



## 20 Contaminated Land and Spoil Management

### 20.1 Overview

This chapter provides an assessment of the contaminated land and spoil management impacts associated with the construction and operation of Melbourne Metro. The chapter is based on the impact assessment presented in Technical Appendix Q *Contaminated Land and Spoil Management*. All relevant references are provided in Technical Appendix Q.

Major tunnelling projects within urban environments have the potential to encounter contaminated soil, rock and groundwater – the legacy of many years of commercial and industrial development combined with poor environmental management and waste disposal practices in the past. Melbourne Metro is no exception, with many known and potentially contaminated sites along or near the proposed project boundary.

The contaminated land impact assessment conducted for the EES found that tunnelling and construction activities have the potential to disturb contaminated soil and groundwater across the Melbourne Metro alignment. The main aspects of contamination and spoil management requiring consideration for the Melbourne Metro project are:

- Non-natural contaminated spoil (fill), particularly at the western portal, eastern portal and Arden station sites and throughout the CBD where there has been a long history of potentially contaminating land use activities

#### What is contaminated land?

Contaminated land refers to soils and, in many instances, groundwater where concentrations of hazardous chemicals exceed those specified in policies and regulations or are at such a concentration as to materially impact the development being proposed. On excavation, contaminated soils may be classified as prescribed industrial waste, the regulation and management of which is governed by the Environment Protection (Industrial Waste Resource) Regulations 2009.

Contamination occurs in a variety of forms, but mainly comprises inorganic compounds such as metals and asbestos, and organic compounds such as petroleum hydrocarbons.

Generally, contamination is caused by historic land use management practices, particularly those related to industrial processes, waste disposal and the storage and use of chemicals.

There are also naturally occurring acid sulfate soils and rock. If disturbed during excavation, these soils and rock can oxidise and produce sulfuric acid.

- Naturally occurring, potentially acid sulfate soil associated with the presence of specific geological formations, such as Coode Island Silt, Werribee Formation and Brighton Group, that may become oxidised during construction – with these formations most likely to be found at the western portal, eastern portal and Arden station sites and in sections of the tunnels between CBD South station and the eastern portal
- Naturally occurring, potentially acid sulfate rock, which is prevalent along most of the alignment
- Interception of contaminated groundwater and/or vapour in the immediate vicinity of the project boundary during construction, with potential exposure risks to workers and the environment
- Handling and disposal of large volumes of contaminated and clean spoil.

Well-established construction techniques and management processes are available to mitigate and avoid these potential impacts and these would be set out in the Contractor's construction environmental management plan (CEMP) for Melbourne Metro. These measures would minimise, as far as reasonably practicable, the disturbance of sources of contamination and the excavation of contaminated spoil. Where sources of contamination are encountered and disturbed, processes would be implemented to minimise the impacts of this disturbance and to handle and dispose of contaminated waste safely. The measures provided in the contractor's CEMP to meet the Environmental Performance Requirements must comply with relevant Commonwealth and Victorian laws and policies, and with EPA and WorkSafe Victoria requirements.

The recommended Environmental Performance Requirements set out in Section 20.17 provide proposed measures that would mitigate these impacts to acceptable levels, resulting in a low to very low risk to human health and the environment from Melbourne Metro.

## 20.2 EES Objective

The EES Scoping Requirements set the following draft evaluation objective for the EES:

- *Hydrology, water quality and waste management – to identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation of spoil and other waste in accordance with relevant best practice principles.*

A study was conducted to collate and compile relevant information about contaminated land conditions along the Melbourne Metro alignment, including risks and impacts associated with contaminated spoil, spoil handling and disposal and contaminated groundwater plume impacts.

Using this information, Environmental Performance Requirements and proposed mitigation measures were recommended to avoid or minimise the adverse environmental effects from any disturbance of contaminated land.

## 20.3 Legislation and Policy

As discussed in Chapter 4 *EES Assessment Framework and Approach*, contaminated land and acid sulfate soils encountered during the construction of Melbourne Metro would be managed in accordance with Commonwealth and Victorian environmental standards and requirements. The main laws and policies relevant to the management of contaminated soil and acid sulfate soil for Melbourne Metro are outlined in Table 20–1.

**Table 20–1 Contaminated land legislation and policy relevant to Melbourne Metro**

Legislation	Policy/guideline	Comment
<b>Commonwealth</b>		
<i>National Environment Protection Council Act 1994</i>	National Environment Protection (Assessment of Site Contamination) Measure	<p>This Act and complementary State and Territory legislation allow the National Environment Protection Council to make National Environment Protection Measures. These measures assist in protecting or managing particular aspects of the environment. The National Environment Protection Measure covering contamination is the National Environment Protection (Assessment of Site Contamination) Measure.</p> <p>This National Environment Protection Measure was updated in 2013 and has been adopted as an amendment to the State Environment Protection Policy (Prevention and Management of Contamination of Land) (see below).</p>
	<p>Australian Standard AS 4482.1-2005: Guide to the investigation and sampling of sites with potentially contaminated soil – Non-volatile and semi-volatile compounds and AS 4482.2 – 1999: Guide to the sampling and investigation of potentially contaminated soil – Volatile substances</p>	<p>These standards provide guidance when sampling and investigating potentially contaminated soils (for non-volatile, semi-volatile and volatile compounds).</p>

Legislation	Policy/guideline	Comment
<b>State</b>		
<i>Environment Protection Act 1970</i>	EPA powers and guidelines	<p>The Act sets out the powers of the EPA in relation to issuing Pollution Abatement Notices or Clean-up Notices.</p> <p>The Act provides for Environmental Audits, which are used to determine the suitability of potentially contaminated land for future use.</p> <p>The EPA publishes a range of guidelines on the management, handling and disposal of contaminated spoil:</p> <ul style="list-style-type: none"> <li>• Asbestos Transport and Disposal (Publication IWRG611.1)</li> <li>• Soil Hazard Categorisation and Management (Publication IWRG621)</li> <li>• Acid sulfate soil and rock (Publication 655.1)</li> <li>• Solid industrial waste hazard categorisation and management (Publication IWRG631).</li> </ul>
	State Environment Protection Policy (Prevention and Management of Contamination of Land) (Land SEPP)	<p>The Act enables the preparation and gazettal of State Environment Protection Policies (SEPPs) and Industrial Waste Management Policies (IWMPs).</p> <p>The Land SEPP requires occupiers of land to ensure that land is managed to prevent contamination and protect the beneficial uses of the land. It also requires that disposal or re-use of any material off-site is undertaken in accordance with legislative requirements and procedures approved by the EPA.</p>
	SEPP (Groundwaters of Victoria)	<p>The SEPP (Groundwaters of Victoria) sets a consistent approach to the prevention and management of groundwater throughout Victoria to protect the beneficial uses. This includes establishing Groundwater Quality Restricted Use Zones, which identify where groundwater is not suitable for use due to contamination.</p>
	Industrial Waste Management Policy, Waste Acid Sulfate Soils (IWMP (WASS))	<p>This policy sets out specific requirements for the management, disposal and re-use of waste acid sulfate soils, and specifies the responsibilities of those involved. The policy applies once acid sulfate soil is disturbed on a site and becomes a waste intended for re-use on that site or for re-use/disposal off-site.</p>

Legislation	Policy/guideline	Comment
	Contaminated Construction Site – Industry Standard (Work Safe, 2009)	Provides land developers and principal building contractors with a guide to safe work practices on contaminated construction sites. Outlines how to identify contamination, determine the level of contamination and provide an acceptable level of protection for workers and sub-contractors.
<i>Planning and Environment Act 1987</i>	Ministerial Direction No 1 – Potentially Contaminated Land	This Ministerial Direction requires planning authorities to satisfy themselves that the environmental conditions of land proposed to be used for a sensitive use, agriculture or public open space are, or will be, suitable for that use. This is generally done through the completion of an environmental site assessment and audit process.
<i>Occupational Health and Safety Act 2004</i>		Employers have general duties under this Act to provide a safe and healthy working environment for workers, any contractors that they hire and others living, working or passing nearby.

## 20.4 Methodology

### 20.4.1 Assessment Approach

In line with the framework set out in the National Environment Protection Measure (Assessment of Site Contamination) and Victoria’s Land SEPP, the approach adopted to assess potential impacts from contaminated land included:

- A desktop review to obtain, collate and review background information and data (see Section 20.4.2) to establish the baseline nature and extent of soil and groundwater contamination along the Melbourne Metro alignment
- A site inspection, comprising a ‘whole of alignment’ walkover to observe current and potential historic land use practices and identify areas of potential contamination
- Development of conceptual site models across the Melbourne Metro alignment to identify potential contamination sources, receptors and exposure pathways against construction activities and infrastructure outlined in the Concept Design
- Conducting a risk assessment to identify the key impacts
- Completing an impact assessment for each precinct
- Recommending Environmental Performance Requirements and identifying proposed measures to avoid or minimise impacts.

