

16 Soils and contamination

This chapter assesses the potential soils and contamination impacts associated with the project. This chapter is informed by **Appendix J** (Contamination technical report), **Appendix L** (Surface water technical report) and **Appendix K** (Groundwater technical report).

Table 16-1 sets out the SEARs relevant to soils and contamination and identifies where the requirements have been addressed in this EIS.

Table 16-1 SEARs – Soils and contamination

SEARs	Where addressed in this EIS
Soils	
1. The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the project.	The potential for acid sulfate soils to occur within the study area is discussed in section 16.2.1 and section 16.3.4 .
2. The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines and detail the mitigation measures proposed to minimise potential impacts.	Potential impacts of acid sulfate soils are discussed in section 16.3.4 . Mitigation for acid sulfate soils is described in section 16.5 .
3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Qualitative assessment of the potential contamination risks is addressed in section 16.3 and section 16.4 . Remediation for construction ancillary facilities is provided in Appendix J (Contamination technical report). Commitment to undertaking and implementing a Remediation Action Plan is provided in section 16.5 . Human health risks are discussed in Appendix F (Human health technical report).
4. A baseline contamination assessment must be undertaken for filled land in the vicinity of the proposed cut and cover works near President Avenue. The Proponent must provide details of contamination characteristics and measures to manage this spoil, including spoil stockpile management, transport and disposal to avoid adverse impacts to land, water quality and sensitive receivers;	A preliminary investigation and assessment is provided in section 16.2.4 for the President Avenue construction ancillary facility (C3) and in section 16.2.6 for the tunnel alignment. Recommended management is provided in section 16.5 .
5. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area.	An assessment of the potential for salinity to be present, and the associated impacts, is provided in section 16.2.1 and section 16.3.2 .
6. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources, hydrology and vegetation.	An assessment of potential project impacts on soil salinity, including how it may affect hydrology, is provided in section 16.3.2 . The impacts of soil salinity on groundwater resources are assessed in Appendix K (Groundwater technical report). The impacts of soil salinity on vegetation are assessed in Appendix H (Biodiversity development assessment report).
7. The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Impacts on erosion and sediment are assessed in section 16.3.1 and section 16.4.1 .
8. The Proponent must assess the impact of any disturbance of contaminated groundwater and the tunnels should be carefully designed so as not to exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow.	Potential impacts on groundwater are addressed in section 16.3 , section 16.4 and Chapter 17 (Groundwater and geology).

SEARs	Where addressed in this EIS
Air Quality	
3. The Proponent must undertake a landfill gas assessment in the vicinity of the President Avenue interchange and provide details on proposed methods and options for managing and mitigation impacts during construction and operation	Potential impacts from landfill gas are addressed in section 16.3.3 .

16.1 Assessment approach

A full discussion on the assessment methodology undertaken to identify potential soil and contamination impacts as a result of the project is provided in **Appendix J** (Contamination technical report), **Appendix L** (Surface water technical report) and **Appendix K** (Groundwater technical report).

16.1.1 Methodology

A desktop data review was undertaken and included:

- Review of soil, groundwater and gas data collected as part of the targeted geotechnical investigations within the study area, in order to characterise contamination in the study area
- Identification and assessment of risk of acid sulfate soil exposure, erosion, soil sediment mobilisation, subsidence, settlement and presence of soil salinity
- A review of relevant data and background information including, but not limited to, previous site contamination reports, historical land titles, NSW Environment Protection Authority (NSW EPA) records and Universal Business to Business Directories Pty LTD (UBD) business directories historical records to evaluate whether historical land uses were likely to have caused contamination of soil and groundwater
- Review of Environmental Risk and Planning (ERP) Reports prepared for the length of the mainline tunnel alignment by Lotsearch Pty Ltd (Lotsearch)¹
- Obtaining and reviewing historical titles and section 149 certificates for the relevant surface works and construction ancillary facilities.

An inspection of the study area from publically accessible land was undertaken by AECOM Environmental Scientists on 11 December 2017 to ground truth information obtained during the desktop review and to inform a description of the existing environment.

A preliminary qualitative risk assessment was then undertaken to assess the potential construction and operation impacts on contamination. The preliminary qualitative risk assessment involved development of a conceptual site model (CSM) for the project to identify and present information about potential contamination sources, receptors and potential exposure pathways between the identified sources and receptors. The CSM provided the framework for identifying how potential receptors may be exposed to contamination from previous or current site sources.

The sources, pathways and receptors were identified by information obtained in the desktop review and site inspection. The qualitative risk ranking was completed by identifying and assessing the pollutant linkages in the CSM and assigning the following risk:

- Low risk: based on the available information, a complete pollutant linkage is considered to be unlikely
- Medium risk: based on the available information, a complete pollutant linkage may potentially be present, however the likelihood and consequence is considered to be medium
- High risk: based on the available information, a complete pollutant linkage is considered to be likely.

Results of the risk assessment are summarised in **section 16.2.8** and **section 16.4**.

¹ Lotsearch (2017a) Environmental Risk and Planning Report, Stage 1 F6 Extension (Section 1 to Section 5)

Adopted assessment criteria

Groundwater contamination results have been screened against the following criteria where relevant for the investigations that have informed this assessment:

- National Environment Protection Measure (NEPM) Table 1C Groundwater Investigation Levels (GILs) for marine and fresh waters and drinking water, National Environment Protection Council (NEPC, 2013 as amended)
- NEPM Table 1A (4) Groundwater Health Screening Levels (HSLs) for vapour intrusion 2 metres to < 4 metres (NEPC, 2013 as amended).

Soil contamination results have been screened against the following criteria where relevant for the investigations that have informed this assessment:

- *National Environment Protection (Assessment of Site Contamination) as amended, 2013* (NEPM, 2013):
 - Soil Health Investigation Levels (HILs): HIL D (commercial/industrial land use)
 - Health Screening Levels (HSLs): HSL D (commercial industrial, zero metres to less than one metre, sand) for non- petroleum sites
 - HSL D for direct contact and intrusive maintenance worker
 - HSL C (open space/recreational land use) for direct contact
 - Ecological Investigation Levels (EIL) EIL D (commercial/industrial land use) and EIL C (open space/recreational land use)
 - Ecological Screening Levels (ESL) ESL D (commercial/industrial land use) and ESL C (open space/recreational land use)
- *Technical Report No.10 – Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater* (Friebel, E. and Nadebaum, P, 2011) – Soil Health Screening Levels (HSLs) Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE)
- *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites* (United States Environment Protection Authority, 2014)
- *Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Alignments in Western Australia* – commercial/industrial land use (Western Australian Department of Health, 2009)
- *Waste Classification Guidelines, Part 1: Classifying Waste* (NSW Environment Protection Authority, 2014).

Refer to **Appendix J** (Contamination technical report) for further information.

16.1.2 Relevant legislation and policies

Soils

The impact assessment of the project on soils has been prepared in accordance with the following key relevant guidelines and policies:

- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and Volume 2 (NSW Department of Environment and Climate Change (DECC) 2008)
- Roads and Maritime Services Erosion and Sediment Management Procedure (Roads and Maritime 2008).

Contamination

Legislation and policies relevant to the assessment and management of contaminated land include:

- *Contaminated Land Management Act 1997* (NSW) (CLM Act)
- *Protection of the Environment Operations Act 1997* (NSW) (POEO Act)
- *Environmentally Hazardous Chemicals Act 1985* (NSW) (EHC Act)
- *State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) Relevant guidelines*
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (NSW EPA 2015)
- *Guidelines for the NSW Site Auditor Scheme (Third Edition)* (NSW EPA 2017)
- *Managing Land Contamination, Planning Guidelines SEPP 55-Remediation of Land*, (NSW Department of Urban Affairs and Planning (DUAP) and NSW EPA 1998)
- *Guidelines for the Assessment and Management of Groundwater Contamination* (Department of Environment and Conservation (DEC) 2007)
- National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM) 2013 (National Environment Protection Council (NEPC) 1999)
- *Environmental Guidelines: Solid Waste Landfills (Second Edition)* (NSW EPA 2016)
- *Guidelines for Consultants Reporting on Contaminated Sites* (NSW Office of Environment and Heritage (OEH) 2011)
- *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (NSW EPA 2012)
- *National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines* (Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000)
- *Acid Sulfate Soils Assessment Guidelines*, Acid Sulfate Soils Management Advisory Committee ((ASSMAC) 1998)
- *Acid Sulfate Soils Assessment Guideline* (Department of Planning (DoP) 2008)
- *Urban and regional salinity* (DLWC, 2002)
- *Landslide risk management guidelines presented in Australian Geomechanics Society* (2007)
- *Soil and Landscape Issues in Environmental Impact Assessment* (DWLC 2002).

