of general uses of waters in Victoria and is the main guidance document for the management of waters in Victoria. The primary objective of SEPP (Waters of Victoria) is to provide a coordinated approach to the protection, and where necessary, rehabilitation of the health of Victoria's waterways. SEPP (Groundwaters of Victoria) refers to SEPP (Waters of Victoria) when assessing the impact of groundwater discharging to surface water environments.
Catchment and Land Protection Act 1994	The Catchment and Land Protection Act provides a framework for the integrated and coordinated management of catchments with regard to long-term land productivity and maintenance of the quality of Victoria's land and water resources.
Environment Protection (Industrial Waste Resource) Regulations	The Environment Protection (Industrial Waste Resource) Regulations 2009 (the Regulations) have been developed by EPA Victoria to assist industry to assess, categorise and classify industrial waste and implement the principles of waste hierarchy as set out in Section 1I of the EP Act. The Regulations allow industrial waste resources to be managed within a risk-based regulatory system, with the key intent of significantly improving the rate of re-use and recycling of industrial waste resources in a sustainable manner. Under the EP Act, waste is defined as: • Any matter whether solid, liquid, gaseous or radioactive which is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment • Any greenhouse gas substance emitted or discharged into the environment • Any discarded, rejected, unwanted, surplus or abandoned matter • Any otherwise discarded, rejected, abandoned, unwanted or surplus matter intended for: o Recycling, reprocessing, recovery or purification by a separate operation from that which produced the matter o Sale o Any matter prescribed to be waste.
Industrial Waste Management Policy	Outlines a management framework and specific requirements for the management of acid sulfate soils in an environmentally responsible manner.

Legislation / policy	Purpose
(Waste Acid Sulfate Soils)	
Planning and Environment Act 1987	Section 12 of the Act includes provisions to ensure that potentially contaminated land is suitable for the use allowed in the relevant planning scheme.

Key guidelines and other relevant documents

Guidelines Title	Description
General	
National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (NEPM) (National Environment Protection Council, 2013)	The NEPM document ensures there is a nationally consistent approach to the assessment of contamination as established in SEPP (Prevention and Management of Contamination of Land). The NEPM includes two main schedules which provide guidance on the methods of site contamination assessment, environmental and health-based investigation levels for soil and groundwater contaminants, human and environmental health risk assessment and reporting requirements.
EPA Victoria (1996) Publication 480: Best Practice Environmental Management – Environmental Guidelines for Major Construction Sites	Publication 480 provides a framework so that due diligence obligations can be met and environmental damage can be avoided during the commissioning or construction of freeways, major roads or major developments.
Soil / Groundwater / Surface Water	
Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (DSE 2010)	Outlines a tiered risk-based approach to identifying, assessing and managing acid sulfate soils.
EPA Victoria (2006) Publication 668: Hydrogeological Assessment (Groundwater Quality) Guidelines	Aims to promote a more consistent approach to data collection, reporting and interpretation.
EPA Victoria (2016) Publication 840.2: The Clean-up and Management of Polluted Groundwater	Provides a formalised approach to the clean-up and management of polluted groundwater to ensure the protection of human health and the environment.
EPA Victoria (2000) Publication 669: Groundwater Sampling Guidelines	Provides a standardised approach to the sampling and analysis of groundwater.
EPA Victoria (2009d) Publication IWRG701: Sampling and Analysis of Waters, Wastewaters, Soils and Wastes	Provides a standardised approach to the sampling and analysis of water, soil and sediment.

Guidelines Title	Description
EPA Victoria (2009e) Publication IWRG702. Soil Sampling	Provides information relating to the most suitable sampling patterns for sampling and the number of samples to be taken to ensure the appropriate hazard categorisation is applied to soils being oved off-site for reuse, treatment or disposal.
EPA Victoria (1991) Publication 275: Construction Techniques for Sediment Pollution Control	The guidelines provide recommendations on structures and strategies that reduce sediment export from construction sites.
EPA Victoria (2015) Publication 347.1: Bunding Guidelines	These guidelines apply to providing a secondary containment system for above-ground storage and transfer areas.
Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1994)	Aims to provide water quality guidelines proposed to protect and manage the environmental values supported by the water resources.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000)	Aims to build on the Australian Water Quality Guidelines for Fresh and Marine Waters (November 1992) by incorporating up-to-date scientific information.
Per-and poly-fluoroalkyl substances (PFAS) National Environmental Management Plan – Consultation Draft (NEMP 2017)	Aims to provide governments with a consistent risk-based framework for the environmental regulation of PFAS-contaminated materials and sites. The Plan is still in its development stage but is designed to be adaptive and respond to emerging research and knowledge.

Guidelines Title	Description
EPA Victoria (2009b) Publication IWRG 621: Industrial Waste Resource Guidelines – Soil Hazard Categorisation and Management	EPA Victoria regulates the storage, transport and disposal of waste in Victoria. Wastes taken off site for treatment and disposal must be classified in order to determine EPA Victoria requirements and to choose an appropriate management option. According to the Gazette S195, contaminated soil means "soil or a mixture of soils that can be classified as Category A, B or C Contaminated Soil as provided for under the Regulations and defined in the Industrial Waste Guidelines (published in Special Gazette No. S177 on 9 June 2009)." The guidelines set the framework for the categorisation of wastes and define criteria used for the categorisation of waste soil in Victoria. The Soil Hazard Categories in accordance with IWRG 621 are: • **Fill** – soil, gravel and rock of naturally occurring materials, often referred to as 'clean fill' by industry, with concentrations less than the upper limits specified for 'fill'. EPA Victoria does not regulate the use of fill material and re-use of this soil does not require EPA Victoria approval, however other authorities such as local councils, may have individual requirements. Use of fill material on any site must take into account general obligations (under the EP Act) to prevent adverse impacts on the environment and human health • **Category C** – contaminated soil with concentrations exceeding the limits for 'fill' but not exceeding the limits for 'Category C'. This is the lower level of contaminated soil classification for disposal and is accepted at a number of licensed landfills in Victoria, once the landfill has reviewed analytical results and agreed to accept the soil. Category C contaminated soils must be transported by an appropriately licensed EPA Victoria vehicle (unless exception issued) and accompanied by Waste Transport Certificates • **Category B** – contaminated soil with concentrations exceeding the limits set out for 'Category C' but not exceeding the limits for 'Category B'. This is the higher level of contaminated soil classification for disposal, and is accepted at only one licensed landfill and/or a limited number of treatment facilities in Victoria. Category B waste is regulated by EPA Victoria and is subject to the same landfill acceptance, transport and certificate requirements as Category C waste soils • **Category A** – contaminated soil with concentrations exceeding the limits set out for 'Category B'. Category A soils are regulated by EPA Victoria are subject to the same transport regulations as Category B or C soils, however soils with this higher level of contamination cannot be disposed of to landfill. The soils must be treated either on or off site, or stored pending availability of an appropriate treatment technology. Once treated (or partially treated) the soils may be reclassified and, if appropriate, retained on site or disposed of to a licensed facility.

Appendix B – CASS Field Indicators

Appendix B Geomorphic indicators of acid sulfate soil

Geomorphic indicators of ASS (source: DSE, 2010)

Geomorphic indicators for CASS may include one or more of the following:

- Sediments of recent geological age (Holocene, i.e. last 10,000 years).
- Land and soil elevations less than 10 m AHD.
- Sediments and tidal lakes of marine origin.
- Coastal wetlands and swamps, waterlogged or scaled areas, interdune swales or coastal sand dune (if deep excavations or draining is proposed), coastal sand sheets.
- Areas where the dominant vegetation is mangroves, reeds, rushes and other swamp tolerant, acid tolerant or marine vegetation such as those documented below.

Vegetation type	Vegetation species (common name)
Reeds, rushes and other swamp tolerant or marine vegetation	Swamp paperbark. White mangrove Swamp mahogany Swamp oak Common reed Salt paperbark vegetation
Acid tolerant	Native spike rushes Cape waterlily Native waterlily Vegetation from the *Nymphaea* and *Elocharis* genera

- Areas identified in geological description or in maps as bearing sulfidic minerals, coal deposits or former marine shales or sediments.
- Older estuarine sediments of Pleistocene age (only a concern if these have been preserved in an anaerobic state since they were deposited).

Landscape, soil and water field indicators for the presence of acid sulfate soil

Soil type	Indicators
Acid sulfate soils (ASS)	**Landscape characteristics** Dominance of mangroves, reeds, rushes and other marine, estuarine or swamp tolerant vegetation. Low lying areas, back swamps, scaled or bare areas in coastal estuaries and floodplains Sulfurous (rotten egg) smell after rain following a dry spell or when soils are disturbed.
Actual acid sulfate soils (AASS)	**Landscape and other characteristics** Scalded or low lying areas Corrosion of concrete or steel structures **Soil characteristics (one, some or all)** Filed soil pH ≤ 4 Presence of shell with or without orange-yellow staining or coating. Any jarosite horizons or iron oxide mottling in auger holes or recently dug surfaces; with a fluctuating water table, jarosite may be found along cracks and root channels in the soil; however jarosite is not always found in ASS. Jarosite present in surface encrustations or in any material dredged or excavated and left exposed. Surface water characteristics Water of pH < 5.5 in adjacent streams, drains, groundwater or ponding on the surface. Unusually clear or milky blue-green drain water flowing from the area and/or Extensive iron stains on any drain or pond surfaces, or iron-stained water and ochre deposits **Groundwater characteristics** Groundwater pH < 5 Elevated dissolved sulphate and/or Dissolved mass-balance chloride: sulfate ratio (Cl:SO4) of < 4
Potential acid sulfate soils (PASS)	**Soil characteristics** Waterlogged soils – soft muds (soft, buttery texture, blue-grey or dark greenish-grey) or estuarine silty sands Sands (mild to dark grey) or bottom sediments of estuaries or tidal lakes (dark grey to black). Presence of shell. Soil pH usually neutral but may be acid when tested with the field peroxide test and/or Offensive odour, predominantly due to rotten egg gas (H2S) **Water characteristics** Water pH usually neutral but may be acid

Source: DSE, 2010

Appendix C – Soil and groundwater sampling and analysis

1. Soil and groundwater sampling and analysis

1.1 Soil

Soil sample analysis

A total of 89 primary soil samples were collected from 41 locations as part of the contamination investigation with all 89 primary soil samples selected for analysis. The soil sample analytical program is outlined in Table 1.

Table 1 Soil analytical program

Project area	Sample Type	Sample ID	Sample Date	Analyses
Edithvale	Primary	ID18CASS01_0.3	21/07/2017	IWRG 621 Screen, ASLP benzo(a)pyrene
		ID18CASS01_1	21/07/2017	IWRG 621 Screen
		ID18CASS01_1.5	21/07/2017	IWRG 621 Screen
		ID18CASS02_0.1	21/07/2017	IWRG 621 Screen
		ID18CASS02_0.5	21/07/2017	IWRG 621 Screen
		ID18CASS02_1.3	21/07/2017	IWRG 621 Screen
		ID18CASS03_5	3/08/2017	IWRG 621 Screen
		ID18CASS03_6.2	3/08/2017	IWRG 621 Screen
		ID18CASS03_7	3/08/2017	IWRG 621 Screen
		ID18CASS04_0.3	1/08/2017	IWRG 621 Screen, ASLP lead
		ID18CASS04_0.5	1/08/2017	IWRG 621 Screen
		ID18CASS04_1	1/08/2017	IWRG 621 Screen
		ID18CASS04_5	1/08/2017	IWRG 621 Screen, PFAS
		ID18CASS05_1.5	17/07/2017	IWRG 621 Screen, PFAS
		ID18CASS06_1	1/08/2017	PFAS
		ID18CASS06_1.5	19/07/2017	IWRG 621 Screen
		ID18CASS08_0.1	1/08/2017	IWRG 621 Screen, ASLP lead
		ID18CASS08_0.5	1/08/2017	IWRG 621 Screen
		ID18CASS08_1.5	1/08/2017	IWRG 621 Screen
		ID18-CASS10_1.55	13/07/2017	IWRG 621 Screen
		ID18 CASS11_1.55	10/07/2017	IWRG 621 Screen

Project area	Sample Type	Sample ID	Sample Date	Analyses
		ID18CASS12_0.1	24/07/2017	IWRG 621 Screen, ASLP lead
		ID18CASS12_0.5	24/07/2017	IWRG 621 Screen
		ID18CASS12_1.5	24/07/2017	IWRG 621 Screen
		ID18CASS13_0.1	24/07/2017	IWRG 621 Screen, ASLP lead
		ID18CASS13_0.3	24/07/2017	IWRG 621 Screen, ALSP benzo(a)pyrene
		ID18CASS13_0.5	24/07/2017	IWRG 621 Screen
		ID18CASS14_0.1	20/07/2017	IWRG 621 Screen, ASLP lead,
		ID18CASS14_0.5	20/07/2017	IWRG 621 Screen
		ID18CASS14_1.5	20/07/2017	IWRG 621 Screen
		ID18CASS15_0.1	20/07/2017	IWRG 621 Screen, ASLP lead
		ID18CASS15_0.3	20/07/2017	IWRG 621 Screen
		ID18CASS15_0.9	20/07/2017	IWRG 621 Screen
		ID18CASS16_0.1	20/07/2017	IWRG 621 Screen, ASLP lead
		ID18CASS16_0.3	20/07/2017	IWRG 621 Screen
		ID18CASS16_1.0	20/07/2017	IWRG 621 Screen
		ID18CASS21_2	3/08/2017	PFAS
		ID18CASS21_3	3/08/2017	PFAS
		ID18CASS21_4	3/08/2017	PFAS
		ID18CASS21_5	3/08/2017	PFAS
		ID18CASS21_6	3/08/2017	PFAS
		ID18CASS21_7	3/08/2017	PFAS
	QC (Duplicate)	DUP5_240710	24/07/2017	IWRG 621 Screen
	QC (Triplicate)	DUP6_240717	24/07/2017	IWRG 621 Screen
Bonbeach	Primary	ID46 CASS01_0.1	14/07/2017	IWRG 621 Screen, ASLP copper, ASLP lead, ASLP benzo(a)pyrene
		ID46 CASS01_0.5	14/07/2017	IWRG 621 Screen
		ID46 CASS01_1.3	14/07/2017	IWRG 621 Screen
		ID46 CASS02_0.1	14/07/2017	IWRG 621 Screen, ASLP copper, ASLP lead