A groundwater impact assessment was also undertaken for Melbourne Metro. This assessment focused on potential impacts on the environment associated with the movement of contaminated groundwater not directly under the alignment. The potential impacts associated with groundwater contaminant migration to third party properties are discussed separately in Chapter 18 *Groundwater* and Technical Appendix O *Groundwater*.

## 20.4.2 Baseline and Background Data

Data sources used in the assessment included:

- Publicly available information, such as EPA audit reports, data held by representatives of sites within the project boundary (for example, previous geo-environmental reports and records of chemicals storage and use), title deeds, development and resource consents, works approvals and licences and planning schemes
- Information and data from contaminated land, hydrogeological and geotechnical investigations conducted by Golder Associates
- Information provided by other discipline specialists (including Land Use and Planning, Groundwater, Surface Water and Design teams)
- Data provided by external agencies such as CityLink, Melbourne Water, DELWP, VicTrack and the EPA
- Information and data obtained from the site inspection (see Section 20.4.1 above).

## 20.5 Existing Conditions

Existing conditions within the project boundary are described in general terms below. Conditions that are specific to individual precincts are described in Sections 20.8 to 20.16.

### 20.5.1 Geological Conditions

Geological formations along the Melbourne Metro alignment extend from sedimentary Melbourne Formation rock beds laid down approximately 430 million years ago to Coode Island Silt deposited within the last 10,000 years. Different geological conditions along the alignment can determine groundwater quality and levels, the possible presence of heavy metals and gases, and the potential for acid sulfate soil and acid sulfate rock. Section 6 of Technical Appendix Q provides further details on the geological conditions across the Melbourne Metro alignment.

## 20.5.2 Contaminated Land

Land contamination is a major environmental issue in Australian cities. Melbourne's industrial and manufacturing heritage, together with environmental practices that would be considered substandard today, has left many thousands of potentially contaminated sites across the city.

### Fill

Historical activities have altered the natural soil profile significantly within the proposed project boundary, either by placing material on top of the existing soil profile or by excavating or reworking soils and depositing imported materials.

For example, sites at the western end of the project boundary (around the western portal and Arden station) have a long history of land uses that may have resulted in potential contamination of groundwater and the soil profile. Conditions at these locations are likely to include contamination associated with heavy industry and land reclamation activities, featuring contaminants such as hydrocarbons and solvents from the storage and/or use of fuels, lubricants and cleaners; heavy metals from rail infrastructure, printing and metal works; and asbestos from past buildings and/or the importation of fill material to reclaim swampy land in the area.

### Asbestos Containing Materials

In areas where historic filling occurred and buildings and structures were erected prior to the 1990s, there would be potential for asbestos containing materials (such as asbestos-cement sheeting) to have been used. Due to significant changes in land use across the alignment, many buildings containing asbestos have been demolished to make way for new developments. Often demolition waste is retained on-site and used as fill. Soil contaminated by asbestos would therefore be expected to be encountered during demolition, construction and excavation works undertaken as part of Melbourne Metro.

#### Waste soil categories

Waste soil is divided into three categories of prescribed industrial waste and 'clean fill'.

'Clean fill' is non-hazardous material. It may include soil, rock, stone, bricks or concrete.

Prescribed industrial waste categories relate to the levels of concentration of contaminants in soil, such as heavy metals, pesticides and hydrocarbons. Category A soils (the highest class of hazardous waste) cannot be disposed of to landfill. Categories B and C soils can only be disposed at licensed facilities. All three waste categories require EPA transport certificates to be transported, and the vehicles transporting this waste must hold an EPA permit.

### 20.5.3 Acid Sulfate Soils and Rock

Geological conditions across parts of the Melbourne Metro alignment are known to have potential acid sulfate properties (see box below). There is a high probability that actual acid sulfate soils are present within the vicinity of the western portal site, the Arden station site and sections of the tunnels between these two sites and between CBD South station and Domain station.

Melbourne Formation rock (Silurian aged mudstones and shales) underlies most of the Melbourne Metro alignment. Testing of this rock indicated that at depths greater than approximately 25 m below ground level (mbgl), it becomes less weathered ('fresh') and oxidation of sulfidic minerals (such as pyrites) contained in the rock has the potential to result in acid generation. This potential acid sulfate rock may be disturbed during tunnelling activities and the construction of station boxes.

#### **What is acid sulfate soil?**

Acid sulfate soil or rock are soils, sediment or rock that contain elevated concentrations of iron sulfides (commonly iron pyrite) or the products of sulfide oxidation. Acid sulfate soil can be present in two forms:

- Potential acid sulfate soil contains iron sulfides that are stable in an un-oxidised state. If left undisturbed, these soils pose little threat of acidification
- Actual acid sulfate soil is material that has been exposed to oxygen, producing sulfuric acid.

Acid sulfate soil can be disturbed by activities such as land excavation, tunnelling, blasting and drilling. It can also be disturbed by lowering the groundwater table. If managed inappropriately, once disturbed, waste acid sulfate soil may pose a risk to human health, buildings and structures, and the environment.

### 20.5.4 Gases and Vapours

Naturally occurring sources of hazardous gases, such as methane, carbon dioxide and hydrogen sulfide, can be trapped within soil, accumulating in soil pores or as pockets of gas. These natural gases would be mainly found associated with sedimentary deposits occurring from Kensington through to Arden and around the Yarra River. Vapours, such as petroleum hydrocarbons and solvents, can also be present below ground as a result of previous releases of contaminants from industrial activities. These vapours are termed volatile organic compounds.

Disturbance of soil and groundwater during construction may cause these gases and vapours to migrate towards infrastructure along the Melbourne Metro alignment. Construction methods may also deflect or modify existing gas and vapour migration routes. These gases and vapours have the potential to create health and safety issues, as well as being hazardous to concrete structures.



Site investigations indicate the presence of limited methane in shallow alluvial soils (Coode Island Silt) at the western portal and Arden station sites, with some methane likely to be present in the vicinity of the Yarra River (CBD South station to Domain station). Investigations have also confirmed limited volatile organic compounds in shallow soils near the Parkville and CBD North precincts and near Fawkner Park.

### 20.5.5 Groundwater Quality and Contamination

The potential interception of contaminated groundwater in the immediate vicinity of the project boundary during construction could lead to exposure risks to workers and the environment. Additionally, the potential movement of contaminated groundwater due to construction/operation activities may impact on the beneficial uses of third party property owners. This latter aspect of groundwater contamination and options for groundwater disposal are addressed further in Chapter 18 *Groundwater*.

### 20.5.6 Durability of Structures and Buildings

The presence of acidity, salinity and organic compounds such as petroleum hydrocarbons and chlorinated solvents in soil and groundwater may degrade and impact buildings and structures (and by extension, building materials). The condition of soil containing such substances is termed 'aggressive ground'. The presence of these conditions is more likely if non-natural fill is in place; however, natural soil and rock can also generate these conditions.

These conditions may reduce the durability of project infrastructure through impacting the structural integrity and lifespan of materials used to construct the tunnels and station boxes. Existing chemical data indicates that elements of these ground conditions are present in the western portal and Domain station precincts, and in sections of the tunnels between the western portal and Arden station and between CBD South station and Domain station.

## 20.6 Risk Assessment

An Environmental Risk Assessment has been completed for the impacts of Melbourne Metro in relation to contaminated land and spoil management. Further information about the risk assessment approach adopted for Melbourne Metro is included in Chapter 4 *EES Assessment Framework and Approach*.

Impact assessment must be informed by risk assessment so that the level of mitigation action relates to the likelihood of an adverse impact occurring.

The contaminated land risk assessment assigned initial risk ratings based on the assumption that Melbourne Metro would follow and/or comply with legislative, regulatory and industry guidelines and standards.

Based on the information gathered, an assessment of the likelihood and consequence of an impact was conducted. The level of uncertainty associated with an assessment of contaminated land has a bearing on both the consequence and likelihood assigned to an impact.

Where initial risks ranked medium or above, additional Environmental Performance Requirements and associated proposed mitigation measures were recommended to reduce the risk. The majority of these risks were associated with spoil management during the construction of Melbourne Metro.

Additional Environmental Performance Requirements and proposed mitigation measures include:

- Collection of additional data on soil/groundwater quality to reduce the level of uncertainty related to estimated volumes of spoil, spoil categorisation and groundwater quality
- Management of risks via implementation of management plans, treatment and engineering measures.

Achieving the recommended Environmental Performance Requirements and implementing the proposed mitigation measures would be expected to reduce the risk ratings of all potential events to low or very low.

A full list of contaminated land and spoil management risks, showing the initial and residual risk rating of each risk, is provided in Technical Appendix B *Environmental Risk Assessment Report* and Technical Appendix Q *Contaminated Land and Spoil Management*. The recommended Environmental Performance Requirements are listed in Section 20.17.