16.1.3 Study area

The study area for the soils and contamination assessment is the same as the project footprint, which comprises the location of all operational infrastructure and areas where construction activities would occur. Particular attention has been given to those areas where historical land use activities have impacted soil, sediment and groundwater and which would require remediation and/or management during the construction and operation of the project.

Information on the operational and construction components of the project is provided in **Chapter 6** (Project description) and **Chapter 7** (Construction) respectively.

The six construction ancillary facilities and surrounding areas assessed for contamination include the Arncliffe construction ancillary facility (C1), Rockdale construction ancillary facility (C2), President Avenue construction ancillary facility (C3), Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) as well as the shared cycle and pedestrian pathways and the Princes Highway construction ancillary facility (C6), on the north-east corner of the President Avenue and Princes Highway intersection.

The project tunnel alignment was assessed in order to identify potential sources for groundwater contamination. The permanent power supply connection from the Ausgrid Canterbury subtransmission substation, to Rockdale Motorway Operations Complex south is included in the study area.

16.2 Existing environment

16.2.1 Soils

Topography

Lands around the tunnel alignment are relatively flat and low lying with gentle undulating hills ranging from around two metres Australian height datum (AHD) to around 16 metres AHD. The lands closest to the northern and southern end of the tunnel alignment are the lowest and flattest and the land with greatest elevation, around 36 metres AHD, is located at Arncliffe near the Princes Highway.

Soil landscapes

The Soil Landscapes of the Sydney 1:100,000 Sheet 9130² indicates that the study area is underlain by seven soil landscapes. These are shown in **Figure 16-1**. The soil landscapes, as well as their potential for erosion are summarised in **Table 16-2**.

Table 16-2 Soil landscape characteristics and erosion potential

Soil landscape	Erosion/mass movement potential
Tuggerah (tg1 to tg6)	Low erodibility as soils consist of highly permeable, coarse sand grains, however lack of cohesion makes these soils susceptible to concentrated flows. Low to moderate erosion hazard for non-concentrated flows. Very high to extreme erosion hazard for concentrated flows.
Warriewood (wa1 to wa6)	Low to very low erodibility. Relatively stable and consist of well drained stable coarse sands or coarse sand grains weakly held together by organic matter or iron compounds. The erosion hazard for non-concentrated flows is low. The erosion hazard for concentrated flows is moderate to high and for wind erosion is low to moderate. Ground surface within the study area is generally stabilised due to urban development.
Newport (np1 to np6)	Soils range from having low erodibility (np 4 and np 5) to being moderately erodible (np1, np2, np3 and np6). Erosion hazard for non-concentrated flows is generally high but ranges from high to extreme. Erosion hazard for concentrated flows and wind is high. Ground surface within the study area is generally stabilised due to urban development.
Lambert (la1 to la6)	Soil materials are low (la5, la6) to moderately erodible. The soil erosion hazard for non-concentrated flows is usually very high but ranges from low to extreme. The soil erosion hazard from concentrated flow is extreme.
Gynea (gy1 to gy4)	Very low (gy1 and gy2), moderately (gy3) and highly erodible (gy4) soils. Erosion hazard for non-concentrated flows is generally high to very high but can range from moderate to extreme. Soil erosion hazard for concentrated flows is high to extreme.
Disturbed Terrain (xx1 to xx4)	Erodibility and erosion hazard is variable.
Hawkesbury (ha1)	Low (ha1) to moderate (ha2, ha3) erodibility. Erosion hazard for non-concentrated flows is generally very high and ranges from moderate to extreme. The soil erosion hazard for concentrated flows is extreme.

² Chapman, G.A. and Murphy, C.L (1989) Soil Landscapes of the Sydney 1:100,000 sheet 9130. Soil Conservation Service of NSW, Sydney

Soil salinity

Salinity refers to the salt content of soil. Salinity is an important variable in landscape systems and is often a determining factor in the capacity of the landscape to absorb change. It can impact on landscapes, namely land salinisation (salts stored in the soil profile are mobilised by water movement), in-stream salt load and in-stream salt concentration³.

Localised soil salinity is reported to occur within the Tuggerah (tg3 and tg5) and Disturbed Terrain (xx4) soil landscapes⁴.

The risk of salinity impacts can be increased by clearing vegetation, irrigation or other activities that can lead to a rise in the groundwater table.

The broad salinity hazard distribution across the Sydney Metropolitan Catchment Management Authority Area (SMCMA) (now Local Land Services) has been mapped as part of the Catchment Action Plan for the SMCMA area³. The salinity hazard mapping in relation to the study area is shown in **Figure 16-2**.

Parts of the study area are located within areas depicted as having a very high salinity hazard based on the Sydney Hazard for Catchment Action Plan Update map³. The remainder of the study area is located within areas of very low salinity hazard³.

³ Department of Primary Industries (2013) Salinity hazard report for Catchment Action Plan upgrade - Hawkesbury-Nepean CMA

⁴ Chapman, G.A. and Murphy, C.L. (1989) Soil Landscapes of the Sydney 1:100,000 sheet 9130. Soil Conservation Service of NSW, Sydney

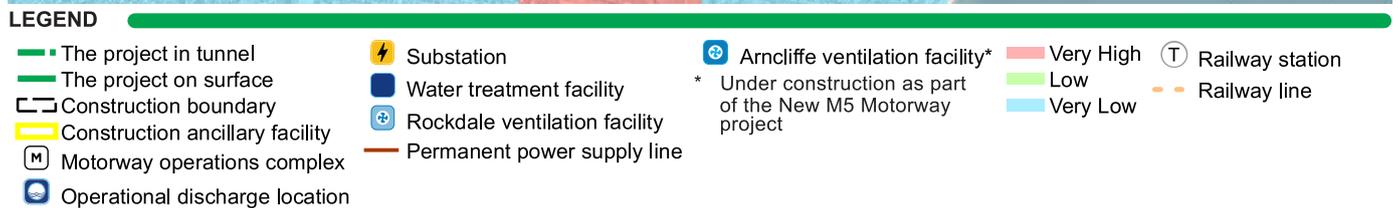
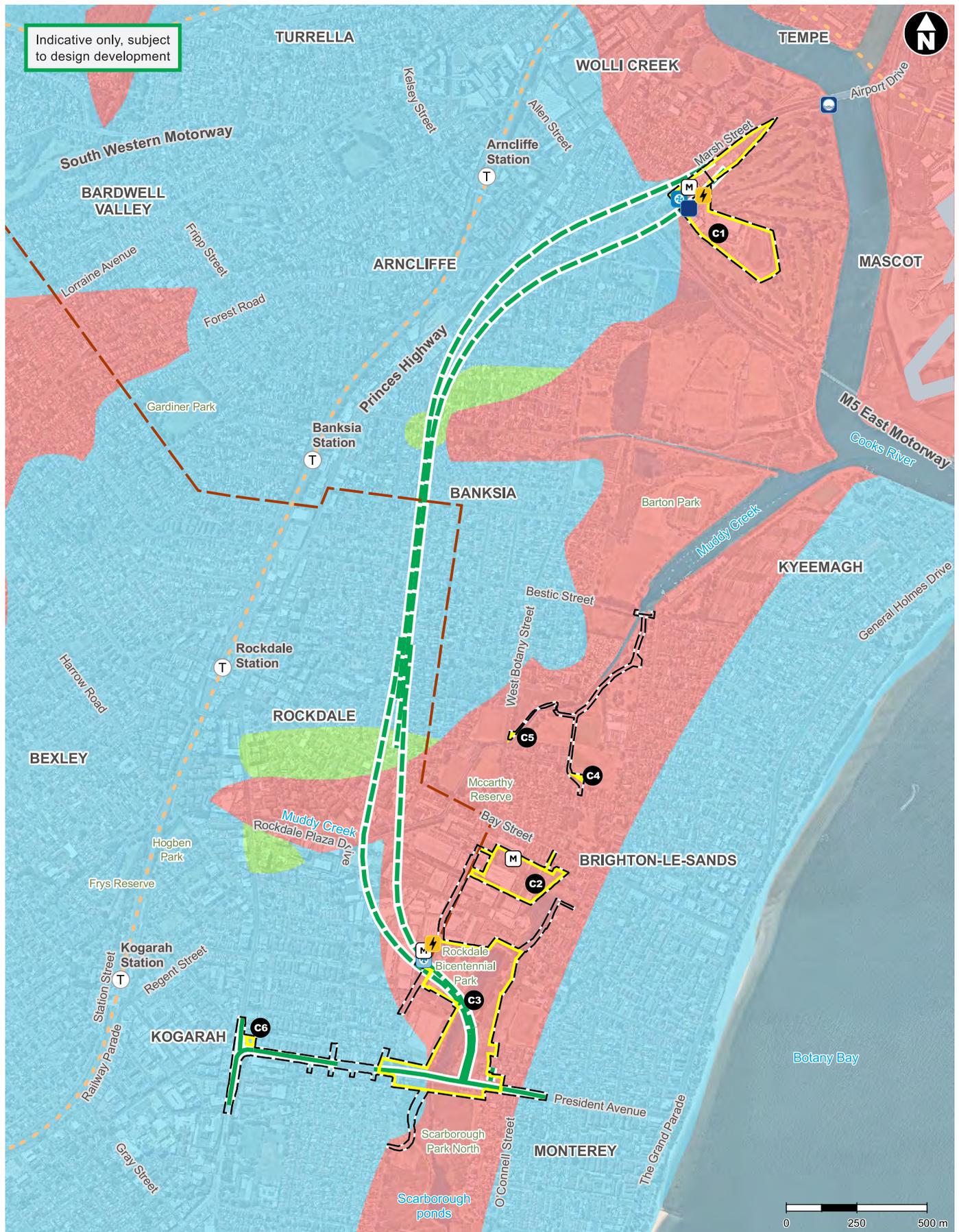