Project area	Sample Type	Sample ID	Sample Date	Analyses
		ID46 CASS02_0.3	14/07/2017	IWRG 621 Screen, ASLP benzo(a)pyrene
		ID46 CASS02_0.7	14/07/2017	IWRG 621 Screen
		ID46-CASS03_0.5	11/07/2017	IWRG 621 Screen, ASLP lead
		ID46-CASS03_1.5	11/07/2017	IWRG 621 Screen
		ID46-CASS03_2.5	11/07/2017	IWRG 621 Screen
		ID46CASS04_0.3	11/07/2017	IWRG 621 Screen
		ID46CASS04_5	11/07/2017	IWRG 621 Screen
		ID46CASS05_0.1	27/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS05_0.5	27/07/2017	IWRG 621 Screen
		ID46CASS05_2	27/07/2017	IWRG 621 Screen
		ID46CASS06_0.1	27/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS06_0.3	27/07/2017	IWRG 621 Screen
		ID46CASS06_1	27/07/2017	IWRG 621 Screen
		ID46CASS07_0.1	18/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS07_0.7	18/07/2017	IWRG 621 Screen
		ID46CASS07_0.9	18/07/2017	IWRG 621 Screen
		ID46CASS08_0.1	28/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS08_0.5	28/07/2017	IWRG 621 Screen
		ID46CASS08_1.5	28/07/2017	IWRG 621 Screen
		ID46_CASS09_2.0	31/07/2017	IWRG 621 Screen
		ID46CASS10_0.1	18/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS10_0.5	18/07/2017	IWRG 621 Screen, ASLP lead, ASLP benzo(a)pyrene
		ID46CASS10_2.2	18/07/2017	IWRG 621 Screen
		ID46CASS11_0.1	17/07/2017	IWRG 621 Screen, ASLP lead
		ID46CASS11_0.3	17/07/2017	IWRG 621 Screen
		ID46CASS11_1	17/07/2017	IWRG 621 Screen

Project area	Sample Type	Sample ID	Sample Date	Analyses
		ID46 CASS12_0.1	14/07/2017	IWRG 621 Screen, ASLP lead
		ID46 CASS12_0.3	14/07/2017	IWRG 621 Screen, ASLP benzo(a)pyrene
		ID46 CASS12_1	14/07/2017	IWRG 621 Screen
		ID46 CASS13_0.3	11/07/2017	IWRG 621 Screen
		ID46 CASS13_3	11/07/2017	IWRG 621 Screen
		ID46 CASS14_0.3	10/07/2017	IWRG 621 Screen
		ID46 CASS14_1.5	10/07/2017	IWRG 621 Screen
		ID46 CASS14_4.0	10/07/2017	IWRG 621 Screen
		ID46 CASS15_0.1	10/07/2017	IWRG 621 Screen, ASLP copper, ASLP lead, ASLP benzo(a)pyrene
		ID46 CASS15_0.5	10/07/2017	IWRG 621 Screen
		ID46 CASS15_1.0	10/07/2017	IWRG 621 Screen
		ID46 CASS15_1.5	10/07/2017	IWRG 621 Screen
		ID46 CASS15_2.0	10/07/2017	IWRG 621 Screen
		ID46 CASS16_0.1	10/07/2017	IWRG 621 Screen, ASLP lead
		ID46 CASS16_0.5	10/07/2017	IWRG 621 Screen
		ID46 CASS16_1.0	10/07/2017	IWRG 621 Screen
		ID46 CASS16_1.5	10/07/2017	IWRG 621 Screen
	QC (Duplicate)	DUP4_280717	28/07/2017	IWRG 621 Screen

NOTES

IWRG 621 Screen: Metals: Total (Ag, As, Cd, Cu, Mo, Ni, Pb, Se, Sn & Zn), Mercury, Hexavalent Chromium, pH, Cyanide – Total, Fluoride – Total, Polychlorinated Biphenyls (PCB), Monocyclic Aromatic Hydrocarbons (MAH), Volatile Halogenated Compounds (VHC), Phenolic Compounds (Halogenated), Phenolic Compounds (Non-halogenated), Polynuclear Aromatic Hydrocarbons (PAH), Organochlorine Pesticides (OCP), Total Petroleum Hydrocarbons (TPH) *C10 – C36 Fractions.*

ASLP: Australian Standard Leaching Procedure

PFAS: Perfluoroheptane sulfonic acid, N-Ethyl perfluorooctane sulfonamidoacetic acid, 10:2 Fluorotelomer sulfonic acid, Perfluorodecanesulfonic acid (PFDS), 4:2 Fluorotelomer sulfonic acid, Perfluorobutane sulfonic acid, N-Methyl perfluorooctane sulfonamidoacetic acid, Perfluorohexane sulfonic acid (PFHxS), Perfluoropentanoic acid, 8:2 Fluorotelomer sulfonic acid, N-Ethyl perfluorooctane sulphonamide, N-Ethyl perfluorooctane sulfonamidoethanol, N-Methyl perfluorooctane sulphonamide, N-Methyl perfluorooctane sulfonamidoethanol, 6:2 Fluorotelomer Sulfonate (6:2 FTS), Perfluorooctanoic acid (PFOA), Perfluoropentane sulfonic acid, Perfluorobutanoic acid, Perfluorodecanoic acid, Perfluorododecanoic acid, Perfluoroheptanoic acid, Perfluorohexanoic acid (PFHxA), Perfluorononanoic acid,

Project area	Sample Type	Sample ID	Sample Date	Analyses
Perfluorooctane sulfonic acid (PFOS), Perfluorooctane sulfonamide (FOSA), Perfluorotetradecanoic acid, Perfluorotridecanoic acid, Perfluoroundecanoic acid.				

1.2 Groundwater

A total of 23 primary groundwater samples were collected from 23 locations as part of the contamination investigation with both primary groundwater samples selected for analysis. The groundwater sample analytical program in respect to contamination is outlined in Table 2.

Table 2 Groundwater analytical program

Project area	Sample Type	Sample ID	Sample Date	Analyses
Edithvale	Primary	ID18-BH01	18/7/17	Nutrients, metals
		ID18-BH02	1/12/16	Nutrients, metals, PFAS
		ID18-BH04	8/6/17	Nutrients, metals, PFAS
		ID18-BH06	21/7/17	Nutrients, metals
		ID18-BH07	19/7/17	Nutrients, metals
		ID18-BH09	21/7/17	Nutrients, metals
		ID18-GWBH01	1/12/16	Nutrients, metals
		ID18-GWBH02	8/6/17	Nutrients, metals
		ID18-GWBH03	21/7/17	Nutrients, metals
		ID18-GWBH04	21/7/17	Nutrients, metals
		ID18-GWBH05	1/12/16	Nutrients, metals
Bonbeach	Primary	ID46-BH08	25/7/17	Nutrients, metals
		ID46-BH10	26/7/17	Nutrients, metals
		ID46-GWBH02	24/7/17	Nutrients, metals
		ID46-GWBH04	25/7/17	Nutrients, metals
		ID46-GWBH05	26/7/17	Nutrients, metals
		ID46-GWBH06	27/7/17	Nutrients, metals
		ID46-BH01	21/7/17	Nutrients, metals
		ID46-BH03	25/7/17	Nutrients, metals
		ID46-BH05	25/7/17	Nutrients, metals
		ID46-BH06	24/7/17	Nutrients, metals
		ID46-GWBH01	26/7/17	Nutrients, metals
		ID46-GWBH03	24/7/17	Nutrients, metals

Project area	Sample Type	Sample ID	Sample Date	Analyses

NOTES

Nutrients: Ammonia as N, Total Kjeldahl Nitrogen, Nitrate (as N), Nitrite (as N), Nitrate + Nitrite as N, Nitrogen (Total), Phosphorous filterable reactive (P), Phosphate total (P).

Metals: Aluminium, Arsenic, Cadmium, Chromium (III+VI), Iron, Manganese, Nickel, Selenium, Zinc.

PFAS: Perfluoroheptane sulfonic acid, N-Ethyl perfluorooctane sulfonamidoacetic acid, 10:2 Fluorotelomer sulfonic acid, Perfluorodecanesulfonic acid (PFDS), 4:2 Fluorotelomer sulfonic acid, Perfluorobutane sulfonic acid, N-Methyl perfluorooctane sulfonamidoacetic acid, Perfluorohexane sulfonic acid (PFHxS), Perfluoropentanoic acid, 8:2 Fluorotelomer sulfonic acid, N-Ethyl perfluorooctane sulphonamide, N-Ethyl perfluorooctane sulfonamidoethanol, N-Methyl perfluorooctane sulphonamide, N-Methyl perfluorooctane sulfonamidoethanol, 6:2 Fluorotelomer Sulfonate (6:2 FTS), Perfluorooctanoic acid (PFOA), Perfluoropentane sulfonic acid, Perfluorobutanoic acid, Perfluorodecanoic acid, Perfluorododecanoic acid, Perfluoroheptanoic acid, Perfluorohexanoic acid (PFHxA), Perfluorononanoic acid, Perfluorooctane sulfonic acid (PFOS), Perfluorooctane sulfonamide (FOSA), Perfluorotetradecanoic acid, Perfluorotridecanoic acid, Perfluoroundecanoic acid.

Appendix D – Tabulated analytical results

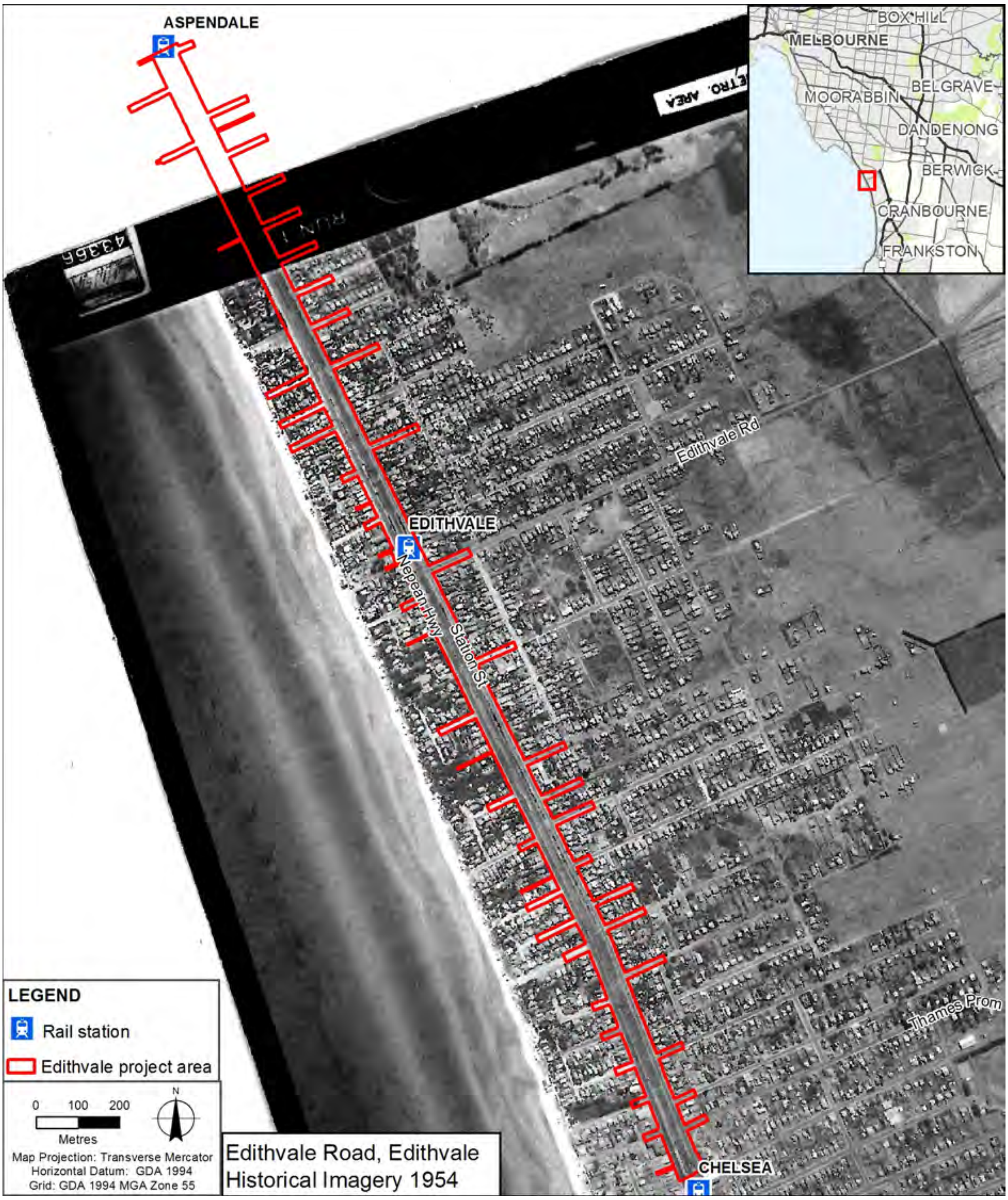
NOTE: THIS DATA IS PROVIDED ELECTRONICALLY ONLY

Appendix E – Laboratory reports

NOTE: THIS DATA IS PROVIDED ELECTRONICALLY ONLY

Appendix F – Historical aerial photographs


ASPENDALE
EDITHVALE
CHELSEA
Nepean Hwy
Station St
Edithvale Rd
Thames Prom
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1945