## 20.7 Impact Assessment

The main impacts from disturbing sources of contamination would be associated with the Melbourne Metro construction phase and with tunnelling activities and deep excavation works at stations in particular.

Overall, the main expected impact pathways would be:

- Handling, transporting and disposing of large volumes of natural and 'clean fill' spoil
- Managing and disposing of potentially large volumes of naturally occurring actual or potential acid sulfate soil and rock
- Handling, transporting and disposing of prescribed industrial waste
- Handling, stockpiling and treating asbestos-containing materials
- Managing potential vapours from contaminated groundwater permeating into structures
- Managing methane-generating sediments (Coode Island Silt)

- Protecting construction/building materials from contaminated soil and groundwater
- Protecting site workers, the general population and the environment from the impacts of intercepting contaminated soil and groundwater.

The contractor's CEMP would include best practice measures to monitor, manage and avoid these impacts, in line with relevant Commonwealth and Victorian laws and policies and EPA requirements.

Adopting these best practice measures would reduce the risk to human health and the environment from Melbourne Metro's construction works to an acceptable level.

The main impacts are described in greater detail in the following sections. These impacts are common to all Melbourne Metro precincts and similar mitigation measures would be adopted in each precinct. Where there are differences, these are identified and discussed under the relevant precinct.

## 20.7.1 Spoil Management Strategy

In constructing the stations and tunnels, the project would displace large volumes of soil and rock (spoil). This material would require removal off-site as no on-site options for re-use have been identified. Management of the excavated material would follow the waste hierarchy as required by the EPA, with avoidance (minimising the volume of spoil generated where possible) being the most preferred option and disposal being the least preferred option. The waste hierarchy is one of the key principles of the *Environment Protection Act 1970* in selecting preferred approaches for the management of contaminated land and site clean-up.

Key aspects of the draft Spoil Management Strategy for Melbourne Metro are:

- *Avoidance.* There is limited scope for avoiding the displacement of spoil during construction. The volume of material to be excavated may be marginally reduced by using techniques such as vertical retaining walls rather than benching, where possible
- *Re-use/recycling/recovery.* Material earmarked for re-use, recovery and recycling is usually 'clean fill'. However, some soil contaminated with organic compounds may also be considered for resource recovery. There is no obvious re-use option for the generated spoil on-site and it would therefore have to be removed off-site for re-use, resource recovery (in consultation with EPA) or disposal. Clean fill would be directed for re-use, subject to finding a suitable site(s)
- *Treatment at off-site facility/containment.* Any Category A spoil would require treatment prior to disposal or re-use. Acid sulfate soils and rock would be managed in accordance with EPA guidelines, with off-site management being undertaken in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils). Prevention of acid sulfate soil oxidation is the

preferred management option, which could involve strategic infilling of excavations below the water table or the addition of lime to neutralise potential acid generation. Any off-site facility accepting acid sulfate soils and rock would need to have an EPA-approved Environmental Management Plan in place

- *Disposal at landfill or licenced facility.* Spoil generated from areas of historic infilling is likely to contain contamination and asbestos and is a defined Prescribed Industrial Waste. The Prescribed Industrial Waste should be separated as far as reasonably practicable into Categories A, B and C waste with a view to disposing of this material at facilities licenced to accept the waste or to a treatment facility that can reduce the concentrations of contaminants prior to disposal. Spoil with asbestos-containing materials would be managed in accordance with WorkSafe occupational health and safety regulations and EPA's Asbestos Transport and Disposal guidelines.

Additional information on the transportation of spoil and the potential impacts on air quality and aquatic ecology can be found in Technical Appendix D *Transport*, Technical Appendix H *Air Quality* and Technical Appendix U *Aquatic Ecology and River Health*.

The investigations completed to date have provided a conservative estimate of the nature and in situ volume of the spoil generated during the project.

The recommended Environmental Performance Requirements would mandate the preparation and implementation of a Spoil Management Plan to manage and monitor spoil generation, handling, categorisation, storage and disposal. An Acid Sulfate Soil and Rock Management Sub-Plan would also be required. Other aspects of contaminated land requiring management and monitoring would be addressed through a pre-construction remedial options assessment (also mandated by the Environmental Performance Requirements).

## 20.7.2 Re-use of excavated spoil (clean fill)

An estimated 2,033,500 m<sup>3</sup> of spoil would be generated by the construction of Melbourne Metro (approximately 613,000 m<sup>3</sup> from the tunnels, 104,200 m<sup>3</sup> from the portals and 1,316,300 m<sup>3</sup> from the stations). Of this, it is anticipated that 1,349,300 m<sup>3</sup> would be clean fill.

During construction of Melbourne Metro, for all precincts, there would be limited opportunities to re-use excavated clean fill on-site. This spoil would have to be removed off-site as a waste or be directed for re-use at another site – a positive outcome from the project. Potential re-use would be subject to further testing to determine the final waste classification and geotechnical suitability of this spoil, in accordance with EPA regulations and guidelines.

### 20.7.3 Acid Sulfate Soil and Rock

As noted in Section 20.5.3, there is a high likelihood of Melbourne Metro encountering potential and actual acid sulfate soil and acid sulfate rock. This means that a high proportion of the spoil excavated from the tunnels (about 221,000 m<sup>3</sup>) would be expected to be acid sulfate soil or acid sulfate rock. The potential impacts from disturbing acid sulfate soil and acid sulfate rock include human health impacts, adverse effects on aquatic environments and the corrosion of concrete and steel infrastructure from acidified groundwater.

Acid sulfate impacts would be managed in accordance with EPA guidelines and the Industrial Waste Management Policy (Waste Acid Sulfate Soils). This would include implementing an environmental management plan that includes:

- Identification of the location and extent of any acid sulfate soil and rock (primarily Fresh Melbourne Formation rock and Coode Island Silt) within the project boundary
- Assessment of the potential environmental risks of disturbance
- Identification of suitable sites for the re-use or disposal of any acid sulfate material.

Prevention of acid generation is the preferred management option. However, a number of off-site waste management options are available for treating acid sulfate material extracted during tunnelling activities, where prevention is not possible. These options include:

- Treating spoil with limestone
- Inhibiting oxidation of pyrite in spoil by underwater disposal or by encapsulation within a water saturated engineered cover
- Preventing leaching of pyritic spoil by encapsulation within a long-term containment system designed to limit infiltration.

Further testing would be undertaken during the project's detailed design and construction phases to determine the most effective management option.

Acid sulfate soil can only be disposed of or re-used on sites that have an EMP approved by the EPA or at a landfill with the appropriate licence. On-site re-use of this material is not considered practical.

### 20.7.4 Temporary Stockpiling of Spoil

The Spoil Management Plan for Melbourne Metro would require spoil to be removed to an off-site location in an expeditious manner and would require pre-categorisation of spoil where practical. Temporary stockpile areas would be provided in the event that unexpected conditions or spoil materials are encountered. It is envisaged that these areas would be located at all construction work sites, with larger facilities at the western portal, Arden station and the TBM southern launch site (Domain or Domain and Fawkner Park).

Residency time of spoil at these temporary stockpile areas would be short due to space limitations and program constraints. Potential environmental impacts could manifest themselves as pollution, runoff, odours and dust. Environmental management of temporary stockpile areas would require management in accordance with EPA publication *Environmental Guidelines for Major Construction Sites*, which would reduce the likelihood of potential environmental impacts. The temporary stockpile areas would likely require consultation with EPA, with requirements likely to be dependent upon details relating to volumes to be stored, siting and platform base engineering, security, environmental protection and monitoring, and details of materials flow and management.

## 20.7.5 Disposal of Prescribed Industrial Waste

While most of the spoil material encountered by the project would be clean fill, some material is anticipated to be prescribed industrial waste due to likely elevated heavy metal concentrations as a result of previous industrial activity. An estimated 133,200 m<sup>3</sup> of prescribed industrial waste would be generated during construction (approximately 25,900 m<sup>3</sup> from the portals and 107,300 m<sup>3</sup> from the stations). It is anticipated that there would not be a significant volume of prescribed industrial waste generated during tunnelling.

Prescribed Industrial Waste generated by Melbourne Metro would be disposed of at facilities licenced to accept the waste or to a treatment facility that can reduce the concentrations of contaminants prior to disposal. Anticipated waste volumes are expected to be accommodated within the parameters of existing licenced facilities within greater Melbourne, minimising the impacts arising from the creation of new sites or intensifying the use of existing sites.

Most environmental impacts from waste management and landfilling relate to the disposal of municipal putrescible waste from within metropolitan Melbourne. The disposal of a relatively small volume of contaminated soil as a result of Melbourne Metro would be unlikely to lead to a significant additional impact.

The precinct-level assessments summarised in Sections 20.8 to 20.15 assume that each precinct would generate some Prescribed Industrial Waste, which would be disposed of as described above.