Figure 16-2 Salinity hazard

Acid sulfate soils

Acid sulfate soils are naturally occurring soils containing iron sulphides, which on exposure to air, oxidise and create sulfuric acid. Disturbance of acid sulfate soils and/or potential acid sulfate soils can result in adverse impacts on surface and groundwater quality, flora and fauna, and degradation of habitats.

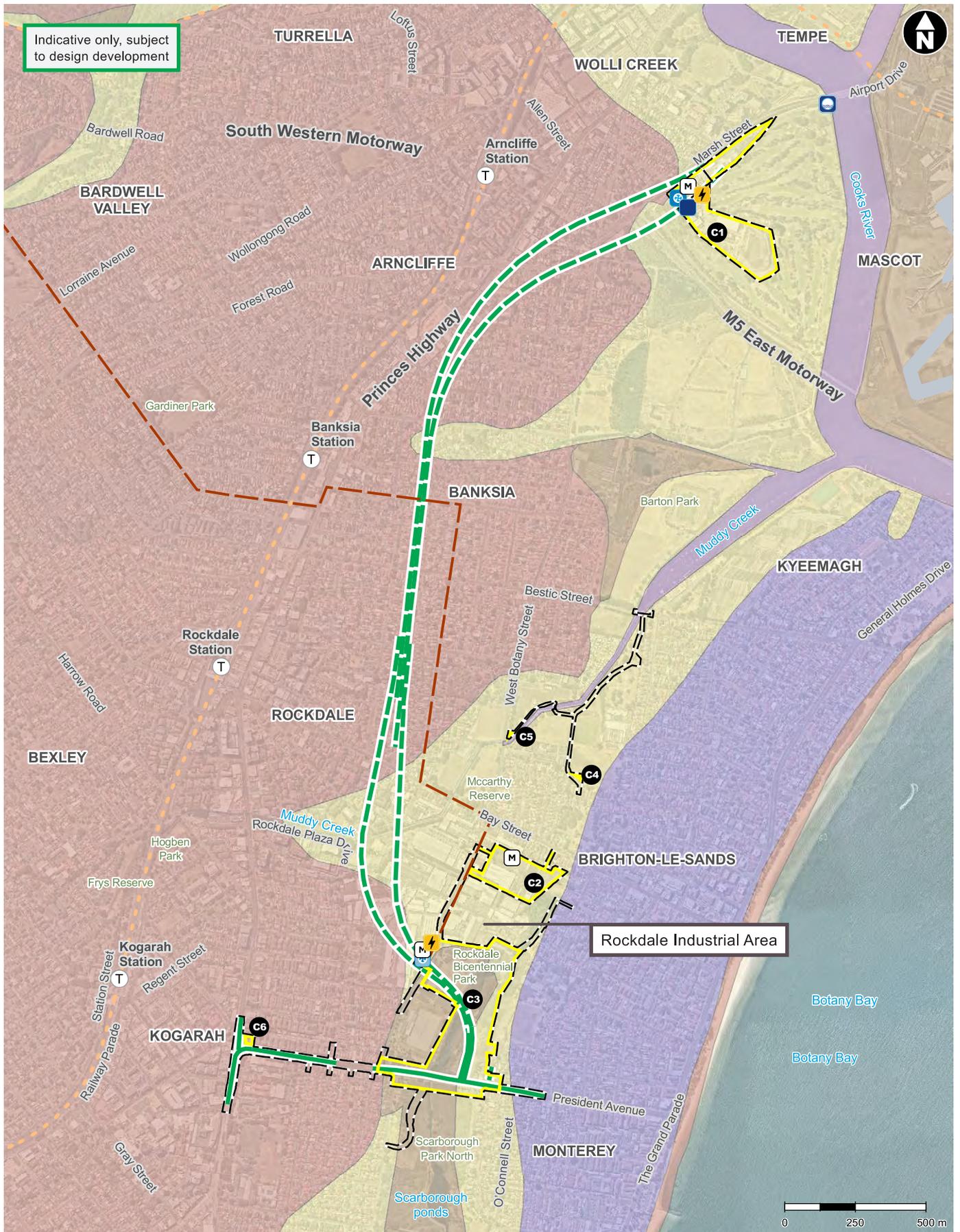
In NSW, land is classified based on the likelihood of acid sulfate soils being present in particular areas and at certain depths. In accordance with the *Guidelines for the Use of Acid Sulfate Soils Risk Maps*⁵, there are five classifications:

- Class 1: Acid sulfate soils are likely to be found on and below the natural ground surface. Any works would trigger the requirement for assessment and may require management
- Class 2: Acid sulfate soils are likely to be found below the natural ground surface. Any works beneath the natural ground surface, or works which are likely to lower the water table, would trigger the requirement for assessment and may require management
- Class 3: Acid sulfate soils are likely to be found more than one metre below the natural ground surface. Any works that extend beyond one metre below the natural ground surface, or works which are likely to lower water table beyond one metre below the natural ground surface, would trigger the requirement for assessment and may require management
- Class 4: Acid sulfate soils are likely to be found more than two metres below the natural ground surface. Any works that extend beyond two metres below the natural ground surface, or works which are likely to lower the water table beyond two metres below the natural ground surface, would trigger the requirement for assessment and may require management
- Class 5: Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres of adjacent Class 1, 2, 3 or 4 land. Works in a Class 5 area that are likely to lower the water table below one metre AHD on adjacent Class 1, 2, 3 or 4 land would trigger the requirement for assessment and may require management.