ASPENDALE
EDITHVALE
CHELSEA
Edithvale Rd
Nepean Hwy
Station St
Thames Prom
MELBOURNE
BOX HILL
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1954


ASPENDALE
EDITHVALE
CHELSEA
Edithvale Rd
Nepean Hwy
Station St
Thames Prom
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1963


ASPENDALE
EDITHVALE
CHELSEA
Nepean Hwy
Station St
Edithvale Rd
Thames Prom
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1970


ASPENDALE
EDITHVALE
CHELSEA
Edithvale Rd
Nepean Hwy
Station St
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1977


ASPENDALE
EDITHVALE
CHELSEA
Nepean Hwy
Station St
Edithvale Rd
Thames Prom
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1980

ASPENDALE
EDITHVALE
CHELSEA
Nepean Hwy
Station St
Edithvale Rd
Thames Prom
BOX HILL
MELBOURNE
BELGRAVE
MOORABBIN
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 1987

Edithvale Road, Edithvale
Historical Imagery 2005


ASPENDALE
EDITHVALE
CHELSEA
Nepean Hwy
Station St
Edithvale Rd
Thames Prom
BOX HILL
MELBOURNE
BELGRAVE
MOORABBIN
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Edithvale project area
0 100 200
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Edithvale Road, Edithvale
Historical Imagery 2016


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
BELGRAVE
MOORABBIN
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1945


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1957


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
86
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1963


CHELSEA
Station St
Nepean Hwy
BONBEACH
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BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1972


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1978


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
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180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1982


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 1987


CHELSEA
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BONBEACH
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DANDENONG
BERWICK
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FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 2005


CHELSEA
Station St
Nepean Hwy
BONBEACH
BOX HILL
MELBOURNE
MOORABBIN
BELGRAVE
DANDENONG
BERWICK
CRANBOURNE
FRANKSTON
LEGEND
Rail station
Bonbeach project area
0 90 180
Metres
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
Bondi Road, Bonbeach
Historical Imagery 2016

Appendix G – CASS Maps

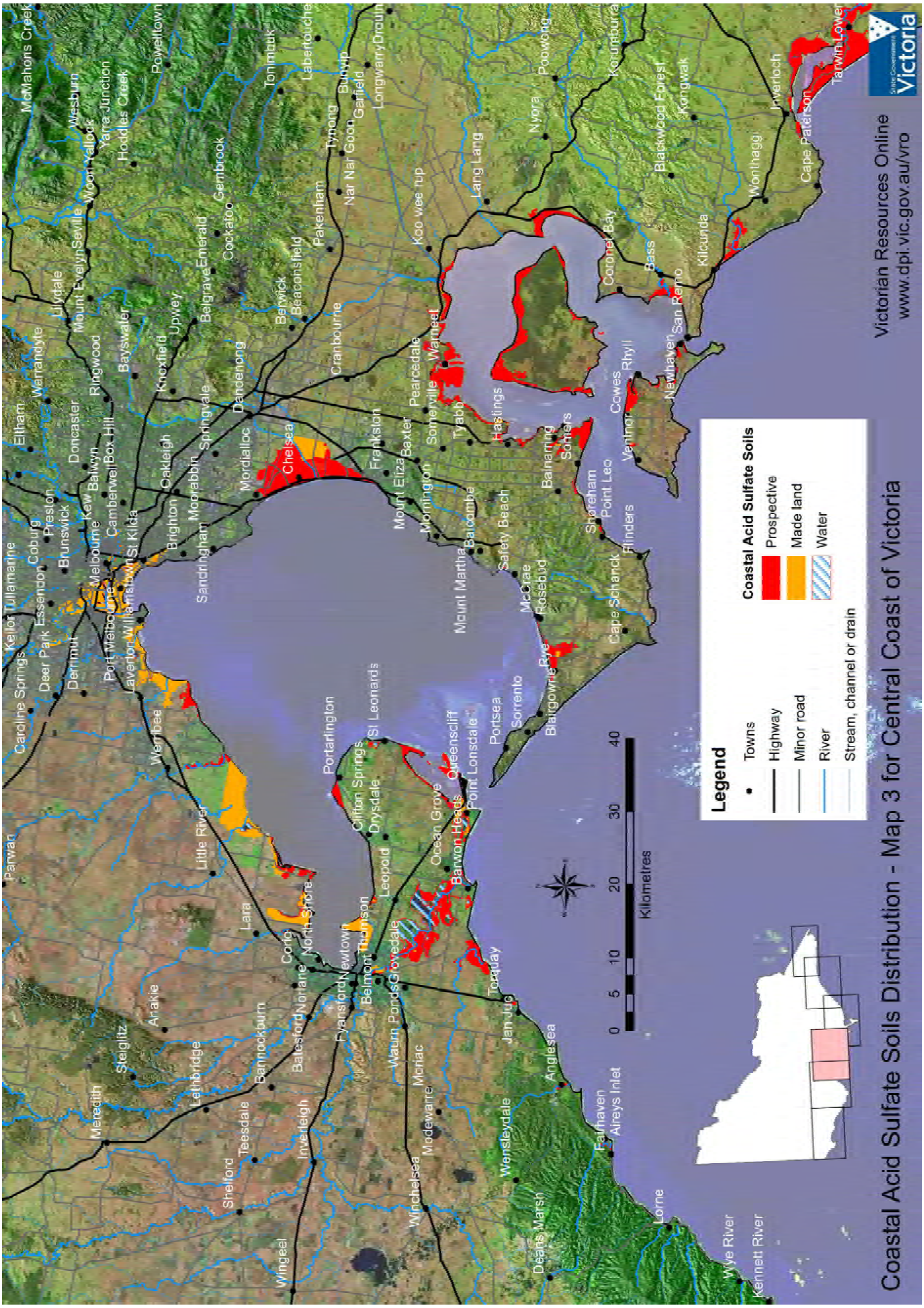

Figure 22 CASS Map

Appendix H – Quality assurance / quality control

1. Data Validation Report

1.1 Compliance with SAP

The fieldwork was completed over approximate five weeks between 11 July 2017 and 15 August 2017. The investigation was completed in accordance with the SAQP (Memorandum AECOM-GHD JV, 2017) with the exception of the following aspects:

- Three boreholes advanced at Edithvale project area, (ID18 CASS03, ID18CASS04 and ID18 CASS05) were extended to 22 meters (m) as compared to original depths ranging between 7 m to 17 m due to changes in design.
- The split duplicate samples were not collected for majority of the blind duplicate sample locations due to unavailability of sample by push tube drilling. As the push tubes are narrow (approximately 3 cm diameter), and samples were collected for every 0.5m, which made it difficult to obtain enough soil for a split duplicate sample at a particular depth. As such the frequency of blind duplicate samples was increased.

1.2 Laboratories and data set

All samples recovered during the soil investigation were submitted to ALS Environmental (ALS) and Eurofins-MGT (MGT), both of which are National Association of Testing Authorities (NATA) accredited laboratories, accredited to perform the required analysis except for the ALS field pH and field oxidised pH for acid sulfate soils. As per ALS, these tests were conducted as per the methodology given in Victorian Best Practice Management Guidelines (BPMG).

The selected laboratories conducted all the requested analyses in accordance with the guidelines outlined in NEPM 1999 (as amended 2013) and BPMG 2010.

The laboratories employed for sample analysis are set out in Table 1.

Table 1 Analytical laboratories

Laboratory	Primary or Secondary Lab?	NATA Certified for Analysis Requested
ALS Environmental (ALS)	Primary	Yes
Eurofins-MGT (MGT)	Secondary	Yes

The primary results and QAQC results were reported in laboratory Certificates of Analysis as set out in **Table 2** and provided in **Appendix D**.

Table 2 Laboratory reports

Laboratory	Report No
ALS	Edithvale: EM1708968, EM1709034, EM1709080, EM1709146, EM1709193, EM1709241, EM1709269, EM1709323, EM1709378, EM1709421, EM1709452, EM1709495, EM1709503, EM1709564, EM1709681, EM1709733, EM1709757, EM1709805, EM1709848, EM1709882, EM1709883, EM1709899, EM1709956, EM1710140, EM1710181, EM1710220, EM1710339, EM1710341, EM1710363, EM1710370, EM1710432, EM1710535, EM1710538, EM1710587, EM1710670, EM1710732, EM1710779, EM1710806, EM1710868, EM1711196, EM1711282, EM1711636

Laboratory	Report No
	Bonbeach EM1708963, EM1708967, EM1709015, EM1709036, EM1709078, EM1709081, EM1709145, EM1709171, EM1709278, EM1709324, EM1709379, EM1709416, EM1709453, EM1709491, EM1709500, EM1709564, EM1709666, EM1709732, EM1709754, EM1709759, EM1709803, EM1709848, EM1709899, EM1709947, EM1709951, EM1709978, EM1710043, EM1710089, EM1710144, EM1710162, EM1710368, EM1710421, EM1710431, EM1710470, EM1710774, EM1711284, EM1711638, EM1712277
MGT	Edithvale: 555657, 555835, 559130 Bonbeach 559130, 554981, 554072

The data quality assessment detailed in the following pages refers to the data provided in these laboratory reports.

1.3 Data quality indicators

Table 3 sets out the Quality Assurance and Quality Control (QAQC) Data Quality Indicators (DQIs) used in the Soil Investigation and whether or not they were achieved.

Table 3 Summary of QAQC compliance for soil sampling

Item	Objective	Outcome	Reference
Field QC Procedures			
Comparison of field and analytical data	Agreement between visual and olfactory evidence with laboratory results	Completed	Visual and/or olfactory evidence of contamination was limited to fill material in soils. This was reflected in analytical results. ALS/MGT Certificates of Analysis (**Appendix D**)
Calibration of field instruments	N/A	N/A	N/A
Chain of Custody documentation	Supply Chain of Custody Documentation with all samples	Completed	Copies of Chain of Custody Documentation (**Appendix D**)
Sample analysis and extraction holding times	Comply with holding times.	Completed	*ALS/MGT* Laboratory Quality Control Reports. (**Appendix D**)
Analysis of inter and intra-laboratory duplicate samples	Analysis of duplicate samples in 5% of primary samples	Completed	AS4482.1-2005 and US EPA NEPM 1999 (as amended 2013) and *ALS/MGT* certificates of analysis (**Appendix D**)
Analysis of rinsate, trip and	Rinsate and Trip blank samples were not collected	Completed	

Item	Objective	Outcome	Reference
field blank samples			
Laboratory QC Procedures			
Analysis of laboratory method blanks	No contamination of blanks.	Completed	*ALS/MGT* Laboratory Quality Control Reports (**Appendix D**)
Analysis of laboratory spike recoveries	Recoveries within the laboratory specified recovery limits.	Completed	*ALS/MGT* Laboratory Quality Control Reports (**Appendix D**)
Analysis of laboratory internal duplicates	Frequencies and RPDs within guideline and internal laboratory limits (RPD of 0-30%)	Completed	NEPM 1999 (as amended 2013) *ALS/MGT* Laboratory Quality Control Reports (**Appendix D**)

1.4 QA/QC assessment method

Established quality assurance/quality control (QA/QC) procedures to assess data quality were maintained throughout the project. The QA/QC program undertaken as part of the assessment included the following:

- Use of appropriately qualified and trained staff;
- Preservation of samples with ice during transport from the field to the laboratory;
- Transportation of samples with accompanying chain-of-custody documentation;
- Compliance with sample holding times;
- Review of results of a blind duplicate sample;
- Review of results of a split duplicate sample; and
- Review of internal analysis of laboratory duplicates, spikes and blanks.

The QC program employed during this investigation was in accordance with the general requirements set out in the Australian Standard AS4482.1 (2005). QC samples provide information that discounts or potentially identifies errors due to possible sources of cross contamination, inconsistencies in sampling and analytical techniques used. The QC program completed included the collection and analysis of a rinsate blank and duplicate samples, these are described below:

- **Split duplicate samples:** These are duplicate samples split in the field, with one sample being sent to a secondary laboratory for check analysis. The same parameters are analysed utilising similar analytical techniques;
- **Blind duplicate samples:** These are coded duplicate samples submitted to the primary laboratory for analysis as individual samples without any indication to the laboratory that they have been duplicated;
- **Trip Blank:** A blank sample placed into the ice chest to indicate whether cross contamination has occurred during transport; and
- **Rinsate blank:** A sample of deionised water collected from equipment used during sampling to indicate whether cross contamination occurred from equipment.