## 20.7.6 Asbestos Containing Materials

The changing nature of inner Melbourne, and the cycle of building demolition and construction that accompanies these changes, mean that asbestos-containing materials may be encountered in the fill material excavated during Melbourne Metro's construction. Due to the potentially severe health effects of these materials, their removal, disposal and transport is heavily regulated in Victoria.

The assessment of the quantity of asbestos-containing materials in each precinct (set out in Sections 20.8 to 20.15) made a conservative assumption that asbestos-containing materials and asbestos fibres may be encountered in the fill material excavated at each precinct. These materials would be required to be managed in accordance with WorkSafe regulations for managing asbestos in workplaces and with EPA guidelines for the disposal and transportation of asbestos.

At sites where asbestos-containing material are expected to be encountered, soil would be managed in accordance with WorkSafe OHS regulations and EPA's Asbestos Transport and Disposal guidelines. Management measures could include dampening soils and the use of containers or sealed/covered vehicles. The contractor would develop appropriate mitigation measures compliant with WorkSafe Victoria's *Compliance Code for Managing Asbestos in Workplaces* and *Guidance Note Asbestos – Contaminated Soil*. The Spoil Management Plan would inform construction workers of the potential presence of asbestos in the soil and establish appropriate management measures and safety protocols should asbestos be encountered.

### 20.7.7 Gases and Vapours

As noted in Section 20.5.4, site investigations indicate the presence of natural methane in Coode Island Silt at the western portal and Arden station sites, with some methane also likely to be present beneath the Yarra River (CBD South station to Domain station).

Site investigations have confirmed the presence of volatile organic compounds (VOCs) in soil and groundwater at Arden, Parkville and CBD North stations. There is potential for VOCs to be present at all station precincts based on historic land uses.

## Construction

Disturbance of ground and groundwater conditions during construction may cause gases and vapours to migrate towards features on the alignment and may result in a short-term release of vapours and consequential odour generation and associated health and safety issues (for example, flammability).

The method of construction (cut and cover and cavern) and provision of air ventilation would largely mitigate any risks to workers during construction. Air quality would be monitored and if it deteriorates to below safe work standards, work would be suspended temporarily. Effects would be transient. Specific mitigation measures would be incorporated into the remedial options assessment for contaminated land and the health, safety and environmental plan for the management of hazardous substances, as set out in the recommended Environmental Performance Requirements.

Gas and vapour risks would also be managed in accordance with EPA guidelines and SEPP (AQM). Specific mitigation measures incorporated into the contractor's CEMP – such as the method of drilling selected and the provision of air ventilation – would mitigate the risks to workers.

Risks to buildings would be mitigated by following the British Standards Institute's 2015 *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* (BSI Code of Practice). Using the terminology from this code of practice, the risk to infrastructure would be characterised as low or very low and mitigation would largely be achieved by the use of structural concrete. Further mitigation measures could be required around the shafts, cross passages and other underground infrastructure and could include incorporating pressure relief blankets or low permeable strips around any structural concrete.

A range of well-tested measures are available to protect the tunnel, portal and station infrastructure from the impacts of gas and vapours. Structural concrete would provide all or most of the protection measures recommended by the relevant standards. Mitigation around penetrations, shafts, cross passages and other infrastructure could include incorporation of pressure relief blankets or strips around any cast-in-situ structural concrete. These blankets could be made of higher permeability materials or could be a geocomposite. Implementation would be considered in association with any potential tanking or waterproofing that might also be required. These measures would be addressed in the detailed design phase of the project.

The need for any further mitigation measures would be addressed in the detailed design phase of the project.

## Operation

During operation of Melbourne Metro, vapours and gases contiguous with the alignment may diffuse into the station boxes or tunnels. This could pose a risk to people (workers and train passengers) and to the tunnel, portal and station infrastructure. In addition, seepage of groundwater with volatile contaminants into station and tunnel sumps and drains may require management.

The provision of air ventilation and periodic pumping out of groundwater sumps and drains (supplemented by further monitoring) would largely mitigate any risks to workers and train passengers during operation. While gases and vapours would likely be dissipated in the ventilated structures such as stations and tunnels, there would be potential for vapour to build up in small spaces (such as cupboards and plant rooms) where no ventilation would be present. This would be addressed in the detailed design phase of the project.



## 20.7.8 Durability of structures and buildings

Site investigations have identified the presence of acid sulfate soils in Coode Island Silt and acid sulfate rock within the Melbourne Formation. Disturbance of Coode Island Silt and Melbourne Formation rock may introduce oxygen, which may generate aggressive (acidic) conditions in direct contact with the structural concrete of the station boxes (and caverns in the case of the two CBD stations). Cut and cover construction and extensive dewatering – bringing oxygenated groundwater into the acid sulfate zones – would likely exacerbate the chemical aggressiveness of the sediments and rock. Impacts to building materials would be avoided or mitigated in accordance with *AS 2159-2009 Piling – Design and installation*.

As discussed in Section 20.7.7, vapours and gases may degrade some building materials. Therefore, the choice of materials and construction design and engineering measures would need to take these risks into account.

Site investigations did not find any methane in the Coode Island Silt at Arden, although it may be encountered. Construction would be within an open box and thus methane accumulation to explosive levels would be unlikely. Following construction, the structural concrete would be likely to form most of the protection to the permeation of gases. No additional protective measures have been identified.

## 20.7.9 Safety and Environmental Hazards

The main hazards likely to be encountered during Melbourne Metro's construction phase are well understood and there are industry standard measures available to minimise the risks associated with them. The main impacts are identified below. The contractor's CEMP would require potential impacts to workers and the environment to be managed and mitigated in accordance with WorkSafe, EPA and other relevant standards and guidelines.

### Hazards for Workers

Construction workers may be exposed to contamination through direct contact with soil or groundwater or indirectly by breathing vapours. Typical construction activities can lead to a higher potential risk of exposure than from other work activities, and – if concentrations are high enough – acute effects may be experienced.

Health and safety in the workplace is heavily regulated in Victoria. As a minimum, safety plans and Safe Working Method Statements would be required to identify hazards, risks and mitigation measures. The contractor's CEMP would include measures to address and manage these potential safety hazards. In addition, the requirement to prepare and implement a health, safety and environmental plan for the management of hazardous substances would specifically address the risk of exposure to employees, visitors and the public.

## Dust and other Emissions

Excavation works may lead to the generation of dust, odours, smoke or vapours. The contractor's CEMP would require the adoption of industry best practice dust prevention, control and suppression measures to manage and minimise the impacts of dust emissions. These measures would include minimising the extent of spoil stockpiles, applying water to unsealed surfaces to suppress dust, minimising double handling of material, revegetating or sealing areas of disturbed soil as soon as practicable and modifying activities according to weather conditions.

These impacts and the recommended Environmental Performance Requirements to address them are discussed in Chapter 12 *Air Quality*.

## Spills and Pollution

Works would be carried out in such a way as to avoid pollution incidents, including complying with relevant EPA guidelines covering the storage, handling, use and disposal of any potentially hazardous materials.

A health, safety and environmental plan for the management of hazardous substances would be prepared, setting out the procedures to be implemented should an incident occur. The plan would include reporting and information protocols, emergency contacts and procedures, and actions to be taken to contain and limit adverse impacts.

## 20.8 Precinct 1: Tunnels

Impacts in the tunnels precinct would be predominantly associated with excavation activities, producing large volumes of clean fill and acid sulfate rock. Tunnels would be formed within natural rock and soil, with most tunnelling being completed within saturated strata. It is unlikely that historically infilled land would be encountered in the tunnels precinct.

### 20.8.1 Bulk Earthworks and Spoil Management

Tunnelling for Melbourne Metro would generate approximately 613,000 m<sup>3</sup> of spoil material. Tunnelling methods – such as using TBMs and tanking (sealing) the tunnels – would be adopted to limit disturbance of the surrounding ground and groundwater.

While almost all of the excavated material would be clean fill, there is a likelihood that a proportion of this fill would be potential acid sulfate soil and/or rock (see Table 20–2). Disturbance of acid sulfate soil is considered unavoidable between the western portal and Arden station, and in the vicinity of the Yarra River (between CBD South and Domain stations) due to the presence of Coode Island Silt. Disturbance of acid sulfate rock is considered unavoidable across the tunnels alignment (except between CBD South station and Domain station), due to tunnelling encountering fresh Melbourne Formation rock.

Acid sulfate soil and rock materials would be separated out and managed separately to the bulk of the other residual natural material. These materials would be managed in accordance with EPA guidelines (as described in Section 20.7.3), with any off-site facility accepting acid sulfate material from the Melbourne Metro tunnelling works requiring an EPA-approved EMP to be in place. The Environmental Performance Requirements would require the contractor to complete further site investigations, undertake waste categorisation, identify suitable re-use and disposal facilities and identify a suitable spoil handling methodology.