Acid sulfate soils risk above and around the project, including the tunnel alignment, are shown in **Figure 16-3**. Areas of a high risk of acid sulfate soil occurrence are located in the following areas:

- An area surrounding the drainage line running south and perpendicular to Spring Street (Soil Class 3) into Muddy Creek (between chainage 1700 and 1900)
- The low lying areas along Muddy Creek and in the industrial area at Rockdale (Soil Class 3)
- The low lying areas surrounding Scarborough Ponds including Rockdale Bicentennial Park (Soil Class 2) and further east (Class 3 and Class 4)
- An area within and around the eastern extent of the Bardwell Valley Golf Club at Bardwell Park and
- The low lying areas within the Wolli Creek Valley at Bardwell Park.

⁵ DLWC (1998) *Guidelines for the Use of Acid Sulfate Soils Risk Maps*



The project in tunnel	Substation	Arncliffe ventilation facility*	Class 1	Railway station
The project on surface	Water treatment facility	Rockdale ventilation facility	Class 2	Railway line
Construction boundary	Rockdale ventilation facility	Permanent power supply line	Class 3	
Construction ancillary facility			Class 4	
Motorway operations complex			Class 5	
Operational discharge location				

* Under construction as part of the New M5 Motorway project

Figure 16-3 Acid sulfate soil risk

16.2.2 Arncliffe construction ancillary facility (C1)

Site description and surrounding land use

The Arncliffe construction ancillary facility (C1) would be located above and below ground at Kogarah Golf Course at Marsh Street, within land currently being used as a construction zone for the New M5 Motorway project. The site would be used to support tunnelling works during construction and then as a permanent motorway operations complex during operation. Prior to being made available for use for construction of the project, the construction site for the New M5 Motorway project would be demobilised and the area rehabilitated to a condition that is suitable for use for construction of the project.

The Arncliffe construction ancillary facility (C1) has previously been assessed by the New M5 Motorway EIS. In particular, in Volume 2F, Appendix O Technical Working Paper: Contamination New M5 Environmental Impact Statement prepared by AECOM, 18 November 2015⁶ and WestConnex New M5 Phase 2 Environmental Site Assessment for Kogarah Golf Course⁷. These assessments have been used to inform the following sections.

The surrounding land use is described in **Table 16-3**.

Table 16-3 Surrounding land use – Arncliffe construction ancillary facility (C1)

Direction	Description of surrounding land use and proximity to the site
North	Marsh Street, followed by residential properties of Arncliffe and Cahill Park, followed by the Cooks River, then Tempe Recreation Reserve. Alexandra Canal enters the Cooks River at the northern extent of the site. Wollie Creek enters the Cooks River about 900 metres north of the site.
South	M5 East Motorway, followed by a driving range, lake, cycleway and a sporting field. Muddy Creek and St George Soccer Stadium were located around 400 metres south of the site.
East	The eastern extent of Kogarah Golf Course, Cooks River, followed by Kingsford Smith Sydney International Airport.
West	Eve Street Cycleway, the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS) No.1, M5 East Motorway and road reserve, Marsh Street wetlands followed by residential properties of Arncliffe.

Site history

Key findings relevant to the Arncliffe tunnel site and ventilation facility (prior to the construction of the New M5 Motorway project) include:

- Historical aerial photographs show the majority of the site being used as market gardens until between 1970 and 1981
- Filling of the land immediately to the east, south and north of the site occurred between 1955 and 1961
- Part of the site was being used as market in 1961 gardens. By 1982 the markets gardens had been replaced with the golf course
- A search of the NSW EPA records of notices and list of NSW contaminated sites identified no sites within 200 metres of the project.

Golder Associated Pty Ltd (Golder) previously undertook a Phase 2 Environmental Site Assessment (ESA)⁷ for the New M5 Motorway Arncliffe Construction Compound which includes the footprint of The Arncliffe construction ancillary facility (C1), as well as land to the north and east. The Phase 2 ESA identified the following:

- Subsurface consisted of various compositions of sand, silt and clay with minor inclusions of ceramic, wire, tile and rubber fragments. No observations of soil discolouration or chemical odour were noted

⁶ AECOM (2015) Technical Working Paper: Contamination New M5 Environmental Impact Statement Volume 2F, Appendix O, 18 November 2015

⁷ Golder (2016) Westconnex New M5 Phase 2 Environmental Site Assessment – Kogarah Golf Course, Marsh Street, Arncliffe, NSW

- No exceedances of the human health based assessment criteria with exception of asbestos containing material and friable asbestos identified in one soil sample at 0.5 metres depth (located in the eastern portion of the facility)
- Potential acid sulfate soils were identified to be present within footprint of the facility
- Arsenic and copper concentrations were greater than the adopted assessment criteria in four groundwater samples. As no sources were identified within the soil, it was considered that it may be indicative of background conditions
- Ammonia was detected in all groundwater wells and exceeded the adopted trigger level of 910 µg/L at five of the six locations sampled. Dissolved methane concentrations ranged between <5 µg/L and 2,700 µg/L.

The report *Design Package Report Groundwater Monitoring Progress Report (Project-wide), July 2017 M5N-GOL-TER-100-200-GT-1516-C⁸* was reviewed for data relevant to the Arncliffe construction ancillary facility. Three groundwater monitoring wells are located within the northern portion of the facility, one of which (LDS-BH-2005) was sampled for contaminants including dissolved heavy metals, total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylenes, (BTEX), Polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), organophosphorous pesticides (OPPs), phenols, volatile hydrocarbons, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), Polychlorinated Biphenyls (PCBs) and nutrients. Low concentrations of dissolved arsenic (8 µg/L, chromium (1 µg/L), copper (6 µg/L) and zinc (14 µg/L) exceeded the adopted assessment criteria.

The report stated that high concentrations of ammonia (1.2 mg/L) and dissolved methane (8.8 mg/L) were detected in another monitoring well (LDS-BH-2001) located 200 metres to the south of the Arncliffe construction ancillary facility in Eve Street.

This result was similar to those reported during a Phase 2 Environmental Site Assessment (M5N-GOL-TER-100-200-EV-1671-A) carried out in May 2016 within Kogarah Golf Course.

Further detail on the site history and previous investigations for the Arncliffe construction ancillary facility (C1) is provided in **Appendix J** (Contamination technical report).

16.2.3 Rockdale construction ancillary facility (C2)

Site description and surrounding land use

The Rockdale construction ancillary facility (C2) would be located above and below ground at Rockdale off West Botany Street within the existing Roads and Maritime maintenance depot. The site would be used to support tunnelling, including loading of spoil and spoil removal. To access the mainline tunnels for excavation, it is proposed to excavate and cut-and-cover a decline tunnel from within the site to join the mainline tunnel in the vicinity of the entry and exit ramps. After construction, part of the site would be permanently used as a motorway operations complex.

The surrounding land use of the site is described in **Table 16-4**.

Table 16-4 Surrounding land use – Rockdale construction ancillary facility (C2)

Direction	Description of surrounding land use and proximity to the site
North	Low density residential adjoining to the north, followed by Bay Street (50 metres north), and then more low density residential properties.
South	The proposed ventilation facility on West Botany Street (around 400 metres south-east) part of the President Avenue construction ancillary facility (C3), warehouses and industrial properties.
East	Infrastructure land, comprised of car parking directly adjoining to the north east, open space with vegetation north of the playing fields to the south east, and then medium density residential properties (180 metres east from the centre of the compound).
West	Industrial properties, and West Botany Street (100 metres west from the centre of the compound).

⁸ Golder (2017) Design Package Report Groundwater Monitoring Progress Report (Project-wide), July 2017 M5N-GOL-TER-100-200-GT-1516-C

Site history

Key findings relevant to the Rockdale construction ancillary facility include:

- Historical aerial photographs dating back to 1943 show parts of the site were first used as market gardens and green houses
- Filling of the western portion of the site was visible in 1961 and there also appeared to be filling or earthworks in the southeast and eastern portion of the site in 1970
- Surrounding land uses comprise residential (unchanged to the present on the north and east), and agricultural land to the west and south. The development of the surrounding industrial land to the west and south began after 1951
- The site is within an area where there have been activities delicensed but still regulated by the NSW EPA. They include the Roads and Maritime maintenance depot (across the site) and Vulcan Industries (400 meters north west)
- The closest site currently licenced under the POEO act is the Rockdale Waste and Recycling Centre (Suez) which is located around 400 metres west of the site.