- A quantitative measure of the accuracy of the check analyses results obtained was made using calculated relative percentage difference (RPD) values. The RPD values were calculated using the following equation.

$$RPD(\%) = \frac{\langle Co - Cs \rangle}{\left\langle \frac{Co + Cs}{2} \right\rangle} \times 100$$

Where *Co* = concentration obtained from the original sample

Cs = concentration obtained from the duplicate sample

1.5 Field QA/QC

Soil duplicate samples

A total of 27 blind duplicate and four split duplicate sample were analysed as part of the Edithvale program. This amounts to duplicates samples analysed with 19% of primary soil samples, satisfying the data quality objective of 5%. Similarly for Bonbeach, a total of 23 blind duplicate and three split duplicate sample were analysed as part of the QC program. This amounts to duplicates samples analysed with 17% of primary soil samples, satisfying the data quality objective of 5%.

The analysis of acid sulfate soils includes using two method including Chromium Reducible Sulfur Suite (CRS) or Suspended Peroxide Suspension Combined Acidity and Sulfate (SPOCAS) suite. The primary samples were analysed for CRS suite and the blind duplicate samples were analysed for SPOCAS. The split duplicate samples (where collected) were analysed for CRS suite. The net acidity with both the methods was used to calculate the RPDs.

The frequency of quality control samples including field duplicate and split duplicate samples collected for analysis of Industrial Waste Resource Guidelines (IWRG) 621 suite of analytes for spoil characterisation was below the data quality objective of 5% due to oversight by field staff (human error). As majority of the results for these analytes for the primary samples are below laboratory limit of reporting (LOR), the Relative percentage difference (RPD) assessment for the four QC samples is considered acceptable.

Calculated RPD values for duplicate samples are presented in the tables included in **Table G1 through to G4** of this Appendix.

All RPDs calculated were within acceptable limits (i.e. <50%) with the exception of three samples where RPDs between primary samples (ID18CASS05_15, ID18CASS07_15 and ID18CASS12_5), and corresponding blind duplicates (CASS05_QC3, CASS07_QC1) and split duplicate DUP2_240717 was noted.

For samples at Bonbeach, all RPDs calculated were within acceptable limits (i.e. <50%) with the exception of six samples where RPDs between primary samples (ID46CASS01_4, ID46CASS05_10, ID46CASS05_14.5, ID46CASS08_10, ID46CASS10_14.5 and ID46CASS13_9), and corresponding blind duplicates (DUP2_14717, DUP1_280717, CASS05_QC1, DUP3_280717, CASS10_QC2, QC1_ALS) and split duplicate QC1_E was noted.

These exceedances maybe attributed to a combination of low analyte concentrations (all results less than 10x limits of reporting) and the heterogeneous nature of the spoil material sampled. These RPD exceedances are not considered to affect the validity of the data set, but do highlight the variable nature of spoil material.

Rinsate blank and trip blank samples

There is no requirement of collection of rinsate and trip blank samples for analytes included in CRS and SPOCAS suites. No rinsate and trip blank samples were collected for IWRG 621 Suite including hydrocarbons and other contaminants. As this analysis was undertaken to characterise the drill cuttings /spoil for disposal purposes, the lack of data for rinsate and trip blank samples is not considered to impact the outcome of this investigation.

1.6 Laboratory QA/QC

Results of the internal laboratory quality control programs are included in the laboratory reports provided in **Appendix D**.

1.6.1 Frequency of Laboratory QC samples

The frequency of laboratory QC samples was within the acceptable limits for both ALS and MGT except for EM1709036 and EM1710363, where a matrix spike was not analysed for total mercury. Also, in ALS batches EM1711636 and EM1711638, the analysis of laboratory duplicate and matrix spike was missed due to insufficient sample obtained after leaching.

1.6.2 Laboratory duplicates

All RPDs for laboratory internal duplicates from the ALS and MGT reports were within the laboratory nominated acceptable ranges.

1.6.3 Matrix spikes (MS)

All matrix spike percentage recoveries conducted by MGT and ALS were measured between the acceptable ranges, except for:

- EM1710406, where the MS recovery for TRH fractions was below the acceptable limits for an anonymous sample
- EM1709978, where MS recovery was below the acceptable limits for hexavalent chromium
- EM1709564, where MS recovery was ‘not-determined’ for pyrene as background levels were greater than 4 times spike level
- EM1710363, where MS recovery was ND for lead and zinc for anonymous sample.

1.6.4 Laboratory control samples (LCS)

All LCS recoveries conducted by MGT and ALS were measured between the acceptable ranges, except for:

- EM1709078, EM1709278, EM1709899, EM1709978, EM1710144, EM1710181 and EM1710406 where the LCS recovery for select PAH/phenol compounds was outside the acceptable limits
- EM1709564, where LCS recovery was outside the acceptable limits for select organophosphorus pesticides

1.6.5 Surrogate samples (SS)

All surrogate sample recoveries analysed by MGT and ALS were measured between the acceptable ranges, except for:

- EM1709416 where the SS recovery for Anthracene was outside the acceptable limits

1.6.6 Method blanks

All reported concentrations for laboratory method blanks analysed by both MGT and ALS were less than their respective laboratory reporting limits.

1.6.7 Holding times

The holding times for analysis at both MGT and ALS were within the required timeframes except for:

- EM1711636, where the holding time for analysis of non-volatile leaching exceeded the holding times ranging between 15 and 27 days for ID18CASS08_0.1, ID18CASS08_0.3, ID18CASS14_0.1, ID18CASS6_0.1, ID18CASS01_0.3, ID18CASS13_0.1 and ID18CASS12_0.1.
- EM1711638, where the holding time for analysis of ASLP leaching exceeded the holding times ranging between 31 and 39 days for ID46CASS15_0.1, ID46CASS01_0.1, ID46CASS02_0.3, ID46CASS12_0.3 and ID46CASS10_0.5.

The exceedance of these holding times was only for leaching procedures. This was undertaken to characterise the drill cuttings/spoil for disposal purposes, as such the holding time issue is not considered to impact the outcome of this investigation.

1.7 Discussion

Based on the QA/QC program undertaken during the soil sampling program, the data obtained during the assessment is considered to be of an acceptable standard on which to base interpretations and draw conclusions regarding the environmental status of the Edithvale and Bonbeach project areas.

AECOM GHD JOINT VENTURE

Table G1 - Relative Percent Difference Calculations
Edithvale CRS Suite

								Field Parameters		ASS - Acid Base Accounting		
								pHF	pHFox	Net Acidity (acidity units)	Net Acidity (sulfur units)	Liming Rate
							Unit	pH Units	pH Units	mole H+/t	%S	kg CaCO3/t
Location Code	Depth	Date	Field ID	Sample Type	Lab Report Field	Lab Report CRS	EQL	0.1	0.1	10	0.02	1
ID18-CASS03	11.5 - 11.5	3/08/2017	ID18-CASS03_11.5	Normal	EM1710363	EM1710779		8.6	5.7	<10	<0.02	<1
	11.5 - 11.5	3/08/2017	DUP2_30817	Field_D	EM1710363	EM1710779		8.7	5.7	<10	<0.02	<1
				RPD				*1*	*0*	*0*	*0*	*0*
	16 - 16	14/08/2017	ID18-CASS03_16	Normal	EM1711196	EM1710806		9.5	7.4	<10	<0.02	<1
	16 - 16	14/08/2017	ID18-CASS03_QC1	Field_D	EM1711196	EM1710806		9.6	8	11	<0.02	<1
				RPD				*1*	*8*	*10*	*0*	*0*
	18 - 18	14/08/2017	ID18-CASS03_18	Normal	EM1711196	EM1710806		8.5	6.6	<10	<0.02	<1
	18 - 18	14/08/2017	ID18-CASS03_QC2	Field_D	EM1711196	EM1710806		8.6	6	<10	<0.02	<1
				RPD				*1*	*10*	*0*	*0*	*0*
	20 - 20	15/08/2017	ID18-CASS03_20	Normal	EM1711196	EM1710868		7.7	5.7	<10	<0.02	<1
	20 - 20	15/08/2017	ID18-CASS03_QC3	Field_D	EM1711196	EM1710868		7.5	5.9	<10	<0.02	<1
				RPD				*3*	*3*	*0*	*0*	*0*
	22 - 22	15/08/2017	ID18-CASS03_22	Normal	EM1711196	EM1710868		7.1	5.4	<10	<0.02	<1
	22 - 22	15/08/2017	ID18-CASS03_QC4	Field_D	EM1711196	EM1710868		7.2	5.7	<10	<0.02	<1
				RPD				*1*	*5*	*0*	*0*	*0*
ID18-CASS04	5.5 - 5.5	1/08/2017	ID18-CASS04_5.5	Normal	EM1710779			5.5	4.1	12	<0.02	<1
	5.5 - 5.5	1/08/2017	DUP2_10817	Field_D	EM1710779			5.8	4.2	<10	<0.02	<1
				RPD				*5*	*2*	*18*	*0*	*0*
	9 - 9	3/08/2017	ID18-CASS04_9	Normal	EM1711196	EM1710341		8.6	2.2	374	0.6	28
	9 - 9	3/08/2017	DUP1_30818	Field_D	EM1711196	EM1710341		8.5	2.1	282	0.45	21
				RPD				*1*	*5*	*28*	*29*	*29*
	15 - 15	10/08/2017	ID18-CASS04_15	Normal	EM1711196	EM1710670		9.5	8.6	<10	<0.02	<1
	15 - 15	10/08/2017	ID18-CASS04_QC1	Field_D	EM1711196	EM1710670		8.9	7.1	<10	<0.02	<1
				RPD				*7*	*19*	*0*	*0*	*0*
	17 - 17	10/08/2017	ID18-CASS04_17	Normal	EM1711196	EM1710670		8.9	8.1	<10	<0.02	<1
	17 - 17	10/08/2017	ID18-CASS04_QC2	Field_D	EM1711196	EM1710670		8.8	8.5	<10	<0.02	<1
				RPD				*1*	*5*	*0*	*0*	*0*
	19 - 19	11/08/2017	ID18-CASS04_19	Normal	EM1711196	EM1710732		8.3	5.9	<10	<0.02	<1
	19 - 19	11/08/2017	ID18-CASS04_QC3	Field_D	EM1711196	EM1710732		7.8	6.3	<10	<0.02	<1
				RPD				*6*	*7*	*0*	*0*	*0*
	22 - 22	11/08/2017	ID18-CASS04_22	Normal	EM1711282	EM1710732		7.2	5.6	<10	<0.02	<1
	22 - 22	11/08/2017	ID18-CASS04_QC4	Field_D	EM1711282	EM1710732		7.7	5.5	<10	<0.02	<1
				RPD				*7*	*2*	*0*	*0*	*0*
ID18-CASS05	15 - 15	18/07/2017	ID18-CASS05_15	Normal	EM1709421	EM1709956		8.5	5.3	13	0.02	1
	15 - 15	18/07/2017	ID18-CASS05_QC2	Field_D	EM1709421	EM1709956		9.1	5.3	<10	<0.02	<1
				RPD				*7*	*0*	*26*	*0*	*0*
	15 - 15	18/07/2017	ID18-CASS05_QC3	Field_D	EM1709421	EM1709956		9.2	5.5	125	0.2	9
				RPD				*8*	*4*	***162***	***164***	***160***
	16.5 - 16.5	18/07/2017	ID18-CASS05_16.5	Normal	EM1709421	EM1709956		8	5.4	<10	<0.02	<1
	16.5 - 16.5	18/07/2017	ID18-CASS05_QC5	Field_D	EM1709421	EM1709956		7.8	5.2	<10	<0.02	<1
				RPD				*3*	*4*	*0*	*0*	*0*
	19 - 19	18/07/2017	ID18-CASS05_19	Normal	EM1709421	EM1709956		7.6	5.4	11	<0.02	<1
	19 - 19	18/07/2017	ID18-CASS05_QC7	Field_D	EM1709421	EM1709956		7.4	5.5	<10	<0.02	<1
				RPD				*3*	*2*	*10*	*0*	*0*
ID18-CASS07	15 - 15	9/08/2017	ID18-CASS07_15	Normal	EM1711196	EM1710587		8.7	6.7	<10	<0.02	<1
	15 - 15	9/08/2017	ID18-CASS07_QC1	Field_D	EM1711196	EM1710587		9.2	2.8	34	0.05	2
				RPD				*6*	***82***	***109***	***86***	***67***
	21 - 21	9/08/2017	ID18-CASS07_21	Normal	EM1711196	EM1710587		7	5.4	10	<0.02	<1
	21 - 21	9/08/2017	ID18-CASS07_QC2	Field_D	EM1711196	EM1710587		7.1	5.6	<10	<0.02	<1
				RPD				*1*	*4*	*0*	*0*	*0*
ID18-CASS08	10.5 - 10.5	1/08/2017	ID18-CASS08_10.5	Normal	EM1710779	EM1710181		6.8	1.8	11	<0.02	<1
	10.5 - 10.5	1/08/2017	DUP1_10817	Field_D	EM1710779	EM1710181		7.1	2	14	0.02	1
				RPD				*4*	*11*	*24*	*0*	*0*
ID18-CASS09	21 - 21	3/08/2017	ID18-CASS09_21	Normal	EM1711196	EM1710339		6.9	4.3	<10	<0.02	<1
	21 - 21	3/08/2017	ID18-CASS09_QC1	Field_D	EM1711196	EM1710339		7.5	5	<10	<0.02	<1
				RPD				*8*	*15*	*0*	*0*	*0*
ID18-CASS12	5 - 5	24/07/2017	ID18-CASS12_5	Normal	EM1709733	EM1710432		4.4	3.4	50	0.08	4
	5 - 5	24/07/2017	DUP1_240717	Field_D	EM1709733	EM1710432		4.7	2.7	45	0.07	3
				RPD				*7*	*23*	*11*	*13*	*29*
	5 - 5	24/07/2017	DUP2_240717	Interlab_D	555835			5.2	3	19	0.03	1.4
				RPD				*15*	*5*	***99***	*2*	*28*
	10 - 10	24/07/2017	ID18-CASS12_10	Normal	EM1709733			8.2	1.9	NA	NA	NA
	10 - 10	24/07/2017	DUP3_240717	Field_D	EM1710432	EM1709733		8.3	1.9	748	1.2	56
				RPD				*1*	*0*	-	-	-
	10 - 10	24/07/2017	DUP4_240717	Interlab_D	555835			7.5	1.7	NA	NA	NA
				RPD				*11*	*15*	-	-	-
ID18-CASS13	6.5 - 6.5	21/07/2017	ID18-CASS13_6.5	Normal	EM1709681			5.4	4.3	<10	<0.02	<1
	6.5 - 6.5	21/07/2017	DUP1_210717	Field_D	EM1709681	EM1710779		5.6	4	<10	<0.02	<1
				RPD				*4*	*7*	*0*	*0*	*0*
	6.5 - 6.5	21/07/2017	DUP2_210717	Interlab_D	555657	559130		5.7	3.8	<10	<0.02	<1
				RPD				*6*	*10*	*0*	*0*	*0*
ID18-CASS14	6.5 - 6.5	20/07/2017	ID18-CASS14_6.5	Normal	EM1709564	EM1710370		6.8	4.2	<10	<0.02	<1
	6.5 - 6.5	20/07/2017	DUP1_200717	Field_D	EM1709564	EM1710370		5.9	4.2	<10	<0.02	<1
				RPD				*14*	*0*	*0*	*0*	*0*
ID18-CASS18	5 - 5	26/07/2017	ID18-CASS18_5	Normal	EM1709883	EM1710432		5.7	3.9	<10	<0.02	<1
	5 - 5	26/07/2017	DUP3_260717	Field_D	EM1709883	EM1710432		5.9	4.4	<10	<0.02	<1
				RPD				*3*	*12*	*0*	*0*	*0*
ID18-CASS19	4 - 4	26/07/2017	ID18-CASS19_4	Normal	EM1709883	EM1710432		5.5	4.9	<10	<0.02	<1
	4 - 4	26/07/2017	DUP2_260717	Field_D	EM1709883	EM1710432		5.3	4.8	<10	<0.02	<1
				RPD				*4*	*2*	*0*	*0*	*0*
ID18-CASS20	2 - 2	26/07/2017	ID18-CASS20_2	Normal	EM1710432	EM1709848		4.5	4.3	<10	<0.02	<1
	2 - 2	26/07/2017	DUP1_260717	Field_D	EM1710432	EM1709848		4.2	3.8	<10	<0.02	<1
				RPD				*7*	*12*	*0*	*0*	*0*