**Table 20–2 Summary of waste spoil and acid sulfate soil/acid sulfate rock throughout the Tunnels precinct**

Category/ Volume (m <sup>3</sup> )	Tunnel (WP-AS) & Tunnel (AS-PS)	Tunnel (PS-CN)	Tunnel (CN-CS)	Tunnel (CS-DS)	Tunnel (DS-EP)	Total volume by category (m <sup>3</sup> )
Clean fill	185,000	7,000	31,000	106,000	74,000	403,000
Category C	None	None	None	None	None	None
Category B	None	None	None	None	None	None
Category A	None	None	None	None	None	None
Acid sulfate soil	1,000	None	None	None	None	1,000
Acid sulfate rock	12,000	72,000	62,000	None	63,000	209,000
<b>Total volume of spoil</b>	<b>198,000</b>	<b>79,000</b>	<b>93,000</b>	<b>106,000</b>	<b>137,000</b>	<b>613,000</b>

Note: All volumes provided are in-situ or dense (no bulking factor applied).

WP=western portal; AS = Arden station; PS = Parkville station; CN = CBD North station; CS = CBD South station; DS = Domain station; EP = eastern portal.

## 20.8.2 Ground Gases and Vapours

Disturbance of ground and groundwater during tunnelling between the western portal and Arden station and in the vicinity of the Yarra River (between CBD South and Domain stations) may cause gases such as methane and hydrogen sulfide from Coode Island Silt to migrate towards either the atmosphere or the tunnel. Pockets of gas may also be intercepted in these tunnel sectors, resulting in a short-term release of gas and consequential odour and associated health and safety issues. Within the tunnel structures, migration would be limited by the concrete liner which would act as an impermeable layer. If methane enters the tunnel it would be significantly diluted by tunnel ventilation; if gas reaches the atmosphere, it would also be significantly diluted.

As described in Section 20.7.7, if gases and vapours are encountered, the method of tunnelling (earth pressured) and provision of air ventilation would largely mitigate any risks to workers. If the monitored air quality deteriorated to below safe work standards, work would be temporarily suspended and the site evacuated. Specific mitigation measures would be set out in the health, safety and environmental plan for the management of hazardous substances, as required by the recommended Environmental Performance Requirements.

Site investigations have confirmed the presence of volatile organic compounds in groundwater between Parkville station and CBD North station, particularly a known plume of chlorinated solvents and petroleum hydrocarbons at a former brewery site on Victoria Street. Further investigations relating to the former brewery site would be conducted to determine whether any specific management measures are needed or whether the owner of the source site is adequately managing the contaminated groundwater plume.

While the risks associated with encountering gases and vapours are considered to be low between CBD North station to CBD South station, CBD South station to Domain station and Domain station to the eastern portal, they would be managed in accordance with EPA guidelines, SEPP (AQM) and the BSI Code of Practice (as set out in Section 20.7.7). Further site investigations would be completed prior to construction to determine the status of gases and vapours in these three sectors of the tunnel. This data would then be used to assess risks and identify appropriate mitigation solutions (as part of the pre-construction remedial options assessment required by the recommended Environmental Performance Requirements).

## 20.9 Precinct 2: Western Portal (Kensington)

Impacts in this precinct would be associated with tunnel excavation and TBM retrieval, and the construction of piled structures, decline structures, cut and cover tunnel segments and services and relief shafts.

Land within the western portal precinct has a history of land use that may have resulted in contamination. Conditions are likely to include contamination associated with heavy industry, which has historically included abattoirs, soap and candle works, manure and bone works, the Kensington Glue Works and a number of flour mills. Land reclamation activities in the late 1800s also led to the importation of large amounts of fill material to reclaim low-lying marshy land in the area.

## 20.9.1 Bulk Earthworks and Spoil Management

The shallow spoil to be excavated to construct the portal is likely to be highly variable in composition and contaminant profile and contain a variety of waste materials – typical of the shallow fill material found across Melbourne.

A large proportion of this material would be clean fill (see Table 20–3), although some material would likely have elevated heavy metal concentrations. There is no obvious re-use option for this material on-site in this precinct.

A small proportion of the spoil excavated at this site would comprise Coode Island Silt, which is known to contain raised levels of sulfates and is defined as acid sulfate soil. Soil testing conducted in the area found either actual or potential acid sulfate soil at relatively shallow depths of between 2.5 mbgl and 4.5 mbgl. Acid sulfate soil would be managed in accordance with EPA guidelines (as described in Section 20.7.3). As is usual with major construction projects, further testing and assessment of options would be required during the construction phase of Melbourne Metro to determine the most effective management approach and options. The recommended Environmental Performance Requirements would establish an effective regime for the management of spoil.

The embankment in Kensington would likely be piled. All excavated materials associated with this structure would be removed as waste. Excavation and piling methods may disturb the surrounding ground, creating the potential for aeration of potential acid sulfate soil.

**Table 20–3 Summary of waste spoil and acid sulfate soil/acid sulfate rock at the western portal site**

Category	Western portal spoil volume (m <sup>3</sup> )
Clean fill	38,000
Category C	12,600
Category B	4,500
Category A	900
Acid sulfate soil	1,000
Acid sulfate rock	None
<b>Total volume of spoil</b>	<b>57,000</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are 'high case', providing a conservative position.

## 20.9.2 Ground Gases and Vapours

As Coode Island Silt has the potential to be a source of natural gases, such as methane and hydrogen sulphide, there is potential to intercept these gases during construction activities in this precinct. Any short-term release of these gases could generate health and safety impacts, as well as impacts to concrete structures. As described in Section 20.7.7, if gases or vapours are encountered, the open excavation would largely mitigate any risks to workers. Specific mitigation measures could be incorporated into the remedial options assessment and health, safety and environmental plan for the management of hazardous substances developed by the contractor to meet the recommended Environmental Performance Requirements.

If methane enters the cut and cover section it would be significantly diluted by tunnel ventilation; if gas reaches the atmosphere, it would also be significantly diluted.

The risks associated with encountering gases and vapours would be managed in accordance with EPA guidelines, SEPP (AQM) and the BSI Code of Practice (as set out in Section 20.7.7). The recommended Environmental Performance Requirements would mandate the preparation of a remedial options assessment for contaminated land, which will consider further site investigations of gases and vapours, the assessment of risks and the identification of appropriate remedial options.

## 20.9.3 Management of Contaminated Groundwater

Groundwater in the area is generally shallow (recorded at depths of between 2.8 mbgl and 8 mbgl in wells installed within the precinct), indicating that groundwater is likely to be intercepted during construction activities. This shallow groundwater is generally of poor quality, with high levels of dissolved solids such as ammonia, iron and manganese. Chapter 18 *Groundwater* provides further details on the quantities of groundwater to be pumped out during construction and associated management measures.

If contaminants are mobilised into groundwater during either piling or construction of the below ground portal (decline) structure, these contaminants would tend to migrate with the direction of groundwater flow. Groundwater (and any contamination) that is adjacent to the decline wall lining may seep through into the structure where the water may collect. The remedial options assessment for contaminated land would facilitate assessment of the risks associated with the collected water and identify the appropriate remedial actions required. This waste water would be collected and disposed of in accordance with an EPA-approved management and disposal plan and is discussed in Chapter 18 *Groundwater*.

## 20.10 Precinct 3: Arden Station

Impacts in this precinct would be associated with the tunnel excavation, TBM launch and station box construction. This would involve the removal of both surface and natural material.

Much of the land in the area was reclaimed from low-lying marshland in the late 1800s and has been subjected to extensive industrial uses for many decades. Historically, the site has been used for activities such as rail yards, concrete production, grain and stock feed storage, flour mills and biscuit factories. Current land uses in or near the precinct are predominantly light to heavy industrial (such as auto repair, petrol service stations, workshops, printers, concrete and asphalt plants, foundries and mills), along with some commercial and residential properties.

The built-up nature of the land and its long history of industrial use means the potential for encountering contamination would be high in this precinct compared to others.

### 20.10.1 Bulk Earthworks and Spoil Management

As Arden station would be constructed using a cut and cover method, the soil and rock excavated would likely be typical of fill found across Melbourne: variable in both composition and contaminant profile and containing a variety of waste materials. There is no obvious re-use option for this material on-site in the precinct.

The majority of this material would be 'clean fill' (see Table 20–4), although some material is likely to have elevated concentrations of heavy metals and other potential contaminants.

Approximately 32,000 m<sup>3</sup> of the total material would be prescribed industrial waste with this material potentially containing contamination and asbestos. The wastes would be separated as far as reasonably practicable into Category A, B or C prescribed industrial waste or soil contaminated with asbestos and managed as described in Section 20.7.5.