Three boreholes (BH208, BH217 and BH218) investigated as part of an AECOM assessment in 2015⁹ are located within the Rockdale construction ancillary facility. Selected samples from the boreholes were analysed as part of the assessments for heavy metals, TRH, PAHs, OCPs, OPPs, PCBs, asbestos and acid sulfate.

No exceedances of adopted commercial/industrial land use screening criteria were reported in any of the boreholes. Exceedances of the contaminated threshold value for general solid waste were reported for concentrations of benzo(a)pyrene and lead in BH208 and BH218. Potential acid sulfate soils was confirmed in BH217 and indicated in BH218.

Another borehole (BH1313) within the southwest portion of the Rockdale construction ancillary facility was investigated as part of a SMEC assessment in 2018¹⁰. Selected groundwater and soil samples were analysed for heavy metals, TRH, PAHs, OCPs, OPPs, PCBs, SVOCs, VOCs, major cations and asbestos. No exceedances of adopted commercial/industrial land use screening criteria were reported in any of the boreholes. Potential acid sulfate soils were confirmed. The groundwater level at the site is expected to be shallow (less than two metres below the ground surface).

Further detail on the site history and previous investigations for the Rockdale construction ancillary facility (C2) is provided in **Appendix J** (Contamination technical report).

16.2.4 President Avenue construction ancillary facility (C3)

Site description and surrounding land use

The President Avenue construction ancillary facility (C3) would be located above ground at Rockdale Bicentennial Park and the western side of West Botany Street. The site would generally be used to support construction of the cut-and-cover structures for the President Avenue intersection. The site also includes the new ventilation facility (Rockdale ventilation facility) at West Botany Street, south of Lindsey Street and north of French Street at Rockdale.

The site includes part of a service station (7-Eleven) at 734 Princes Highway, Kogarah and a narrow strip of the western boundary of the TAFE NSW St George campus and a substation within the St George TAFE property. Construction works for the Princes highway and President Avenue intersection would include the full or partial demolition of the 7-Eleven service station (including excavation and removal of underground storage tanks (USTs)) and substation within St George TAFE.

⁹ AECOM (2015) Westconnex Stage 2: M5 Factual Contamination Assessment

¹⁰ SMEC (2018) F6 Extension Stage 1 Geotechnical Investigations

The surrounding land use of the site is described in **Table 16-5**.

Table 16-5 Surrounding land use – President Avenue construction ancillary facility (C3)

Direction	Description of surrounding land use and proximity to the site
North	Commercial/industrial properties along Bermill Street and West Botany Street, Rockdale and Rockdale construction ancillary facility (C2).
South	Parkland - Civic Avenue Wetlands and Reserve, residential land use, retail shops on President Avenue and Caltex service station at 29 President Avenue, Kogarah.
East	President Avenue, playing fields, open space, residential properties either side of President Avenue, and then The Grand Parade and Botany Bay.
West	Rockdale Industrial Area (north west), residential properties either side of President Avenue, TAFE NSW St George campus corner of Princes Highway and President Avenue and then Princes Highway and various commercial premises along the Princes Highway.

Site history

Key findings relevant to the President Avenue construction ancillary facility (C3) include:

- The 1943 historical aerial photograph shows a narrow strip of market gardens along the western side of the now Rockdale Bicentennial Park and Ilinden Sports Field along West Botany Street. The remainder of the land appears to be uncultivated
- Filling of different sections of the site began in the 1950s, up to around 2009
- Rockdale Bicentennial Park appeared to be developed into the parklands and sports field in the 1980s
- Prior to the 1980s the Rockdale Bicentennial Park appeared to be swamp
- Moorfield Racecourse was located to the south of President Avenue until after 1956 when it was redeveloped into residential housing, with the eastern section remaining part of Scarborough Park north
- Generally the surrounding land uses have comprised parkland, residential and roadway
- The industrial area of Rockdale to the north and west has been developed and consolidated since 1961
- A search of the NSW EPA records of notices and list of NSW contaminated sites identified no sites within 200 metres of the project
- The closest site currently licenced under the POEO act is the Rockdale Waste and Recycling Centre (Suez) which is located around 500 metres west of the site.

Staged combined geotechnical and contamination investigations were undertaken within the President Avenue construction ancillary facility (C3) boundary in 2016¹¹, 2017^{12,13} and 2018¹⁴.

The soil investigation results indicate that fill containing demolition type waste and waste typical of inert landfills (plastics, glass, metal and timber) is present below Rockdale Bicentennial Park and portions of Civic Avenue Reserve, within the President Avenue construction ancillary facility (C3).

The investigations indicate that concentrations of PAHs, TRH C10-C40, heavy metals, asbestos and acid sulfate soils are present in soil and fill materials above the assessment criteria.

¹¹ SMEC (2017) F6 Northern Geotechnical Investigations – Geotechnical Factual Report – Contract No. 14.2166.0517.0047, 23 February

¹² SMEC (2017) F6 Extension – EIS Section A Phase 1: Groundwater Monitoring Boreholes Geotechnical Factual Report Prepared for Roads and Maritime Services – Contract No. 14.2166.0517-0047, Reference No. 30012460-053-Rev0, 2017, 8 January

¹³ SMEC (2017) F6 Northern SEA Geotechnical Investigations Final Geotechnical Factual Report Prepared for Roads and Maritime Services – Contract No. 14.2166.0517-0047, Reference No. 30012460, 13 September

¹⁴ SMEC (2108) F6 Extension Stage 1 Geotechnical Investigations Draft Geotechnical Factual Report – Contract 17.000302526.1197, Reference No. 30012161-023-RevA-Draft GFR, 23 February

Concentrations of ground gases including methane, hydrogen sulphide, carbon dioxide and carbon monoxide were also detected within the subsurface at Rockdale Bicentennial Park. The results were interpreted as having a risk classification of characteristic gas situation (CGS) 2 (low risk) in accordance with NSW EPA (2012) guidelines. Sites classified as CGS 2 are recommended to have mitigation measures to address the risk of explosive conditions or exposure to the site. The concentrations of hydrogen sulphide also present a potential risk of nuisance odours and risk to health.

Concentrations of ammonia and nitrogen in groundwater were elevated, exceeding the assessment criteria and indicative of typical landfill leachate. Concentrations of heavy metals arsenic, lead and zinc were detected at concentrations slightly above the assessment criteria in groundwater within the fill. Concentrations of TRH, Benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN), volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were detected above the limit of reporting but less than the assessment criteria.

Further detail on the site history and previous investigations for the President Avenue construction ancillary facility (C3) is provided in **Appendix J** (Contamination technical report).

16.2.5 Shared cycle and pedestrian pathways (C4 and C5)

The project would deliver new pedestrian and cyclist infrastructure, in the form of a shared cycle and pedestrian pathways. The shared cycle and pedestrian pathways would be developed from Bestic Street, Brighton-Le-Sands to Civic Avenue, Kogarah via the reinstated Rockdale Bicentennial Park and a shared cycle and pedestrian bridge over President Avenue. The alignment of the shared cycle and pedestrian pathways is shown in **Figure 6-13**. The shared cycle and pedestrian pathways has been considered in two sections which correspond to the northern and southern sections of the corridor as described below.

Shared cycle and pedestrian pathways (north)

The land uses in the northern section of the shared cycle and pedestrian pathways between Bestic Street, Brighton-Le-Sands and Bruce Street, Brighton-Le-Sands comprises of part of Bestic Street and recreational open space including Whiteoak Reserve, C A Redmond Field, Rockdale Women's Sportsfields and Greg Atkins Mini Field.

Construction ancillary facilities for the shared cycle and pedestrian pathways (north) would include:

- Shared cycle and pedestrian pathways east (C4) construction ancillary facilities
- Shared cycle and pedestrian pathways west (C5) construction ancillary facilities

The locations of the construction ancillary facilities are shown on **Figure 7-1** in **Chapter 7** (Construction).

The surrounding land use of the shared cycle and pedestrian pathways is described in **Table 16-6**.