Table G2 - Relative Percentage Difference Calculations
Bonbeach IWRG Suite

AECOM GHD JOINT VENTURE

		Location Code	ID46-CASS08	ID46-CASS08	
		Depth	1.5 - 1.5	1.5 - 1.5	
		Date	28/07/2017	28/07/2017	
		Field ID	ID46-CASS08_1.5	DUP4_280717	
		Sample Type	Normal	Field_D	
		Lab Report Number	EM1710043	EM1710043	RPD
	Unit	EQL			
Inorganics					
Moisture (%)	%	1	4.1	3.4	19
Cyanide (Total)	mg/kg	1	<1	<1	0
pH (CaCl2)	pH Units	0.1	6	6.2	3
Metals					
Arsenic	mg/kg	5	<5	<5	0
Cadmium	mg/kg	1	<1	<1	0
Chromium (hexavalent)	mg/kg	0.5	<0.5	<0.5	0
Copper	mg/kg	5	<5	<5	0
Lead	mg/kg	5	<5	<5	0
Mercury	mg/kg	0.1	<0.1	<0.1	0
Molybdenum	mg/kg	2	<2	<2	0
Nickel	mg/kg	2	<2	<2	0
Silver	mg/kg	2	<2	<2	0
Tin	mg/kg	5	<5	<5	0
Zinc	mg/kg	5	<5	<5	0
TRH - NEPM 2013					
C6-C10 minus BTEX (F1)	mg/kg	10	<10	<10	0
C6 - C10 Fraction	mg/kg	10	<10	<10	0
>C10-C16 minus Naphthalene (F2)	mg/kg	50	<50	<50	0
>C10 - C16 Fraction	mg/kg	50	<50	<50	0
>C16 - C34 Fraction (F3)	mg/kg	100	<100	<100	0
>C34 - C40 Fraction (F4)	mg/kg	100	<100	<100	0
>C10 - C40 (Sum of Total)	mg/kg	50	<50	<50	0
TRH - NEPM 1999					
C6 - C 9 Fraction	mg/kg	10	<10	<10	0
C10 - C14 Fraction	mg/kg	50	<50	<50	0
C15 - C28 Fraction	mg/kg	100	<100	<100	0
C29 - C36 Fraction	mg/kg	100	<100	<100	0
C10 - C36 (Sum of Total)	mg/kg	50	<50	<50	0
PAH					
Polycylic aromatic hydrocarbons	mg/kg	0.5	<0.5	<0.5	0
Pyrene	mg/kg	0.5	<0.5	<0.5	0
Acenaphthene	mg/kg	0.5	<0.5	<0.5	0
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	0
Anthracene	mg/kg	0.5	<0.5	<0.5	0
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	0
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	0
Benzo(g,h,i)perylene	mg/kg	0.5	<0.5	<0.5	0
Chrysene	mg/kg	0.5	<0.5	<0.5	0
Dibenz(a,h)anthracene	mg/kg	0.5	<0.5	<0.5	0
Fluoranthene	mg/kg	0.5	<0.5	<0.5	0
Fluorene	mg/kg	0.5	<0.5	<0.5	0
Indeno(1,2,3-c,d)pyrene	mg/kg	0.5	<0.5	<0.5	0
Naphthalene	mg/kg	0.5	<0.5	<0.5	0
Phenanthrene	mg/kg	0.5	<0.5	<0.5	0
Benzo(a)pyrene TEQ (zero) - Lab Calc	mg/kg	0.5	<0.5	<0.5	0
Benzo(a)pyrene TEQ (half LOR) - Lab Calc	mg/kg	0.5	0.6	0.6	0
Benzo(a)pyrene TEQ (LOR) - Lab Calc	mg/kg	0.5	1.2	1.2	0
Phenols					
Phenols (non-halogenated) - Lab Calc	mg/kg	1	<1	<1	0
Phenols(halogenated) - Lab Calc	mg/kg	0.03	<0.03	<0.03	0
2,3,5,6-Tetrachlorophenol	mg/kg	0.03	<0.03	<0.03	0
2,4,5-trichlorophenol	mg/kg	0.05	<0.05	<0.05	0
2,4,6-trichlorophenol	mg/kg	0.05	<0.05	<0.05	0
2,4-dichlorophenol	mg/kg	0.03	<0.03	<0.03	0
2,4-dimethylphenol	mg/kg	1	<1	<1	0
2,4-dinitrophenol	mg/kg	5	<5	<5	0
2,6-dichlorophenol	mg/kg	0.03	<0.03	<0.03	0
2,3,4,5 & 2,3,4,6-Tetrachlorophenol	mg/kg	0.05	<0.05	<0.05	0
2-chlorophenol	mg/kg	0.03	<0.03	<0.03	0
2-methylphenol	mg/kg	1	<1	<1	0
2-nitrophenol	mg/kg	1	<1	<1	0
3-&4-methylphenol	mg/kg	1	<1	<1	0
4,6-Dinitro-o-cyclohexyl phenol	mg/kg	5	<5	<5	0
4-chloro-3-methylphenol	mg/kg	0.03	<0.03	<0.03	0
4-nitrophenol	mg/kg	5	<5	<5	0
Pentachlorophenol	mg/kg	0.2	<0.2	<0.2	0
Phenol	mg/kg	1	<1	<1	0
VOCs					
Chlorinated hydrocarbons	mg/kg	0.01	<0.01	<0.01	0
TCE	mg/kg	0.02	<0.02	<0.02	0
Tetrachloroethene	mg/kg	0.02	<0.02	<0.02	0
trans-1,2-dichloroethene	mg/kg	0.02	<0.02	<0.02	0

Table G2 - Relative Percentage Difference Calculations
Bonbeach IWRG Suite

		Location Code	ID46-CASS08	ID46-CASS08	
		Depth	1.5 - 1.5	1.5 - 1.5	
		Date	28/07/2017	28/07/2017	
		Field ID	ID46-CASS08_1.5	DUP4_280717	
		Sample Type	Normal	Field_D	
		Lab Report Number	EM1710043	EM1710043	RPD
SVOCs					
4,6-Dinitro-2-methylphenol	mg/kg	5	<5	<5	0
BTEXN					
Benzene	mg/kg	0.2	<0.2	<0.2	0
Toluene	mg/kg	0.5	<0.5	<0.5	0
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	0
Xylene (o)	mg/kg	0.5	<0.5	<0.5	0
Xylene (m & p)	mg/kg	0.5	<0.5	<0.5	0
Xylene Total	mg/kg	0.5	<0.5	<0.5	0
OC Pesticides					
Organochlorine pesticides - Lab Calc	mg/kg	0.03	<0.03	<0.03	0
Other organochlorine pesticides - Lab Calc	mg/kg	0.03	<0.03	<0.03	0
4,4-DDE	mg/kg	0.05	<0.05	<0.05	0
a-BHC	mg/kg	0.03	<0.03	<0.03	0
Aldrin	mg/kg	0.03	<0.03	<0.03	0
Aldrin + Dieldrin	mg/kg	0.03	<0.03	<0.03	0
b-BHC	mg/kg	0.03	<0.03	<0.03	0
chlordane	mg/kg	0.03	<0.03	<0.03	0
Chlordane (cis)	mg/kg	0.03	<0.03	<0.03	0
Chlordane (trans)	mg/kg	0.03	<0.03	<0.03	0
d-BHC	mg/kg	0.03	<0.03	<0.03	0
4,4 DDD	mg/kg	0.05	<0.05	<0.05	0
4,4 DDT	mg/kg	0.05	<0.05	<0.05	0
DDT+DDE+DDD - Lab Calc	mg/kg	0.05	<0.05	<0.05	0
Dieldrin	mg/kg	0.03	<0.03	<0.03	0
Endosulfan I	mg/kg	0.03	<0.03	<0.03	0
Endosulfan II	mg/kg	0.03	<0.03	<0.03	0
Endosulfan sulphate	mg/kg	0.03	<0.03	<0.03	0
Endrin	mg/kg	0.03	<0.03	<0.03	0
Endrin aldehyde	mg/kg	0.03	<0.03	<0.03	0
g-BHC (Lindane)	mg/kg	0.03	<0.03	<0.03	0
Heptachlor	mg/kg	0.03	<0.03	<0.03	0
Heptachlor epoxide	mg/kg	0.03	<0.03	<0.03	0
Hexachlorobenzene	mg/kg	0.03	<0.03	<0.03	0
Methoxychlor	mg/kg	0.03	<0.03	<0.03	0
PCBs					
PCBs (Total)	mg/kg	0.1	<0.1	<0.1	0
MAH					
Styrene	mg/kg	0.5	<0.5	<0.5	0
MAH (Sum of Total)	mg/kg	0.2	<0.2	<0.2	0
Herbicides					
Dinoseb	mg/kg	5	<5	<5	0
Chlorinated Hydrocarbons					
Other chlorinated hydrocarbons - Lab Calc	mg/kg	0.01	<0.01	<0.01	0
1,1,1,2-tetrachloroethane	mg/kg	0.01	<0.01	<0.01	0
1,1,1-trichloroethane	mg/kg	0.01	<0.01	<0.01	0
1,1,2,2-tetrachloroethane	mg/kg	0.02	<0.02	<0.02	0
1,1,2-trichloroethane	mg/kg	0.04	<0.04	<0.04	0
1,1-dichloroethene	mg/kg	0.01	<0.01	<0.01	0
1,2,4-trichlorobenzene	mg/kg	0.01	<0.01	<0.01	0
1,2-dichlorobenzene	mg/kg	0.02	<0.02	<0.02	0
1,2-dichloroethane	mg/kg	0.02	<0.02	<0.02	0
1,4-dichlorobenzene	mg/kg	0.02	<0.02	<0.02	0
Carbon tetrachloride	mg/kg	0.01	<0.01	<0.01	0
Chlorobenzene	mg/kg	0.02	<0.02	<0.02	0
Chloroform	mg/kg	0.02	<0.02	<0.02	0
cis-1,2-dichloroethene	mg/kg	0.01	<0.01	<0.01	0
Dichloromethane	mg/kg	0.4	<0.4	<0.4	0
Hexachlorobutadiene	mg/kg	0.02	<0.02	<0.02	0
Vinyl chloride	mg/kg	0.02	<0.02	<0.02	0
Major Ions					
Fluoride	mg/kg	40	<40	<40	0

Appendix I – Borelogs

NOTE: THIS DATA IS PROVIDED ELECTRONICALLY ONLY

Appendix J – Assessment Criteria

1. Assessment criteria

1.1 Groundwater assessment criteria

1.1.1 Beneficial use of groundwater

The Victorian Government State Environment Protection Policy (Groundwaters of Victoria), 1997, as varied March 2002 (Groundwater SEPP) prescribes Beneficial Uses and objectives that are to be protected for each of the various segments of the environment SEPP,.