A proportion of the spoil generated at this site would comprise Coode Island Silt, which is known to contain raised levels of sulfates and is classified as an acid sulfate soil. Soil testing conducted in this precinct found either actual or potential acid sulfate soil at relatively shallow depths of between 0.5 mbgl and 4.75 mbgl, indicating that disturbance of this material would be unavoidable at the Arden station site. Acid sulfate soil would be managed in accordance with EPA guidelines (as described in Section 20.7.3), with the off-site management in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils). Any off-site facility accepting the acid sulfate soil would need to have an EPA-approved EMP in place.

The base of the station box may extend into fresh Melbourne Formation rock, which is likely to be classified as potentially acid forming when exposed to air. The extraction and disposal of this material would be managed in accordance with EPA guidelines and the Acid Sulfate Soil and Rock Management Sub-Plan required by the recommended Environmental Performance Requirements (see Section 20.7.3).

**Table 20–4 Summary of waste spoil and acid sulfate soil/acid sulfate rock at Arden station site**

Category	Arden station spoil volume (m³)
Clean fill	135,000
Category C	19,200
Category B	6,400
Category A	6,400
Acid sulfate soil	35,000
Acid sulfate rock	None
<b>Total volume of spoil</b>	<b>202,000</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are ‘high case’, providing a conservative position.

## 20.10.2 Ground Gases and Vapours

There is a high likelihood of intercepting pockets of methane gas contained in Coode Island Silt anywhere within the Arden station precinct during construction. This could result in a short-term release of gas and consequential odour generation and associated health and safety issues (such as flammability). Specific mitigation measures would be incorporated into the health, safety and environmental plan for the management of hazardous substances developed by the contractor. Effects would be likely to be transient and release would be likely to occur within an open box, making accumulation within enclosed spaces unlikely. If methane enters the finished station box, it would be significantly diluted by ventilation; if gas reaches the atmosphere, it would also be significantly diluted. In both cases, health and safety risks would be avoided.

Given the surrounding land uses, groundwater and soil may be of poor quality and contain VOCs that may migrate to station structures during construction. The use of diaphragm walls (as discussed further in Section 20.10.3) would likely reduce any potential flow of gases or vapours to below ground structures.



The risks associated with encountering gases and vapours would be managed in accordance with EPA guidelines. The Environmental Performance Requirements would mandate the preparation of a remedial options assessment for contaminated land, which will consider further site investigations of gases and vapours, the assessment of risks and the identification of appropriate remedial options.

### 20.10.3 Management of Contaminated Groundwater

Groundwater in the area is shallow (recorded at depths of between 4 mbgl and 7.3 mbgl in wells installed within the precinct), indicating that groundwater is likely to be intercepted during construction activities (refer to Chapter 18 *Groundwater* for inflow quantities). Given the surrounding land use, this groundwater may be of poor quality with a number of groundwater contamination sources being identified near the precinct. Sampling of the groundwater in the precinct found heavy metals, metalloids, cyanide, fluoride, nitrite and ammonia. Dewatering, treatment and discharge of groundwater during construction and possibly over the longer term is considered further in Chapter 18 *Groundwater*.

The construction technique for this station is bottom up cut and cover, where the station box is fully excavated and built-up from the base slab. Due to the sensitive geological conditions at this location, diaphragm walls would be used as the retaining structures for this station, with toe grouting beneath the diaphragm wall. This construction method would be likely to result in very little groundwater inflow, which would be largely restricted to the floor of the excavation prior to installation of the concrete base slab. Therefore, groundwater seepage into the excavation and station box sumps would be likely to be minimal.

The preparation and implementation of a remedial options assessment for contaminated land as required by the recommended Environmental Performance Requirements would facilitate the assessment of the risks associated with the collected water and identify the appropriate remedial actions required. However, this waste water would be collected and discharged in accordance with an EPA-approved management and disposal plan.

## 20.11 Precinct 4: Parkville Station

Impacts in this precinct would be associated with tunnel excavations, station structural works and construction of the underground pedestrian connection.

A number of historical land uses indicate the potential for ground contamination in the precinct, including the area being the historical site of the Melbourne Hay and Pig Markets and various industrial activities (such as galvanised iron and timber merchants and furniture manufacture).

## 20.11.1 Bulk Earthworks and Spoil Management

As Parkville station would be constructed using a cut and cover method, the soil and rock excavated would be expected to be mainly shallow Melbourne Formation. While the bulk of this material would be clean fill (see Table 20–5), the known geology of the area and the depth of the station box (22 m to 27 m) suggests that relatively small volumes of excavated spoil may require management in relation to acid generation.

If construction activities do encounter potential acid sulfate soil or rock, this material would be extracted and disposed of in accordance with EPA guidelines (see Section 20.7.3).

There is no obvious re-use option for the spoil material on-site.

**Table 20–5 Summary of waste spoil and acid sulfate soil/acid sulfate rock at Parkville station site**

Category	Parkville station spoil volume (m <sup>3</sup> )
Clean fill	239,000
Category C	23,800
Category B	1,300
Category A	None
Acid sulfate soil	None
Acid sulfate rock	35,000
<b>Total volume of spoil</b>	<b>299,100</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are ‘high case’, providing a conservative position.

## 20.11.2 Management of Contaminated Groundwater, Gases and Vapours

No specific groundwater plumes or volatile compounds in soil or groundwater have been identified in this precinct. Accordingly, no significant impacts from contaminated groundwater or soil gases and vapours would be anticipated, over and above that expected normally for construction.

## 20.12 Precinct 5: CBD North Station

Impacts in this precinct would be associated with the station structural works and underground pedestrian connection to Melbourne Central station.

The precinct is currently used for a variety of commercial, educational and residential uses as well as for transport infrastructure. A number of historical land uses in the precinct indicate the potential for ground contamination, with the area being used previously for industrial and commercial activities such as factories, sawmills, timber yards, lead works (shot tower) and foundries, and well as being the location of the former Melbourne Hospital (on the corner of Lonsdale and Swanston Streets). A former brewery with a known groundwater contamination plume is located to the north of the station.

### 20.12.1 Bulk Earthworks and Spoil Management

CBD North station would be constructed using the mined cavern method, with cut and cover entrances at Franklin and La Trobe Streets. This means that shallow spoil would be excavated at the site (see Table 20–6). Some spoil could be prescribed industrial waste with heavy metal concentrations. There is no obvious re-use option for this material on-site.

Soil and rock samples from locations within this precinct indicate that acid sulfate rock may be encountered below 25 mbgl in Melbourne Formation rock. The extraction and disposal of this material would be managed in accordance with EPA guidelines (see Section 20.7.3).

**Table 20–6 Summary of waste spoil and acid sulfate soil/acid sulfate rock at CBD North station site**

Category	CBD North station spoil volume (m <sup>3</sup> )
Clean fill	142,000
Category C	12,800
Category B	2,800
Category A	400
Acid sulfate soil	None
Acid sulfate rock	187,000
<b>Total volume of spoil</b>	<b>345,000</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are 'high case', providing a conservative position.

## 20.12.2 Management of Contaminated Groundwater, Gases and Vapours

A number of groundwater contamination source sites have been identified near the precinct. In particular, the former brewery site on Victoria Street containing a Groundwater Quality Restricted Use Zone (petroleum hydrocarbons and chlorinated solvents) is located immediately north of the precinct.

In addition to groundwater contamination issues, the presence of chlorinated hydrocarbons may lead to vapours or gases collecting in the construction works or in the station. These impacts and the associated mitigation measures are discussed in Section 20.7.7.

In regard to groundwater contamination, extensive dewatering may pull off-site contaminated plumes towards the Melbourne Metro alignment, with the potential contaminated groundwater seeping and collecting in the tunnel and station structures where volatilisation of contaminants (such as chlorinated hydrocarbons) may occur. The preparation and implementation of a remedial options assessment for contaminated land as required by the Environmental Performance Requirements would facilitate the assessment of the risks associated with the collected water and identify the appropriate remedial actions required. However, this waste water would be collected and discharged in accordance with an EPA-approved management and disposal plan. Refer to Chapter 18 *Groundwater* for further details of quantities of groundwater and management measures.

Specific mitigation measures relating to the management of vapours would be incorporated into the health, safety and environmental plan for the management of hazardous substances developed by the contractor.

## 20.13 Precincts 6 and 7: CBD South Station and Domain Station

Impacts in the CBD South station precinct would be associated with the station structural works and underground connections to Flinders Street Station and Federation Square. Impacts in the Domain station precinct would be associated with TBM excavations and station structural works.

Both precincts are currently used for a variety of commercial, educational and residential uses as well as transport structures. Historical land uses that may have been potentially contaminative are industrial and commercial activities and a swampy plain that may have undergone some land reclamation works near Domain.

While the CBD South and Domain station precincts do not contain the same geology, impacts would be similar and hence the precincts are discussed concurrently.

The South Yarra Main Sewer near Domain station would require relocation along with other service utilities at CBD South and Domain (including tram lines) as part of early works. The generation of contaminated spoil is likely to be the main impact associated with these works and would be managed in a similar way as for bulk earthworks and spoil management (outlined below).