Table 16-6 Surrounding land use – Shared cycle and pedestrian pathways

Direction	Description of surrounding land use and proximity to the site
North	Muddy Creek, Barton Park, Lance Studdert Reserve, residential land use in suburbs of Kyeemagh and Banksia. Market gardens to the north-east and 7-Eleven to the north-west on West Botany Street.
South	Residential land use in the suburb of Brighton-Le-Sands, Bay Park, Bay Street and the C2 ancillary facility.
East	Cairnsfoot Special School, residential land use in the suburb of Brighton-Le-Sands.
West	Residential land use in the suburb of Rockdale, West Botany Street, Rockdale Park, Ador Avenue Reserve and McCarthy Reserve.

Site history

Key findings relevant to the active transport network (north) include:

- The 1943 historical aerial photograph shows that the active transport network (north) and immediate surrounding land was cultivated as market gardens
- A search of the NSW EPA records of notices and list of NSW contaminated sites identified no sites within 200 metres of the project
- The closest site currently licenced under the POEO act is the Rockdale Waste and Recycling Centre (Suez) which is located around 500 metres south-west of the shared cycle and pedestrian pathway.

Further detail on the site history and previous investigations for the shared cycle and pedestrian pathways is provided in **Appendix J** (Contamination technical report).

Shared cycle and pedestrian pathways (south)

The southern portions of the shared cycle and pedestrian pathway fall within or adjacent to the Rockdale construction ancillary facility (C2) and the President Avenue construction ancillary facility (C3) and have been discussed previously in **section 16.2.3** and **section 16.2.4**, above.

16.2.6 Princes Highway construction ancillary facility (C6)

The Princes Highway construction ancillary facility (C6) would be located at Kogarah, on the north-east corner of Princes Highway and President Avenue. The land is currently occupied by 7-Eleven Kogarah.

This construction ancillary facility would be around 1,500 square metres. This site would primarily be used for the laydown and parking of construction vehicles and equipment required for the construction of the President Avenue and Princes Highway intersection upgrade. The site will also include some offices, amenities and workshops.

The 7-Eleven Service Station is currently under assessment by the NSW EPA for contamination. Petroleum soil and/or groundwater contamination is therefore known to be present at concentrations above the relevant assessment criteria. Based on the pathways for exposure to human and ecological receptors during construction, the 7-Eleven Service Station has been assessed as a high risk.

16.2.7 Tunnel alignment

Location description

The mainline tunnel alignment runs from below the Kogarah Golf Course at Arncliffe where it connects to the New M5 Motorway tunnel stubs. It then travels south, to the east of the Princes Highway beneath the suburbs of Arncliffe, Banksia and Rockdale until it emerges in the location of Rockdale Bicentennial Park at Rockdale. Tunnel stubs for the continuation for the future stages of the F6 Extension are located north of Bay Street at Rockdale. The tunnels would comprise two mainline tunnels (about three kilometres in length) in each direction and entry and exit ramp tunnels to President Avenue (about 1.5 kilometres in length). The alignment of the tunnel is shown in **Figure 6-1** and **Figure 6-2** in **Chapter 6** (Project description).

Current potentially contaminating land uses

Current commercial and industrial land uses within 250 metres of the tunnel alignment that could contain potential contaminating activities are listed in **Table 16-7**.

Table 16-7 Current potentially contaminating land uses

Land use	Activity
Numerous Petrol stations	Underground fuel storage
Numerous mechanical workshops and car dealerships with workshops	Use of oils, solvents and underground fuel storage
Arncliffe Fire Station	Fire Fighting Foam residues
23 Field Regiment Royal Australian Artillery	Potential oils, solvents and underground fuel storage
Suez Waste Transfer Stations	Waste management
Numerous manufacturing sites	Manufacturing including plastics
St George metal recovery	Storage of waste oils

Notified and regulated sites

A search of the NSW EPA records indicated that there were no sites currently regulated by NSW EPA under Section 60 of the CLM Act 1997 within 500 metres of the tunnel alignment.

Licensed sites

Current and formerly licensed and delicensed sites within 500 metres of the tunnel alignment are listed in **Table 16-8**.

Table 16-8 Tunnel alignment – currently and formerly licensed and delicensed sites within 500 metres

Property and address	Proximity to alignment	Summary
WestConnex New M5 Motorway tunnels, between Beverly Hills and St Peters, Beverly Hills	Above alignment	Currently licensed under the POEO Act 1997
Sydney Trains, Illawarra railway	124 metres north west	Currently licensed under the POEO Act 1997
Morris, McMahon & Co Pty Ltd, 34 Arncliffe Street, Arncliffe	381 metres north	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage
Bilfinger Berger Project Investments Pty Ltd, M5 East Between Kings Georges Rd, Beverly Hills & General Holmes Drive, Kyeemagh	Above alignment	Former license for road construction
Luhrmann Environment Management Pty Ltd, Robert Orchard and Sydney Weed and Pest Management Pty Ltd, Waterways Throughout NSW	Above alignment (including Muddy Creek and Cooks River)	Former license for Other Activities / Non Scheduled Activity - Application of Herbicides
McConnell Dowell Constructors (Aust.) Pty Ltd	365 metres south east (Cooks River)	Former license for water-based extractive activity, miscellaneous licensed discharge to waters (at any time)
SUEZ Recycling and Recovery Pty Ltd Rockdale Waste and Recycling Centre Lindsay Street Rockdale	Above alignment	Non-thermal treatment and recovery of general waste, as well as storage of all types of waste including hazardous waste (including asbestos)
Jacron Pty Ltd/Vulkan Industries 3 Garnet Street, Rockdale	25 metres east	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage
Roads and Traffic Authority of New South Wales, 422 West Botany Street	Above alignment	Delicensed activity for Hazardous, Industrial or Group A Waste Generation or Storage

Groundwater quality

Groundwater monitoring was undertaken within the study area by SMEC in 2016¹⁵, 2017^{16,17} and 2018¹⁸ as part of the geotechnical and contamination investigations. Samples were collected and analysed for major cations, major anions, electrical conductivity, dissolved and total heavy metals, nutrients, total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes and naphthalene, organochlorine pesticides, organophosphorous pesticides, volatile organic compounds, semi volatile organic compounds, chlorinated hydrocarbons and phthalates.

There were exceedances of the criteria for heavy metals (arsenic, chromium, copper, lead and zinc), ammonia and nitrogen in groundwater from monitoring wells screened within landfill at Rockdale Bicentennial Park, at the proposed location of the cut-and-cover tunnel.

In the alluvium between Arncliffe and Rockdale industrial area, there were exceedances of zinc and ammonia, at lower concentrations than those at Rockdale Bicentennial Park. There were low concentrations of TRH and VOC compounds detected above the limit of reporting in alluvium in wells in the Rockdale industrial area and in Banksia.

In two deep monitoring wells screened in sandstone, there was one exceedance of the groundwater investigation level for fresh and marine water for nickel at Arncliffe. Low concentrations of TRH, VOCs and phenols were detected in the northern most groundwater well in Kyle Street, Arncliffe.

Further detail on the groundwater monitoring results is provided in **Appendix J** (Contamination technical report) and **Appendix K** (Groundwater technical report).

16.2.8 Permanent power supply

Location Description

The permanent power supply route is located between the Ausgrid Canterbury subtransmission substation, and the Rockdale Motorway Operations Complex south.

The power supply would be located underground from the Ausgrid Canterbury subtransmission at Westfield Street, along Mooney Avenue, through local roads until Harthill-Law Avenue in the suburb of Earlwood. It would pass through the local roads of Bardwell Park including part of Bardwell Valley Golf Club and along the edge of Silver Jubilee Park. It would continue along Wolli Creek Road, Kimpton Street through the T4 Eastern Suburbs and Illawarra Line, the Princes Highway and Tarbrett Street in the suburb of Banksia and along Farr Street and Bay Street before connecting to the Rockdale Motorway Operations Complex south at West Botany Street in Rockdale. The surrounding land use along the power supply route is low to medium residential housing.

The power supply would be installed underground, within the existing road reserve with the exception of:

- Ausgrid Canterbury sub-transmission substation, 16A Hansen Avenue, Earlwood
- Across Bardwell Valley Golf Club
- Along the edge of Silver Jubilee Park
- Under the T4 Eastern Suburbs and Illawarra Line.