The Groundwater SEPP determines the beneficial uses of an aquifer to be protected according to the salinity of the groundwater as measured in total dissolved solids (TDS). Based on the salinity, groundwater is classified into one of five (5) Segments (A1, A2, B, C, D) for which certain beneficial uses are nominated for protection. The Beneficial Uses to be protected for each of the groundwater segments are defined in Table 2 of the Groundwater SEPP which is reproduced in this Appendix as Table 1

The reported TDS results from the groundwater monitoring event completed in July 2017 were relatively consistent across the Edithvale and Bonbeach project areas, ranging from 220 ppm (ID18-GWBH01) to 12,000 ppm (ID18-GWBH02). Borehole ID18-GWBH01 had a screened interval of 5.0 to 8.0 mbgl is considered to be representative of the uppermost water bearing sequence of the Quaternary sands in the region (EES Technical Report A – Groundwater). Borehole ID18-GWBH02 had a screened interval of 21.0 to 28.0 mbgl and is considered to be representative the Upper-Mid Tertiary Aquitard (EES Technical Report A – Groundwater).

Based on the TDS concentration the salinity of the groundwater in the Quaternary sands at the project areas would be categorised as Segment A1, as defined in the Groundwater SEPP and shown in Table 1**.**

Table 1 Protected beneficial uses of groundwater segments

Beneficial Use	Segments (mg/L TDS)				
	A1 (0-500)	A2 (501-1 000)	B (1 001- 3 500)	C (3 501- 13 000)	D (> 13 000)
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply:					
Desirable	✓				
Acceptable		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks & gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓

Beneficial Use	Segments (mg/L TDS)				
	A1 (0-500)	A2 (501-1 000)	B (1 001-3 500)	C (3 501-13 000)	D (> 13 000)
Primary contact recreation (e.g. Bathing, swimming)	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

1.1.2 Adopted Groundwater Water Quality Criteria

Table 3 of the Groundwater SEPP specifies the water quality indicators that are used to assess groundwater contamination with respect to pollution and protection of beneficial uses. The water quality indicators for the applicable beneficial uses are provided in Table 2. In addition, Table 2 provides details of other guidelines referred to when the primary water quality indicators do not provide a guideline value for a contaminant of concern.

Table 2 Groundwater quality indicators

Beneficial Use Category	Water Quality Indicators
Maintenance of Ecosystems	Those specified in the relevant SEPP for surface waters. This site is located in an area covered by the SEPP Waters of Victoria (June 2003). The SEPP lists the beneficial uses to be protected for each segment of the water environment. In accordance with Figure 1 and Part VII, Annex A, the rivers and streams on the project areas are included in the “Cleared Hills and Coastal Plains” Segment. The environmental quality objectives specified for this segment are those values provided in the SEPP, or where values are not provided in the SEPP, in the ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters Maintenance of Ecosystems Criteria. The level of ecosystem protection for this Segment is 95% for slightly to moderately modified aquatic ecosystems. PFAS National Environment Management Plan Consultation Draft (2017) provides interim/draft criteria for PFAS for slightly to moderately modified aquatic ecosystems (95% species protection).
Potable Water Supply (Desirable and acceptable)	ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* refers to the Australian NHMRC and ARMCANZ (1996) *Australian Drinking Water Guidelines.* The NHMRC and ARMCANZ (2011) *National Water Quality Management Strategy -Australian Drinking Water Guidelines* supersede these guidelines (ADWG 2015) PFAS National Environment Management Plan Consultation Draft (2017) provides interim/draft health based criteria for PFAS in drinking water.
Potable mineral water supply	ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* refers to the Australian NHMRC and ARMCANZ (1996) *Australian Drinking Water Guidelines.* The NHMRC and ARMCANZ (2011) *National Water Quality Management Strategy -Australian Drinking Water Guidelines* supersede these guidelines (ADWG 2015) PFAS National Environment Management Plan Consultation Draft (2017) provides interim/draft health based criteria for PFAS in drinking water.

Beneficial Use Category	Water Quality Indicators
Agriculture Parks and Gardens	ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters, investigation levels for long and short term irrigation (Primary Industries).
Stock Watering	ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, investigation levels for Primary Industries (Chapter 4.3 Livestock drinking water quality)
Industrial Water Use	There is no specific guidance for industrial water use as industrial water requirements are so varied (both within and between industries) and sources of water for industry have other coincidental environmental values that tend to drive management and resource. Industrial water use has been considered through regard for other environmental values.
Primary Contact Recreation	The ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters, Guidelines for Recreation Water Quality and Aesthetics, refers to the NHMRC (2008) Guidelines for Managing Risks in Recreational Water. NHMRC (2008) refers to the ADWG guidelines which have been updated and as such the current version ADWG (2015) has been referenced.
Buildings & Structures	Introduced contaminants shall not cause groundwater to be corrosive to structures or building materials (pH, sulphate, redox potential).

Appendix K – Spoil volume estimates

1. Spoil volume estimates

1.1 Spoil volume inputs

1.1.1 Edithvale level crossing removal spoil volume inputs

The indicative spoil volumes have been calculated for the Edithvale level crossing removal based on the following inputs:

- LX31-Site 18-Edithvale Road, Edithvale Rail under road plan and longitudinal section (8.5 platform) (Drg No:LXRA-LX31-18-R1-MD-SKT-3001 Rev: A)
- 1,300 metre of piles constructed along both sides of the trench, with the pile depth increasing step-wise from 6m at the ends of the trench to 23m in the deepest part of the trench.
- The 21 boreholes advanced at the Edithvale project area during the Stage B: Detailed site soil assessment sampling program. The borehole locations and depths are detailed in Table 1

Table 1 Boreholes at ID18 Edithvale

Bore ID	Bore Depth (m)	Easting	Northing	Elevation (mAHD)
ID18-CASS01	5.0	333721.45	5788894.77	6.504
ID18-CASS02	5.0	333759.97	5788815.61	6.500
ID18-CASS03	22.5	333840.78	5788654.78	6.452
ID18-CASS04	22.0	333876.05	5788582.91	6.473
ID18-CASS05	22.5	333924.93	5788482.71	6.543
ID18-CASS06	22.0	333956.28	5788419.27	6.606
ID18-CASS07	22.0	333999.36	5788331.80	6.546
ID18-CASS08	22.0	334065.46	5788176.35	6.598
ID18-CASS09	22.0	334092.18	5788122.19	6.473
ID18-CASS10	22.5	334142.96	5788045.93	6.357
ID18-CASS11	20.5	334200.79	5787920.57	6.558
ID18-CASS12	14.0	334231.32	5787857.57	6.665
ID18-CASS13	10.0	334275.84	5787775.33	6.681
ID18-CASS14	7.0	334343.46	5787637.27	6.452
ID18-CASS15	5.0	334389.56	5787546.88	6.347
ID18-CASS16	5.0	334431.53	5787461.49	6.242
ID18-CASS17	7.0	333793.79	5788610.37	4.923
ID18-CASS18	7.0	333927.17	5788328.49	5.482
ID18-CASS19	7.0	334016.38	5788139.66	5.566

ID18-CASS20	7.0	334237.59	5787673.16	5.602
ID18-CASS21	7.5	333958.00	5788423.00	6.606

– The spoil category locations provided in Table 2. The spoil categories are based on the assumptions discussed in Section 1.2.

Table 2 Edithvale spoil categories locations

Bore ID	Spoil category	Depth of spoil	
		From (m)	To (m)
ID18-CASS01	Category C contaminated soil	0	0.5
	Fill material	0.5	5
ID18-CASS02	Category C contaminated soil	0	0.3
	Fill material	0.3	5
ID18-CASS03	Category C contaminated soil	0	0.5
	Fill material	0.5	8
	Waste acid sulfate soil	8	13
	Fill material	13	22.5
ID18-CASS04	Category C contaminated soil	0	0.5
	Fill material	0.5	8.1
	Waste acid sulfate soil	8.1	15
	Fill material	15	22
ID18-CASS05	Category C contaminated soil	0	0.6
	Fill material	0.6	7
	Waste acid sulfate soil	7	14.5
	Fill material	14.5	22.5
ID18-CASS06	Category C contaminated soil	0	0.5
	Fill material	0.5	5
	Waste acid sulfate soil	5	5.5
	Fill material	5.5	8
ID18-CASS06	Category C contaminated soil	0	0.5
	Fill material	0.5	5
	Waste acid sulfate soil	5	5.5
	Fill material	5.5	8
	Waste acid sulfate soil	8	15

	Fill material	15	22
ID18-CASS07	Category C contaminated soil	0	0.5
	Fill material	0.5	9
	Waste acid sulfate soil	9	14.5
	Fill material	14.5	22
ID18-CASS08	Category C contaminated soil	0	0.5
	Fill material	0.5	6
	Waste acid sulfate soil	6	15
	Fill material	15	22
ID18-CASS09	Category C contaminated soil	0.2	0.4
	Fill material	0.4	7
	Waste acid sulfate soil	7	14
	Fill material	14	22
ID18-CASS10	Category C contaminated soil	0	0.4
	Fill material	0.4	8
	Waste acid sulfate soil	8	14
	Fill material	14	22.5
ID18-CASS11	Category C contaminated soil	0	0.4
	Fill material	0.4	10
	Waste acid sulfate soil	10	14
	Fill material	14	20.5
ID18-CASS12	Category C contaminated soil	0	0.4
	Fill material	0.4	10
	Waste acid sulfate soil	10	14
ID18-CASS13	Category C contaminated soil	0	0.3
	Fill material	0.3	9.5
	Waste acid sulfate soil	9.5	10
ID18-CASS14	Category C contaminated soil	0	0.7
	Fill material	0.7	7
ID18-CASS15	Category C contaminated soil	0	0.3
	Fill material	0.3	5
ID18-CASS16	Category C contaminated soil	0	0.3

	Fill material	0.3	5
ID18-CASS17	Category C contaminated soil	0	0.2
	Waste acid sulfate soil	0.2	0.5
	Fill material	0.5	7
	Waste acid sulfate soil	7	7
ID18-CASS18	Category C contaminated soil	0	0.2
	Fill material	0.2	4
	Waste acid sulfate soil	4	5.5
	Fill material	5.5	7
ID18-CASS19	Category C contaminated soil	0	0.3
	Fill material	0.3	5.5
	Waste acid sulfate soil	5.5	6
	Fill material	6	7
ID18-CASS20	Category C contaminated soil	0	0.2
	Fill material	0.2	7
ID18-CASS21	Category C contaminated soil	0	0.3
	Fill material	0.3	7.5
	Fill material	0.3	9.5
	Waste acid sulfate soil	9.5	10

1.1.2 Bonbeach level crossing removal spoil volume inputs

The indicative spoil volumes have been calculated for the Bonbeach level crossing removal based on the following inputs:

– LX31-Site 46-Station Street, Bonbeach Rail under road plan and longitudinal section (Drg No:LXRA-LX31-46-R1-MD-SKT-3001 Rev: A)

– 1,200 metre of piles constructed along both sides of the trench, with the pile depth increasing step-wise from 6m at the ends of the trench to 23m in the deepest part of the trench.

– The 20 boreholes advanced at the Bonbeach project area during the Stage B: Detailed site soil assessment sampling program. The borehole locations and depths are detailed in Table 1

Table 3 Boreholes at ID46 Bonbeach

Bore ID	Bore Depth (m)	Easting	Northing	Elevation (mAHD)
ID46-CASS01	5.0	334927.37	5786156.76	5.814
ID46-CASS02	5.0	334950.63	5786078.25	5.765

ID46-CASS03	7.0	334979.38	5785982.16	5.761
ID46-CASS04	10.0	335012.23	5785867.61	5.813
ID46-CASS05	17.5	335037.90	5785753.45	5.877
ID46-CASS06	21.0	335050.28	5785679.84	5.910
ID46-CASS07	19.0	335062.07	5785600.28	6.008
ID46-CASS08	22.0	335075.43	5785435.02	6.289
ID46-CASS09	22.0	335086.08	5785366.98	6.470
ID46-CASS10	20.5	335102.84	5785283.41	6.258
ID46-CASS11	20.0	335116.47	5785181.24	6.050
ID46-CASS12	17.0	335128.14	5785098.30	5.895
ID46-CASS13	10.0	335142.71	5785010.95	5.766
ID46-CASS14	7.2	335165.97	5784907.92	5.675
ID46-CASS15	5.2	335195.90	5784780.87	5.839
ID46-CASS16	5.2	335213.88	5784703.60	5.896
ID46-CASS17	7.0	334868.69	5786102.58	5.629
ID46-CASS18	7.0	334972.73	5785725.81	5.863
ID46-CASS19	7.0	335045.83	5785269.53	5.584
ID46-CASS20	6.0	335057.80	5785058.47	4.311

– The spoil category locations provided in Table 4. The spoil categories are based on the assumptions discussed in Section 1.2.