### 20.13.1 Bulk Earthworks and Spoil Management

CBD South station would be constructed using the mined cavern method, while Domain station would be constructed using a cut and cover method. The bulk of the material would be clean fill (see Table 20–7). A proportion would likely be prescribed industrial waste with heavy metal concentrations. As there is no obvious re-use option for the material on-site at either location, it would have to be removed off-site as a waste. Subject to further testing, this material could be directed for re-use at another site in accordance with EPA regulations and guidelines.

The known geology of the area suggests that Fresh Melbourne Formation rock would be encountered in the deeper parts of the excavation and tunnelling at CBD South station, while being avoided at Domain station. This material is likely to be classified as acid sulfate rock when exposed to air and its extraction and disposal would be managed in accordance with EPA guidelines (see Section 20.7.3).

**Table 20–7 Summary of waste spoil and acid sulfate soil/acid sulfate rock at CBD South station and Domain station sites**

Category	CBD South station spoil volume (m <sup>3</sup> )	Domain station spoil volume (m <sup>3</sup> )
Clean fill	168,000	196,000
Category C	10,400	6,300
Category B	2,300	7,400
Category A	400	7,400
Acid sulfate soil	None	None
Acid sulfate rock	72,000	None
<b>Total volume of spoil</b>	<b>253,100</b>	<b>217,100</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are ‘high case’, providing a conservative position.

## 20.13.2 Management of Contaminated Groundwater, Gases and Vapours

No specific groundwater plumes or volatile compounds in soil or groundwater have been identified in either precinct. Accordingly, no significant impacts from contaminated groundwater or soil gases and vapours are anticipated.

The depth to groundwater in the vicinity of CBD South station precinct is shallow; between 6 mbgl and 25 mbgl and likely to be intercepted during most of the excavation work within this precinct. Sampling found that groundwater contains ammonia, sodium, chloride, magnesium and fluoride at levels above various guidelines.

The depth to groundwater in the Domain precinct varies from 11.7 mbgl to 12.7 mbgl in the Melbourne Formation and 8 mbgl in the Brighton Group. The station box would be constructed using a cut and cover method, which would likely induce dewatering and drawdown of the groundwater level in the area. Sampling of groundwater found metal (arsenic, iron, manganese, molybdenum, nickel, selenium) and inorganic (ammonia, fluoride, sulfate, chloride, magnesium, sodium) concentrations above various guideline values.

Dewatering, treatment and discharge of groundwater during construction (and possibly more longer term) is discussed in more detail in Chapter 18 *Groundwater*.

## 20.14 Precinct 8: Eastern Portal (South Yarra)

Impacts in this precinct would be associated with the cut and cover excavation of the portal, widening of the existing rail corridor and construction of retaining walls and construction of an emergency access shaft and the TBM retrieval shaft.

### 20.14.1 Bulk Earthworks and Spoil Management

The bulk of the spoil generated at this site would be clean fill (see Table 20–8), mostly comprising the sands, silts and clays of the Brighton Group.

The Brighton Group can generally be classified as an acid sulfate soil, although laboratory testing results suggest this is a low likelihood at this location and therefore it has not been included in the volume calculations listed below. If present, acid sulfate soil would be managed in accordance with EPA guidelines (see Section 20.7.3), with off-site management conducted in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils) (see Section 20.7.1). Further testing and assessment of options would be undertaken during the construction phase of Melbourne Metro to determine the most effective management option.

**Table 20–8 Summary of waste spoil and acid sulfate soil/acid sulfate rock at the eastern portal site**

Category	Eastern portal spoil volume (m³)
Clean fill	39,300
Category C	6,300
Category B	1,400
Category A	200
Acid sulfate soil	None
Acid sulfate rock	None
<b>Total volume of spoil</b>	<b>47,200</b>

Notes:

All volumes provided are in-situ or dense (no bulking factor applied).

Volumes are sourced from Golder Associates Preliminary Spoil Volume Estimate Report – Appendix E of Contaminated Land Assessment – EES Summary Report (April 2016) and are ‘high case’, providing a conservative position.

## 20.14.2 Management of Contaminated Groundwater, Gases and Vapours

Limited data is available on the quality of soil and groundwater at the portal. However, a significant number of groundwater contamination source sites have been identified near the eastern portal, with groundwater at these sites reporting raised levels of metals, VOCs and free phase oils.

Lowering the groundwater table during construction of the eastern portal would eventually cause a hydraulic gradient towards the portal. This would then draw existing off-site groundwater contamination towards the portal.

If contaminants are mobilised into groundwater during construction works, these contaminants would tend to migrate with the direction of groundwater flow. Groundwater (and any contamination) that is adjacent to the tunnel portal may seep through into the structure where the water may collect. The preparation and implementation of a remedial options assessment for contaminated land as required by the recommended Environmental Performance Requirements would facilitate the assessment of the risks associated with the collected water and potential volatilisation of contaminants and identify the appropriate remedial actions required. However, this waste water would be collected and discharged in accordance with an EPA-approved management and disposal plan. Refer to Chapter 19 *Groundwater* for further details of quantities of groundwater and management measures.

Specific mitigation measures relating to vapour migration would be incorporated into the health, safety and environmental plan for the management of hazardous substances developed by the contractor.

## 20.15 Precinct 9: Western Turnback (West Footscray)

Impacts in this precinct would be associated with construction of a new platform and modifications to the concourse at West Footscray station, and construction of new track and turnouts. It is assumed that all works would be at or above the existing ground surface, with the exception of the installation of shallow footings and or shallow excavation works that would not intercept groundwater.

### 20.15.1 Bulk Earthworks and Spoil Management

A small (but yet to be quantified) volume of material potentially containing contamination and asbestos would be excavated at this site. As with all other precincts, waste spoil would be categorised as far as reasonably practicable prior to excavation and managed and disposed of in the same way as outlined in Section 20.7.4. Asbestos containing materials (if encountered) would be managed in accordance with WorkSafe regulations and EPA guidelines.

As recommended by the Environmental Performance Requirements, further site investigations would be completed during the detailed design phase to assess the environmental status of soils in the vicinity of the western turnback. Given that there would be limited room to stockpile material on-site during construction, this data would then be used by the contractor to categorise the soil for disposal or re-use.

No management requirements for contaminated groundwater or soil gases and vapours are anticipated at this site due to the shallow nature of construction.

## 20.16 Early Works

The impacts of early works would be associated with the relocation, decommissioning and demolition of existing utilities and buildings, and the construction and provision of the necessary utilities, cables and substations for Melbourne Metro. The land uses and potential contaminating activities for the early works and substation locations are described in the precinct descriptions of this chapter.

### 20.16.1 Bulk Earthworks and Spoil Management

The potential volumes and characteristics (quality) of spoil generated from early works activities are not able to be quantified at this stage, although the volumes are likely to be small in comparison to the project as a whole.

Shallow fill and natural soils excavated as part of early works would likely be managed in small batches. Shallow groundwater may be encountered during the excavation of some underground services, requiring the management and disposal of small volumes of groundwater.



As with all other precincts, asbestos-containing materials (if encountered) would be managed in accordance with WorkSafe regulations and EPA guidelines (see Section 20.7.3).

No management requirements for contaminated groundwater or soil gases and vapours are anticipated during early works due to the shallow nature of construction.

## 20.17 Environmental Performance Requirements

As discussed in Section 20.7, existing regulations, standards and guidelines are available – and are used regularly – to avoid or minimise the effects on encountering contaminated soil, rock and groundwater. The following table shows the recommended Environmental Performance Requirements for Melbourne Metro and proposed mitigation measures in relation to contaminated land and spoil management.

The risk numbers listed in the final column align with the list of groundwater risks provided in Technical Appendix B *Environmental Risk Assessment Report*.