The existing environment and areas and contaminants of concern for the section of the power supply route between Rockdale Motorway Operations Complex (south) (MOC3) and Princes Highway has been assessed in **section 16.2.4** and **section 16.2.7** respectively.

¹⁵ SMEC (2017)F6 Northern Geotechnical Investigations – Geotechnical Factual Report – Contract No. 14.2166.0517.0047, 23 February

¹⁶ SMEC (2017) F6 Extension – EIS Section A Phase 1: Groundwater Monitoring Boreholes Geotechnical Factual Report Prepared for Roads and Maritime Services – Contract No. 14.2166.0517-0047, Reference No. 30012460-053-Rev0, 2017, 8 January

¹⁷ SMEC (2017) F6 Northern SEA Geotechnical Investigations Final Geotechnical Factual Report Prepared for Roads and Maritime Services – Contract No. 14.2166.0517-0047, Reference No. 30012460, 13 September

¹⁸ SMEC (2108) F6 Extension Stage 1 Geotechnical Investigations Draft Geotechnical Factual Report – Contract 17.000302526.1197, Reference No. 30012161-023-RevA-Draft GFR, 23 February

Table 16-9 Current surrounding commercial and industrial uses

Property identification	Proximity to power supply route	Activity
Earlwood Dry Cleaners & Commercial Laundry 334 Homer Street, Earlwood	130 metres north east and topographically up-gradient	Dry cleaning
Bardwell Park Dry Cleaners 8 Hartill-Law Avenue, Bardwell Park	<3 metres west and topographically up-gradient	Dry cleaning
262 Wollongong Road, Arncliffe	<3 metres east and topographically up-gradient	Former dry cleaning premises
T&G Auto Repairs 270 Wollongong Road, Arncliffe	45 metres west and topographically up-gradient	Mechanical workshop
Nissan Rockdale 371 Princes Highway, Rockdale	<3 metres north and topographically up-gradient	Mechanical workshop
Storage King 373 Princes Highway, Rockdale	<3 metres south and topographically up-gradient	Former Ricketts & Thorp Pty Ltd furniture manufacturers factory

Site history

Key findings relevant to the permanent power supply route include:

- The 1943 aerial photograph showed the same general land uses as the 1916 aerial with the exception of the following:
 - Bardwell Valley Golf course was mostly undeveloped, consisting of uneven terrain with gullies and tracks
 - The retail buildings along William Street, Earlwood and Hartill-Law Avenue and Slade Road, Bardwell Park were not present
 - There was a quarry between Slade Road and the railway that has since been filled and now consists of a public carpark and Slade Road Reserve.
- A search of the NSW EPA records of notices and list of NSW contaminated sites identified no sites within 200 metres of the project
- The Storage King at 373 Princes Highway, Banksia was formally Ricketts & Thorp Pty Ltd furniture manufacturing factory and consisted of workshops and timber yards from 1910s to 1970s.

Further detail on the site history and previous investigations for the permanent power supply route is provided in **Appendix J** (Contamination technical report).

16.2.9 Areas and contaminants of potential concern

The contaminants of potential concern for each area are summarised in **Table 16-10**. Further detail is provided in **Appendix J** (Contamination technical report).

Table 16-10 Contaminants of potential concern

Location	Area of concern	Contaminants of potential concern
Arncliffe construction ancillary Facility (C1)	<ul style="list-style-type: none"> • Historical use of the site for agricultural purposes • Current use of the site as a golf course • Areas of historical landfilling • Migration of potentially contaminated groundwater beneath the site • Acid sulfate soils • Up-gradient commercial/industrial land uses 	<ul style="list-style-type: none"> • Pesticides • Herbicides • Nutrients (ammonia, nitrate, nitrite and phosphorus) • Methane • Heavy metals • Hydrocarbons • Organic Compounds • Asbestos • PCBs • Perfluoralkylated Substances (PFAS) • Acid sulfate soils
Rockdale construction ancillary facility (C2)	<ul style="list-style-type: none"> • Historical use of the site for agricultural purposes • Former, current and surrounding industrial properties (chemical manufacturing) • Soils underlying the site comprising uncontrolled fill • Acid sulfate soils 	<ul style="list-style-type: none"> • Pesticides • Herbicides • Nutrients (ammonia, nitrate, nitrite and phosphorus) • Hydrocarbons • BTEXN • Metals • PCBs • Organic Compounds • Phenols • Asbestos • Acid sulfate soils
President Avenue construction ancillary facility (C3)	<ul style="list-style-type: none"> • Historical use of the site for agricultural purposes • Former, current and surrounding industrial properties (chemical manufacturing, plastics, fertilisers, pesticides/herbicides) • Uncontrolled fill within Rockdale Bicentennial Park and Civic Avenue • Acid sulfate soils • Up-gradient service stations, motor and mechanical businesses 	<ul style="list-style-type: none"> • Pesticides • Herbicides • Nutrients (ammonia, nitrate, nitrite and phosphorus) • Hydrocarbons • BTEXN • Metals • PCBs • Organic Compounds • Asbestos • Landfill gas (methane, carbon monoxide, carbon dioxide, hydrogen sulphide) • Acid sulfate soils

Location	Area of concern	Contaminants of potential concern
Shared cycle and pedestrian pathways (C4/C5)	<ul style="list-style-type: none"> Historical use of the shared cycle and pedestrian pathways for agricultural purposes Former, current and surrounding industrial properties (chemical manufacturing, plastics, fertilisers, pesticides/herbicides) Uncontrolled fill within Rockdale Bicentennial Park, Ilinden Sports Centre and Civic Avenue and within soils underlying the corridor Acid sulfate soils Up-gradient service stations, motor and mechanical businesses 	<ul style="list-style-type: none"> Pesticides Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus) Hydrocarbons BTEXN Metals PCBs Organic Compounds Asbestos Landfill gas (methane, carbon monoxide, carbon dioxide, hydrogen sulphide) Acid sulfate soils
Princes Highway construction ancillary facility (C6)	<ul style="list-style-type: none"> Current use of the site as a petrol station 	<ul style="list-style-type: none"> The 7-Eleven Service Station is currently under assessment by the NSW EPA for contamination. Petroleum soil and/or groundwater contamination is therefore known to be present at concentrations above the relevant assessment criteria.
Along the tunnel alignment	<ul style="list-style-type: none"> Commercial/industrial land uses located above and adjacent to the tunnel alignment particularly Rockdale Industrial area and former commercial/industrial land use along Princes Highway Arncliffe Areas of historical landfilling at Rockdale Bicentennial Park and the lands east of Muddy Creek Historical use pesticides and herbicides in market gardens, waterways in the vicinity of the tunnel alignment and use of fertilisers in market gardens 	<ul style="list-style-type: none"> Heavy metals Hydrocarbons Organic Compounds Asbestos PCBs PFAS Pesticides Herbicides Nutrients (ammonia, nitrate, nitrite and phosphorus)
Along the permanent power supply corridor	<ul style="list-style-type: none"> Ausgrid Canterbury sub-transmission substation Sections of the powerline adjacent and route downgradient to current and former dry cleaners (334 Homer Street, Earlwood, 8 Hartill-Law Avenue, Bardwell Park and 262 Wollongong Road, Arncliffe) Uncontrolled filling within parts of Bardwell Valley Golf Course, a former quarry adjacent to Slade Road in Bardwell Park and West Botany Street Rockdale Former and current commercial/industrial properties on Kimpton Street and Princes Highway, Banksia West Botany Street – surrounding Rockdale industrial area (former, current and surrounding industrial properties including chemical manufacturing) Areas mapped Class 3 for acid sulfate soil risk 	<ul style="list-style-type: none"> TRH BTEX PAHs Metals PCBs VHCs BTEXN TRH PAHs OP/OC Pesticides VOCs SVOCs Asbestos Landfill gases Acid sulfate soils

16.3 Potential impacts – construction

The project has the potential to generate contamination during construction and operation, including the potential to disturb existing contaminated lands at surface works locations.