Table 4 Bonbeach spoil categories locations

Bore ID	Spoil category	Depth of spoil	
		From (m)	To (m)
ID46-CASS01	Category C contaminated soil	0	0.5
	Fill material	0.5	5
ID46-CASS02	Category C contaminated soil	0	0.4
	Fill material	0.4	5
ID46-CASS03	Category C contaminated soil	0	0.5
	Fill material	0.5	6.5
	Waste acid sulfate soil	6.5	7
ID46-CASS04	Category C contaminated soil	0	0.7
	Fill material	0.7	5.5

	Waste acid sulfate soil	5.5	10
ID46-CASS05	Category C contaminated soil	0	0.3
	Fill material	0.3	7.5
	Waste acid sulfate soil	7.5	14.5
	Fill material	14.5	17.5
ID46-CASS06	Category C contaminated soil	0	0.5
	Fill material	0.5	10.5
	Waste acid sulfate soil	10.5	14
	Fill material	14	21
ID46-CASS07	Category C contaminated soil	0	0.7
	Fill material	0.7	10.5
	Waste acid sulfate soil	10.5	15
	Fill material	15	19
ID46-CASS08	Category C contaminated soil	0	0.5
	Fill material	0.5	9.5
	Waste acid sulfate soil	9.5	15
	Fill material	15	22
ID46-CASS09	Category C contaminated soil	0	0.3
	Fill material	0.3	11
	Waste acid sulfate soil	11	16
	Fill material	16	22
ID46-CASS10	Category C contaminated soil	0	0.5
	Fill material	0.5	10
	Waste acid sulfate soil	10	14.5
	Fill material	14.5	20.5
ID46-CASS11	Category C contaminated soil	0	0.5
	Fill material	0.5	9.5
	Waste acid sulfate soil	9.5	12
	Fill material	12	20
ID46-CASS12	Category C contaminated soil	0	0.8
	Fill material	0.8	8.5

	Waste acid sulfate soil	8.5	14.5
	Fill material	14.5	17
ID46-CASS13	Category C contaminated soil	0	0.7
	Fill material	0.7	8
	Waste acid sulfate soil	8	10
ID46-CASS14	Category C contaminated soil	0	0.5
	Fill material	0.5	3.5
	Waste acid sulfate soil	3.5	4
	Fill material	4	6
	Waste acid sulfate soil	6	6.5
	Fill material	6.5	7.2
ID46-CASS15	Category C contaminated soil	0	0.2
	Fill material	0.2	5.2
ID46-CASS16	Category C contaminated soil	0	0.4
	Fill material	0.4	5.2
ID46-CASS17	Category C contaminated soil	0	0.2
	Fill material	0.2	4
	Waste acid sulfate soil	4	4.5
	Fill material	4.5	7
ID46-CASS18	Category C contaminated soil	0	0.2
	Fill material	0.2	7
ID46-CASS19	Category C contaminated soil	0	0.2
	Fill material	0.2	7
ID46-CASS20	Category C contaminated soil	0	0
	Fill material	0	6

1.2 Indicative spoil volume assumptions

The following assumptions have been made in relation to the volumes and potential for contamination on the site:

– The waste acid sulfate soil volumes have been calculated by using the depths where net acidity (Sections 5.2.12 and 5.3.12) exceeded the action criteria for CASS management.

– Soil chemical analytical results and lithology detailed in Sections 5.2.14 and 5.3.14 of the report are indicative only of soil conditions within the Edithvale and Bonbeach level crossing removal construction footprints and do not represent a full soil characterisation in accordance with IWRG guidelines

- Surface soils within the Edithvale and Bonbeach construction footprints contain imported material which is considered likely to be contaminated to some degree with metals, total recoverable hydrocarbons (TRH) and polycyclic aromatic hydrocarbons (PAH)
- The imported fill is likely to be classified as contaminated soil in accordance with the Industrial Waste Resources Guidelines (IWRG)
- Natural material is generally uncontaminated and is classified as Fill material in accordance with the Industrial Waste Resources Guidelines (IWRG)
- Soil beneath the footprint of the substation located at the eastern end of Wimborne Avenue, Chelsea is contaminated by polychlorinated biphenyls (PCBs)
- A bulking factor of 1.3 was used to calculate ex-situ volumes.

1.3 Indicative spoil volumes

Leapfrog Geo was used to calculate in-situ spoil category volumes from the Edithvale and Bonbeach level crossing removal projects using the inputs and assumptions detailed in Section 1.1 and Section 1.2. The calculated in-situ spoil category volumes for the Edithvale and Bonbeach level crossing removal projects are presented in Table 5 and Table 6.

Table 5 Edithvale indicative spoil volumes

Spoil category	Trench (m^3 in-situ)	Piles (m^3 in-situ)	Total (m^3 in-situ)
Fill material	84115	8455	**92570**
Category A	0	0	**0**
Category B	0	0	**0**
Category C	8760	40	**8800**
Waste acid sulfate soil	16090	17260	**33350**
Total	**108965**	**25755**	**134720**

Table 6 Bonbeach indicative spoil volumes

Spoil category	Trench (m^3 in-situ)	Piles (m^3 in-situ)	Total (m^3 in-situ)
Fill material	94375	17655	**112030**
Category A	50	0	**50**
Category B	50	0	**50**
Category C	22065	15	**22080**
Waste acid sulfate soil	0	6550	**6550**
Total	116540	24220	**140760**

Appendix L – Risk assessment

Table L1 Guide to quantification of likelihood

Qualitative descriptions	Probability over a given time period	Basis
A. Certain	1 (or 0.999, 99.9%)	Certain, or as near to as makes no difference
B. Almost certain	0.2 – 0.9	One or more incidents of a similar nature has occurred here
C. Highly probable	0.1	A previous incident of a similar nature has occurred here
D. Possible	0.01	Could have occurred already without intervention
E. Unlikely	0.001	Recorded recently elsewhere
F. Very unlikely	1×10^{-4}	It has happened elsewhere
G. Highly improbable	1×10^{-5}	Published information exists, but in a slightly different context
H. Almost impossible	$1 \text{ X } 10^{-6}$	No published information on a similar case

Source: Bowden, A.R., Lane, M.R. and Martin, J.H., 2001, Triple Bottom Line Risk Management – Enhancing Profit, Environmental Performance and Community Benefit, Wiley and Sons, New York, 314 pp.

Table L2 Consequence table

Qualitative descriptor	Negligible		Minor		Moderate		Major		Extreme
Consequence description	**Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals**		**Low level impact for some communities, or high impact for a small number (<10) of individuals**		**High level of impact for some communities, or moderate impact for communities area-wide**		**High level of impact for communities area-wide**		**High level of impact State-wide**
	0.1	**0.3**	**1**	**3**	**10**	**30**	**100**	**300**	**1000**
ENVIRONMENT **Contaminated soil/** **Acid sulfate soils**	The release of contaminant(s) has no measureable effect on the environment.		The release of contaminant(s) is measureable but does not result in a loss of one or more beneficial uses of the environment.		The release of contaminant(s) into the environment causes temporary and reversible loss of one or more beneficial uses of the environment.		The release of contaminant(s) into the environment causes permanent loss of one or more beneficial uses of the environment on a localised scale.		The release of contaminant(s) into the environment causes permanent loss of one or more beneficial uses of the environment across a large geographic area.
	No disturbance of contaminated soils/rock or ASS.		Handling (including transportation, treatment and/or disposal) of contaminated soils/rock or ASS with negligible risk to human health and/or the environment.		Handling (including transportation, treatment and/or disposal) of contaminated soils/rock or ASS with localised risk to human health and/or the environment.		Handling (including transportation, treatment and/or disposal) of contaminated soils/rock or ASS with risk to human health and/or the environment in a number of localised areas.		Widespread, irreversible risk to human health and/or the environment from handling (including transportation, treatment and/or disposal) of contaminated soils/rock or ASS.
ENVIRONMENT **Land capability and soil contamination**	Negligible soil disturbance and low erosion potential.		Some soil disturbance with minor implications for soil erosion.		Disturbance or changes to surface soil with moderate implications for soil erosion.		Surface soil, covering vegetation, land function significantly compromised.		Extensive impact to surface soil, covering vegetation or land function with irreversible soil erosion.
	Applicable soil standards met locally and across the region.		Isolated, minor and temporary exceedance of soil quality standards in a localised area.		Localised exceedance of applicable soil quality standards.		Major exceedance of soil quality standards in a localised area.		Widespread exceedance of applicable soil quality standards in a number of local areas, impacting on regional conditions or with

Qualitative descriptor	Negligible		Minor		Moderate		Major		Extreme
Consequence description	**Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals**		**Low level impact for some communities, or high impact for a small number (<10) of individuals**		**High level of impact for some communities, or moderate impact for communities area-wide**		**High level of impact for communities area-wide**		**High level of impact State-wide**
	0.1	**0.3**	**1**	**3**	**10**	**30**	**100**	**300**	**1000**
									prolonged effects.
ENVIRONMENT Groundwater	Changes to groundwater levels, flows or quality have no detectable impact.		Changes to groundwater levels, flows or quality within range of typical variation and does not result in loss of one or more beneficial uses of groundwater.		Changes to groundwater levels, flows or quality results in temporary and reversible loss of one or more beneficial uses of groundwater.		Changes to groundwater levels, flows or quality results in permanent loss of one or more beneficial uses of groundwater in a local area.		Changes to groundwater levels, flows or quality results in permanent loss of one or more beneficial uses of groundwater over a widespread area.
SOCIAL **Amenity** **(Traffic/ air/noise/odour/visual impacts)**	Short term impacts that alter perception of area as a high amenity place to live / visit.		Short term (months) localised impacts that alter perception of area as a high amenity place to live / visit.		Medium term (1-2 years) regional impacts that alter perception of area as a high amenity place to live / visit.		Community perception that the area is significantly damaged.		Community perception that the area has experienced major damage.
	Region still seen as attractive place to live.		Region not locally seen as attractive place to live.		Region not widely seen as attractive place to live.		Area loses appeal as residential area. Recovery > 2 yrs.		Area is a place to be avoided. Recovery, if at all, >10 yrs.
PUBLIC HEALTH AND SAFETY Illness/Injury/Fatality	Potentially some impact to less than 10 individuals.		Minor injury or illness to less than 10 individuals.		Minor injury or illness to between 10 and 100 individuals. Major injury or illness to 1 individual.		Minor injury or illness to between 100 and 1000 individuals. Major injury or illness to between 1 and 10 individuals. 1 fatality or serious injury.		Major injury or illness to between 10 and 100 individuals. Between 1 and 10 fatalities or serious injuries.

Table L3 Contamination and CASS risks (detailed)

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Edithvale and Bonbeach construction risks										
CL50	Contaminated soil/CASS (residents)	Disturbance, handling, storage or disposal of CASS/contaminated soil (including asbestos) results in adverse health and environmental impacts to the community.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan	Unlikely	Moderate	Negligible	As initial EPR	Unlikely	Moderate	Negligible
CL51	Contaminated soil/CASS (odour)	Disturbance, handling, storage or disposal of CASS/contaminated soil leads to the generation of odorous material and results in a loss of amenity.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan EPR SC1 - Community and Stakeholder Engagement Management Plan	Highly probable	Minor	Negligible	As initial EPR	Highly probable	Minor	Negligible
CL52	Contaminated groundwater	Disturbance, handling, storage or disposal of acidic and/or contaminated groundwater results in adverse health and environmental impacts.	EPR CL4 – Acidic and/or contaminated groundwater (construction)	Very unlikely	Minor	Negligible	As initial EPR	Very unlikely	Minor	Negligible

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
CL53	Unknown contamination	Unknown contamination encountered during construction results in environmental, health or amenity impacts.	EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Unlikely	Moderate	Negligible	As initial EPR	Unlikely	Moderate	Negligible
CL54	Spill	Fuel/chemical spill results in adverse health or environmental impact.	EPR CL3 – Waste management	Very unlikely	Moderate	Negligible	As initial EPR	Very unlikely	Moderate	Negligible
CL55	Other waste streams	Management of other waste (solid inert, liquid, organic, packaging and food scraps) results in environmental impact.	EPR CL1 – SMP EPR CL3 – Waste management	Almost impossible	Negligible	Negligible	As initial EPR	Almost impossible	Negligible	Negligible
CL56	Non-compliance (waste transport / disposal)	Transport or disposal of CASS and/or contaminated soil is not in compliance with EPA Victoria permit/licence and results in an environmental impact.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan	Very unlikely	Minor	Negligible	As initial EPR	Very unlikely	Minor	Negligible

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
CL57*	Contamination (vapour) - EV	Intersection of contaminated soil and/or groundwater resulting in vapour impacts on human health.	EPR CL1 – SMP EPR CL2 – Acid Sulfate Soil Management Plan EPR CL4 – Acidic and/or contaminated groundwater (construction) EPR GW3 – Groundwater Management Plan (construction)	Highly improbable	Minor	Negligible	As initial EPR	Highly improbable	Minor	Negligible
Groundwater associated risks (operation phase)										
GW60	CASS activation - EV	Drawdown on the down gradient side of trench and mounding on upgradient side of the trench could result in changes in regional groundwater levels, which could give rise to activation of CASS and/or mobilise any existing acidity and groundwater acidification affecting beneficial uses of land and	EPR GW1 - Rail trench design EPR GW4 – Groundwater Management and Monitoring Plan	Almost certain	Moderate	Moderate	EPR GW1 - Rail trench design EPR GW2 – Groundwater performance outcomes EPR GW4 – Groundwater Management and Monitoring Plan	Possible	Moderate	Negligible