Table 20–9 Environmental Performance Requirements for Contaminated land and spoil management

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
<p><b>Hydrology, water quality and waste management</b></p> <p>– To identify and prevent potential adverse environmental effects resulting from the disturbance of contaminated or acid-forming material and to manage excavation of spoil and other waste in accordance with relevant best practice principles</p>	<p>Prior to construction of main works or shafts, prepare and implement a Spoil Management Plan (SMP) in accordance with the Melbourne Metro Spoil Management Strategy and relevant regulations, standards and best practice guidance. The SMP shall be developed in consultation with and to the satisfaction of the EPA. The SMP will include but is not limited to the following:</p> <ul style="list-style-type: none"> <li>• Applicable regulatory requirements</li> <li>• Identifying nature and extent of spoil (clean fill and contaminated spoil) across all precincts</li> <li>• Roles and responsibilities</li> <li>• Identification of management measures for handling and transport of spoil for the protection of health and the environment</li> <li>• Identification, design and development of specific environmental management plans for temporary stockpile areas</li> <li>• Identifying suitable sites for re-use, management or disposal of any spoil</li> <li>• Monitoring and reporting requirements</li> <li>• Identifying locations and extent of any prescribed industrial waste (PIW) and characterising PIW spoil prior to excavation</li> <li>• Identifying suitable sites for disposal of any PIW.</li> </ul> <p>The SMP shall include sub-plans as appropriate, including but not limited to an Acid Sulfate Soil and Rock (ASS/ASR) Management Sub-Plan (see below).</p>	<p>The collection of additional data (samples) in accordance with EPA IWRG702, IWRG621, IWRG611.1 and Worksafe Victoria guidelines on asbestos in order to allow for the appropriate in situ categorisation of spoil prior to excavation. The collection and analysis of samples will reduce the level of uncertainty around spoil quality and quantity at the point of generation and allow for forward planning of management and disposal options.</p> <p>Engagement with EPA licensed waste disposal and soil treatment facility operators located within a feasible distance from the CBD to identify potential PIW disposal and/or treatment sites.</p> <p>Provide requirements for work site monitoring, material (spoil) tracking, work site environmental management, identify roles and responsibilities and provide contingency measures to account for:</p> <ul style="list-style-type: none"> <li>• Larger than anticipated volumes or levels of contamination</li> <li>• Transport to the wrong disposal/treatment facility</li> <li>• Delay in removal of spoil from site (for example, truck breakdown)</li> <li>• Emergency measures in the case of a spill or release (or any other unexpected event).</li> </ul>	All	Construction	<p>CL001 CL002 CL005 CL006 CL016 CL018</p> <p>CL021 to CL026</p> <p>CL043 CL044 CL046 CL048 CL049</p>

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
	<p>Prepare and implement an Acid Sulfate Soil and Rock (ASS/ASR) Management Sub-Plan prior to construction of the project as a Sub-Plan of an overarching SMP in accordance with the regulations, standards and authoritative best practice guidance and to the satisfaction of EPA. This sub-plan will include the general requirements of the SMP and also:</p> <ul style="list-style-type: none"> <li>• Identify locations and extent of any potential ASS/ASR</li> <li>• Characterise ASS/ASR spoil prior to excavation</li> <li>• Identify and implement measures to prevent oxidation of ASS/ASR wherever possible</li> <li>• Identify suitable sites for re-use, management or disposal of any ASS/ASR.</li> </ul>	<ul style="list-style-type: none"> <li>• The collection of additional data (samples) in accordance with EPA IWRG702, IWRG621 and EPA publication 655.1 in order to allow for the appropriate in situ categorisation of spoil prior to excavation. The collection and analysis of samples will reduce the level of uncertainty around spoil quality and quantity at the point of generation and allow for forward planning of management and disposal options</li> <li>• Engagement with EPA licensed waste disposal and soil treatment facility operators located within a feasible distance from the CBD to identify potential PIW disposal and/or treatment sites</li> <li>• Provide requirements for work site monitoring, material (spoil) tracking, work site environmental management, identify roles and responsibilities and provide contingency measures to account for: <ul style="list-style-type: none"> <li>– Larger than anticipated volumes or levels of contamination</li> <li>– Transport to the wrong disposal/treatment facility</li> <li>– Delay in removal of spoil from site (for example, truck breakdown)</li> <li>– Emergency measures in the case of a spill or release (or any other unexpected event).</li> </ul> </li> </ul>	All	Construction	CL002 CL005 CL006 CL018 CL044 CL046

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
	<p>Prior to construction of main works or shafts, undertake a remedial options assessment (ROA) for contaminated land. The assessment must:</p> <ul style="list-style-type: none"> <li>Consider the outcomes of further investigations</li> <li>Interpretation of groundwater permeation and VOC result</li> <li>Present and take account of the outcomes of risk assessments</li> <li>If required, identify remedial options in accordance with relevant regulations, standards and best practice guidance and to the satisfaction of EPA.</li> </ul> <p>If required, as an outcome of the ROA, prepare a remedial action plan and integrate the remediation approach into the design in accordance with relevant regulations, standards and best practice guidance and to the satisfaction of EPA.</p>	<ul style="list-style-type: none"> <li>The collection of additional data (samples) in accordance with NEPM, AS4482.1 and AS4482.2 and EPA Publications 668 and 840.1 (the clean-up and management of polluted groundwater) in order to appropriately characterise the nature and extent of contamination to allow for the appropriate design and mitigation measures to be put in place prior to excavation</li> <li>The collection and analysis of samples will reduce the level of uncertainty around contaminant nature and extent and be used to conduct a human health or environmental risk assessment if required</li> <li>Based on additional sampling and risk assessment results, remediation may be required. This may be in the form of treatment of materials to reduce the level of contamination (such as in situ chemical or physical treatment of contaminants) or engineering or design controls to reduce the exposure pathway (such as vapour barriers).</li> </ul>	<p>1 - Tunnels 2 - Western portal 5 - CBD North station 7 - Domain station</p>	<p>Construction/ Operation</p>	<p>CL008 CL010 CL013 CL027 CL030 CL033 CL036 CL039 CL040 CL050 CL052 CL054 CL056 CL058</p>

Draft EES evaluation objective	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk No.
	<p>Prior to construction of main works or shafts commencing, prepare and implement a health, safety and environmental plan for the management of hazardous substances. The plan must include but not be limited to:</p> <ul style="list-style-type: none"> <li>• Consideration of the risks associated with exposure to hazardous substances for employees, visitors and general public</li> <li>• The identification of methods to control such exposure in accordance with relevant regulations, standards and best practice guidance and to the satisfaction of WorkSafe and the EPA</li> <li>• Method statements detailing monitoring and reporting.</li> </ul>	<p>Health and safety:</p> <ul style="list-style-type: none"> <li>• Identification of chemicals or other hazardous substances in the work space (directly or indirectly)</li> <li>• Assess risks</li> <li>• Determine how to prevent or control exposure</li> <li>• Ensure controls measures are used</li> <li>• Monitor exposure</li> <li>• Undertake appropriate health surveillance</li> <li>• Prepare plans and procedures to deal with emergencies and accidents</li> <li>• Ensure employees are properly informed, trained and supervised</li> <li>• Engage with appropriate regulatory authorities where appropriate.</li> </ul>	All	Construction	CL015 CL038 CL042 CL059

Refer also to the recommended Environmental Performance Requirements in relation to groundwater impacts. These requirements and proposed mitigation measures are provided in Chapter 18.

## 20.18 Conclusion

The assessment has identified a number of environmental impacts from the construction and operation of Melbourne Metro that are typical of large-scale infrastructure projects within an urban setting.

Short-term impacts during construction would arise primarily from disturbing contaminated soil, potential and actual acid sulfate soil and rock, hazardous gases and vapours, and contaminated groundwater.

The management and safe disposal of potentially large volumes of spoil materials (including clean fill, Prescribed Industrial Waste and acid sulfate soil and rock) would be a significant logistical issue for Melbourne Metro. However, with the adoption of the recommended Environmental Performance Requirements and the implementation of the proposed mitigation measures, the scope of spoil management activities required is considered manageable and there is available capacity for spoil disposal within a reasonable distance of the CBD (refer to the draft Spoil Management Strategy in Technical Appendix Q). Traffic impacts for the haulage of spoil to disposal locations have also been assessed (see Technical Appendix D *Transport*).

While the environmental impacts would vary from precinct to precinct, mitigation measures across all precincts would focus on:

- Preparing and implementing a remedial options assessment for contaminated land prior to construction to gather additional information to enable the Spoil Management Plan to be prepared, assess contaminated land risks and identify where further assessment and/or remediation may be warranted
- Completing further investigations, sampling analysis and monitoring to enable the nature and extent of contamination to be clarified and spoil to be categorised
- Selecting piling techniques (and other construction techniques and materials) that take into account potential aggressive ground conditions and that minimise as far as reasonably practicable disturbance of contaminated soil
- Minimising as far as reasonably practicable disturbance of contaminated groundwater and managing groundwater in accordance with SEPP (Groundwaters of Victoria) and EPA guidelines
- Minimising as far as reasonably practicable the disturbance of hazardous gases and vapours in soil and groundwater in accordance with SEPP (Air Quality Management) and a number of Australian and UK guidance documents (refer to Technical Appendix for further details)

- Preparing and implementing a Spoil Management Plan (including an Acid Sulfate Soil and Rock (ASS/ASR) Management Sub-Plan)
- Preparing and implementing a health, safety and environmental plan for the management of hazardous substances that complies with WorkSafe Victoria and EPA guidelines and with all relevant Commonwealth and Victorian policies and laws to provide a safe working environment and minimise or avoid impacts to human health and the environment.

The contaminated land impact assessment found that Melbourne Metro would be consistent with the draft EES evaluation objective as any potential adverse environmental impacts would be appropriately managed by meeting all relevant regulations and standards, achieving the recommended Environmental Performance Requirements and implementing the proposed mitigation measures.