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		groundwater.								
GW62	Contaminant migration - EV	Project infrastructure or mounding on the up gradient side of trench and drawdown on down gradient side of trench could result in changes to regional groundwater levels, which could alter the flow paths of groundwater and contamination plumes impacting beneficial use of land and groundwater.	EPR GW1 – Rail trench design EPR GW4 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Almost certain	Moderate	Moderate	EPR GW1 – Rail trench design EPR GW2 – Groundwater performance outcomes EPR GW4 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (operation) EPR CL5 – Acidic and/or contaminated groundwater (operation)	Highly probable	Moderate	Minor
GW67	CASS activation - BB	Drawdown on the down gradient side of trench and mounding on upgradient side of the trench could result in changes in groundwater levels,	EPR GW1 - Rail trench design EPR GW4 – Groundwater Management and Monitoring Plan	Almost certain	Moderate	Minor	EPR GW1 - Rail trench design EPR GW2 – Groundwater performance outcomes EPR GW4 –	Almost certain	Moderate	Minor

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
		which could give rise to activation of CASS and/or mobilise any existing acidity and groundwater acidification affecting beneficial uses of land and groundwater					Groundwater Management and Monitoring Plan			
GW69	Contaminant migration - BB	Project infrastructure or mounding on the up gradient side of trench and drawdown on down gradient side of trench could result in changes to regional groundwater levels, which could alter the flow paths of groundwater and contamination plumes impacting beneficial use of land and groundwater.	EPR GW1 - Rail trench design EPR GW4 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction)	Unlikely	Moderate	Negligible	EPR GW1 - Rail trench design (Edithvale and Bonbeach) EPR GW2 - Groundwater EPR GW4 – Groundwater Management and Monitoring Plan EPR CL1 – SMP EPR CL4 – Acidic and/or contaminated groundwater (construction) EPR CL5 –	Unlikely	Moderate	Negligible

Risk ID	Risk name	Risk pathway	EPR ID (initial)	Initial risk			EPR ID (final)	Residual risk		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
							Acidic and/or contaminated groundwater (operation)			

**Risk CL56 only applies to the project at Edithvale.*

Appendix M – Independent peer reviewer assessment

24 January 2018

Level Crossing Removal Authority (LXRA)
c/- AECOM – GHD Joint Venture
Level 9, 121 Exhibition Street
Melbourne VIC 3004

Attention: **Natalie Jiricek**
Technical Services Lead - Environment and Planning

Dear Natalie

Independent Peer Review (IPR) of Contaminated Land (CL) and Coastal Acid Sulfate Soils (CASS) Technical Report for Edithvale and Bonbeach Level Crossing Removal Projects

1.0 Summary of CASS IPR Findings

Overall, the IPR has found the CASS and CL assessment works to be of appropriate standard, in particular being a comprehensive assessment that adequately covers the various aspects being assessed (i.e. CASS, groundwater assessment, CL assessment, waste classification and interaction between each). This has led to recommendations and conclusions that are supported (and therefore justified) by a robust investigation.

2.0 Purpose and Scope

Environmental Earth Sciences has been requested by AECOM-GHD Joint Venture (JV) to undertake an independent peer review (IPR) of a Coastal Acid Sulfate Soil (CASS) technical assessment completed as part of the Environment Effects Statement (EES) relating to both Edithvale and Bonbeach level crossing removal sites.

2.1 Purpose

The IPR is intended to assess the design and adequacy of the CASS technical assessment. This will be achieved by the IPR ensuring that the CASS technical assessment works are performed to the requirements of relevant national and state guidance and legislation relating to CASS and land contamination.

The primary sources of guidance are:

- for CASS, the *Best Practice Guidelines* (DSE, 2010); and
- for land contamination, the *National Environment Protection (Assessment of Site Contamination) Measure* (ASC NEPM) (NEPC, 2013).

2.2 Scope

The scope performed to achieve the purpose of the IPR comprised the following:

- CASS Stage A:
  - review of the scope of assessment, existing reports and Sampling Analysis and Quality Plan (SAQP);
- CASS Stages B, C & D:
  - undertake a site inspection during investigation works;
  - Stage B – review of soil sampling program and assessment;
  - Stage C – review of groundwater sampling program and assessment;
  - Stage D – review of CASS hazard assessment;
  - Review of contamination assessment and soil hazard categorization and management report for off-site spoil disposal classification;
- CASS Impact Assessment (IA):
  - review of one combined Impact Assessment Report, including risk assessment and Environmental Performance Requirements (EPRs).

The IPR has considered the following as part of the process:

- relevant legislation and guidance;
- consistency of methodology with best industry practice, including the approach to desk-top research, field work, data collection, analysis and interpretation;
- the assumptions and integrity of the data used in the assessment; and
- confirmation that the conclusions made and any proposed mitigation are sound, reasonable and practicable.

3.0 Review Author Background

The primary author of this document (Mark Stuckey) is a senior principal soil scientist, hydrogeologist and risk assessor with Environmental Earth Sciences whose primary fields of expertise are soil science and hydrogeology. Mark holds tertiary qualifications in agricultural science (majoring in soil science) with over 23 years experience, and has completed a Master of Science (Groundwater Hydrology) and has been a practising hydrogeologist for over 20 years. Mark has published papers and provided presentations in these fields, including identification and management of acid sulfate soil.

Mark is a Certified Professional Soil Scientist (CPSS) as accredited by Soil Science Australia (SSA) with recognised expertise in the fields of contaminated land and acid sulfate soil assessment, remediation and management, and has been since 1997. Mark is also an EPA Victoria approved Environmental Auditor (Contaminated Land) appointed pursuant to the Environment Protection Act 1970, and holds similar approvals in NSW (under the Contaminated Land Management Act 1997) and Queensland (under the Environmental Protection Act 1994).

Mark has completed over 120 acid sulfate soil projects, including at sites in Sumatra Indonesia, and in Victoria (including at the nearby Wannarkladdin Wetlands, and sites in

Edithvale and Seaford). Mark also provided the draft *Best Practice Management Guidelines for Coastal Acid Sulfate Soils in Victoria* to the Department of Sustainability and Environment (DSE) in February 2008. Mark has also performed expert witness roles relating to acid sulfate soils, including for sites in Victoria at Yaringa, Barwon Heads and Bulla.

4.0 Implementation of Scope

The following documents were reviewed as part of the IPR process (also listed in Section 10.0):

- Aecom GHD Joint Venture (2017a) *Contamination / PASS Desktop Assessment – Rail Under Road number 18 – Edithvale Road, Edithvale*. Report to LXRA dated 24 February 2017.
- Aecom GHD Joint Venture (2017b) *Contamination / PASS Desktop Assessment – Rail Under Road number 46 – Station Street/ Bondi Road, Bonbeach*. Report to LXRA dated 24 February 2017.
- Aecom GHD Joint Venture (2017c) *Preliminary Impact Assessment: Groundwater – Rail Under Road number 18 – Edithvale Road, Edithvale*. Report to LXRA dated 24 February 2017.
- Aecom GHD Joint Venture (2017d) *Preliminary Impact Assessment: Groundwater – Rail Under Road number 46 – Station Street/ Bondi Road, Bonbeach*. Report to LXRA dated 24 February 2017.
- Aecom GHD Joint Venture (2017e) *Provision of Technical Services – Indicative CASS proposed scope for Bonbeach and Edithvale Stage B, C, D*. Report to LXRA dated 16 June 2017 (Final).
- Aecom GHD Joint Venture (2017f) *Contamination and Spoil Management Impact Assessment Technical Report – Edithvale and Bonbeach Level Crossing Removal Projects Environmental Effects Statement*. Report to LXRA dated 24 July 2017 (Revision A).
- Aecom GHD Joint Venture (2017g) *Numerical Groundwater Modelling Report – Level Crossing Removal Projects Southern Program*. Report to LXRA dated 10 October 2017 (Revision A).
- Aecom GHD Joint Venture (2017h) *Contamination and Acid Sulfate Soils Technical Report – Edithvale and Bonbeach Level Crossing Removal Projects Environmental Effects Statement*. Report to LXRA dated 17 October 2017 (Revision A).
- Aecom GHD Joint Venture (2017i) *Contamination and Acid Sulfate Soils Technical Report – Edithvale and Bonbeach Level Crossing Removal Projects Environmental Effects Statement*. Report to LXRA dated 11 December 2017 (Revision B).

5.0 Reference Documents used in Review

The following guidance documents were utilised in the IPR process (also listed in Section 10.0):

- Acid Sulfate Soils:
  - Ahern, C R, Sullivan, L A and McElnea, A E (2004) *Laboratory methods guidelines 2004 – Acid Sulfate Soils*. In *Queensland acid sulfate soil technical*

manual. Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

- Dear, S E, Ahern, C R, O'Brien, L E, Dobos, S K, McElnea, A E, Moore, N G and Watling, K M (2014) *Soil management guidelines*. In Queensland Acid Sulfate Soil Technical Manual. Department of Science, Information Technology, Innovation and the Arts (DSITIA), Queensland. Version 4.0.
- Department of Sustainability and Environment (DSE) Victoria (2009) *Victorian Coastal Acid Sulfate Soils Strategy*. July 2009.
- DSE (2010) *Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils*. October 2010.
- EPA Victoria (2009b) Industrial waste resource guidelines (IWRG) (*Acid Sulfate Soil and Rock*) publication 655.1 – July 2009.
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6.0 Key Issues Identified and Resolved

The key issues identified as part of the IPR were communicated to the Aecom GHD JV team via Reviewer Comments at each stage of the review process (as detailed in Section 2.2 above). A log of the initial IPR comment, the JV team response and action, and the IPR further response was compiled for each stage of the review process.

6.1 Stage A and planning for Stages B, C, D

The initial IPR consisted of a review of Stage A documents (Aecom GHD JV 2017a-d) and the SAQP (Aecom GHD JV 2017e).

The key issues identified in the initial IPR primarily related to ensuring a robust and complete Stage B, C and D CASS assessment (and Contaminated Land assessment) was performed and included the following resolutions:

- agreement that, due to the size of the investigation, field testing would be performed in the laboratory rather than field, and testing would be at 0.5m rather than 0.25m depth intervals for each borehole;
- recognition that for waste classification purposes, subsequent analysis for chemical leachability using the ASLP method may be required;
- confirmation that no permanent or ephemeral water bodies exist on the sites; and
- inclusion of a wide range of water quality parameters (including nutrients, cations and anions) in the groundwater analytical suite.

6.2 Stages B, C and D CASS assessment and Contaminated Land assessment

The IPR issues identified in the Technical Report (Aecom GHD JV 2017h) were resolved as part of the revision of this report (Aecom GHD 2017i). Aecom GHD JV (2017f and 2017g) were also included in this stage of the IPR process.

In addition to official correspondence, numerous conversations were held between the IPR and the JV technical team regarding the IPR findings, in order to resolve the key issues identified.

The three major issues discussed related to:

- the depths of CASS occurrence in the soil profile;
- interpretation of CASS laboratory results (in particular titratable actual acidity [TAA] data); and
- clarification of groundwater levels compared to CASS occurrence in the soil profile.

A summary of the more pertinent IPR comments associated with one of the major issues identified (CASS laboratory results interpretation, after Environmental Earth Sciences 2017) has been retained in Section 6.2.1 below.

6.2.1 Section 7 – Spoil assessment

In performing CASS assessment, specifically determination of Net Acidity (NA) using the Acid Base Account (ABA) where NA = Actual Acidity (AA or TAA) + Partially Oxidised/ Retained Acidity (S_{NAS}) + Potential Acidity (PA as CRS/ S_{POS}) – Acid Neutralising Capacity (ANC), we would advise caution in assessing TAA data where Partially Oxidised and/or Potential Acidity is absent or very low (and pH is >4). The reason for this is that in such instances you likely have <u>acid soil</u> rather than <u>acid sulfate soil</u>.

Based on the above interpretation, we would recommend that where soil pH is >4 and S_{NAS}/CRS/S_{POS} are all absent or very low (i.e. well below action criteria), yet TAA exceeds the action criteria (i.e. 0.03%S/ 18 mol H^+/T/ 1.0 kgH_2SO_4/T, after DSE October 2010 and EPA 655.1), the soil is not CASS and can be classified on the basis of its contaminant chemical concentrations (i.e. Fill Material or Category C, B or A).

7.0 Confirmation of Appropriateness of Approach, Methodology and Findings

Based on the IPR process, it is confirmed that the approach adopted for the CASS and Contaminated Land assessment works for the LXRA projects at Bonbeach and Edithvale are considered by the IPR to have resulted in a sound methodology that has arrived at appropriate findings for the assessment. This is because the methodology adopted has been based on best practice using industry accepted guidelines and legislation (as listed in Sections 5.0 above and 10.0 below), and the interpretation of the data obtained has been appropriately conservative with demonstrated quality control.

8.0 Concluding Statement

Overall, the IPR has found the CASS and Contaminated Land assessment works to be of appropriate standard, in particular being a comprehensive assessment that adequately covers the various aspects being assessed (i.e. CASS, groundwater assessment, contaminated land assessment, waste classification, and interaction between each). This has led to recommendations and conclusions that are supported (and therefore justified) by a robust investigation.

9.0 Limitations

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from AECOM-GHD JV on behalf of LXRA;
2. The specific scope of works set out in PO717040 issued by Environmental Earth Sciences VIC;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences VIC (which consent may or may not be given at the discretion of Environmental Earth Sciences VIC);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at the Edithvale and Bonbeach level crossing removal sites;
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill if deposited off site;
9. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and

10. Our General Limitations set out at the back of the body of this report.

Should you have any queries, please do not hesitate to contact us on (03) 9687 1666 or on (07) 3852 6666.

On behalf of
Environmental Earth Sciences VIC

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ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services

The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report

A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change

Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others

Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval

The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability

This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

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