16.3.1 Soil erosion

Construction of the project has the potential to result in erosion and sediment migration. Surface disturbance and vegetation removal exposes soils and may weaken surface soil structure. This could lead to erosion, sedimentation and soil slippage within and around waterways and slopes in the study area, particularly during periods of high wind or rainfall. Areas of high erosion potential are at a higher risk of being subject to erosion and sedimentation. These areas are identified in **Table 16-2**.

Uncompacted or unconsolidated materials (such as excavated and stockpiled soils) have the potential to leave construction areas during rain (through surface water runoff) causing downstream sedimentation. Sedimentation in natural waterways can result in reduced water quality as well as smothering of vegetation and clogging of the channels, impacting the natural flow paths of the waterway. Potential impacts on surface water quality resulting from soil erosion are provided in **Table 16-11**.

Table 16-11 Potential impacts on surface water quality resulting from soil erosion

Construction activity / source of pollutants	Pollutants of concern	Potential impact	Receiving waterways
Erosion and mobilisation of exposed soils from open cuts, batter slopes and stockpiles by stormwater runoff and wind leading to sedimentation in receiving waterways	Sediment, nutrients, gross pollutants	Increased turbidity, lower dissolved oxygen levels and nutrients which could lead to algal blooms and aquatic weed growth Increases in toxicant concentration Reduced visual amenity (visible gross pollutants)	Rockdale wetland Northern Scarborough Pond Cooks River Muddy Creek
Soil and bank erosion and mobilisation of sediments into receiving waterways during the direct disturbance of waterway bed and/or banks as a result of earthworks and construction of instream structures	Sediment, nutrients and heavy metals stored in bed sediments	Increased turbidity, lower dissolved oxygen levels, increased nutrients which may exacerbate aquatic weed growth and algal blooms, increased toxicant concentrations	Rockdale wetland Northern Scarborough Pond

Erosion and sediment control would be implemented on and around areas of surface disturbance (i.e. surface road works, construction ancillary facility sites and excavation and vegetation removal). Particular emphasis would be given to areas of surface disturbance near waterways, including Rockdale wetland, Northern Scarborough Pond, Cooks River, Muddy Creek and Wolli Creek.

16.3.2 Soil salinity

Salinity impacts occur when salts naturally present in soil or groundwater are mobilised and accumulate to a level that damages the natural and built environment. Salinity impacts could potentially occur during construction of the project as a result of soil disturbance during earthworks and through changes in groundwater levels during tunnelling.

Measures to manage potential soil salinity impacts are provided in **section 16.5**. With the proposed management measures in place potential impacts associated with disturbance of saline soils are considered to be negligible.

Potential salinity impacts associated with groundwater are assessed in **Appendix K** (Groundwater technical report).

Saltwater intrusion from saline tidal water would occur due to groundwater level decline associated with the tunnels for the project. During construction, the slight salinity increase anticipated for the project is unlikely to impact on the environment since the groundwater along the tidal fringe is naturally saline due to tidal mixing.

During operation, initial saline groundwater inflows would represent extremely small inflows and would slowly become a larger proportion of flow over time. Groundwater quality in the tunnel catchment zones would slowly become more saline over thousands of years. Since the operational lifetime for major infrastructure is in the order of 100 years, the slow salinity increase would have minimal impacts on the tunnels, infrastructure and the environment in the short term.

16.3.3 Landfill gases and leachate

Landfill gases and leachate have been identified to be present within Rockdale Bicentennial Park, based on the results of preliminary investigations. The landfill gases and leachate have a potential to cause nuisance odours to the surrounding area during excavation for the construction of the cut and cover tunnel and associated works. The landfill gases also have the potential to accumulate within the subsurface service trenches and pits as well as within aboveground spaces such as buildings and basins.

Further detailed investigation and assessment would be undertaken in order to develop plans for leachate and landfill gas management that may comprise:

- Leachate extraction, storage, treatment and disposal during construction
- Landfill gas drainage and ventilation
- Staging of landfill excavation and spoil management to manage odour impacts
- Landfill gas monitoring of the subsurface at the ancillary facility boundary, of the surface within the ancillary facility and of service pits and trenches within and surrounding the ancillary facility
- Ambient air quality and odour monitoring around the ancillary facility boundary, including the development of site specific action criteria
- Capping and drainage plans for areas not to be excavated within the ancillary facility
- Downstream surface water monitoring during construction (refer to **Appendix L** (Surface water technical report)).

16.3.4 Construction ancillary facilities and surface works

The assessment of contamination impacts for surface works during construction is presented in **Table 16-12**. The construction works to be undertaken at each of the construction ancillary facilities are described in **Chapter 7** (Construction).

The risk ratings presented in **Table 16-12** are prior to the implementation of the management measures identified in **section 16.5**. Following the implementation of management measures, it is anticipated that identified high or medium risk rankings for the construction ancillary facilities and shared cycle and pedestrian pathways would ultimately present a low risk.

Table 16-12 Assessment of construction impacts – ancillary facilities and surface works

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
<p>Arncliffe construction ancillary facility (C1)</p>	<p>Previous investigations completed within the New M5 Motorway Arncliffe Construction Compound, which would be used as the Arncliffe construction ancillary facility (C1) for the project, identified asbestos in fill at one location which exceeded the adopted assessment criteria. Ammonia and methane concentrations in groundwater were identified as a potential concern during construction works, due to the potential for worker exposure to ammonia in groundwater during dewatering and excavation and the potential for methane to accumulate in subsurface structures.</p> <p>The works would include further excavation of the existing access shaft for the construction of the mainline tunnel; and minor excavations at the surface may occur. Temporary stockpiling would also occur.</p> <p>Acid sulfate soil risk is classified as Class 3 and there is a high probability of disturbed terrain. The Phase 2 ESA for the New M5 Motorway confirmed the presence of Potential Acid Sulfate Soils (PASS) within C1.</p> <p>Use of the site as an ancillary construction facility also has the potential for leaks and spills from plant and machinery.</p> <p>Potential pathways of contaminants are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Groundwater extraction and discharge to the receiving environment • Leaching of contaminants to groundwater from stockpiles with contaminants. <p>Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds and/or potential leaks and spills from construction equipment and plant is a potential impact during construction, if appropriate controls and handling procedures are not implemented.</p>	<p>Potentially present at concentrations above the relevant assessment criteria and widespread.</p>	<p>Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).</p>	<p>Medium</p>

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
<p>Rockdale construction ancillary facility (C2)</p>	<p>The area has been used for market gardens and industrial activities and was formerly filled and therefore there is potential for soil and groundwater contamination to be present.</p> <p>Previous limited investigations have confirmed the presence of uncontrolled fill. Soil contamination was not detected above the assessment criteria, however additional investigations would be required to characterise the site adequately.</p> <p>Acid sulfate soil risk is classified as Class 3 and there is a high probability of disturbed terrain.</p> <p>The works would include bulk excavation for the construction of the decline (cut-and-cover) to the mainline tunnels.</p> <p>Potential pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Groundwater extraction and discharge to the receiving environment • Leaching of contaminants to groundwater from stockpiles with contamination. <p>Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds and/or potential leaks and spills from construction equipment and plant is a potential impact during construction, if appropriate controls and handling procedures are not implemented.</p>	<p>Potentially be present at concentrations above the relevant assessment criteria and widespread.</p>	<p>Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).</p>	<p>Medium</p>

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
<p>President Avenue construction ancillary facility (C3) – works within Rockdale Bicentennial Park</p>	<p>Rockdale Bicentennial Park is known to have been used as an uncontrolled landfill and the area is surrounded to the north east by industrial land use which has included a range of manufacturing industries, workshops and garages since the 1950s and 1960s.</p> <p>An investigation of the site indicated that concentrations of some contaminants exceeded accepted limits in soil and fill materials, ground gases and groundwater. These are identified in section 16.2.4.</p> <p>Acid sulfate soil risk is classified as Class 2 and there is a high probability of disturbed terrain.</p> <p>The works would include bulk surface excavation for the construction of cut-and-cover tunnels, entry and exit ramps and surface road construction.</p> <p>Potential pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Groundwater extraction and discharge to the receiving environment • Landfill gas migration and exposure • Generations of odour during excavation and dispersion in wind • Leaching of contaminants to groundwater from stockpiles with contamination. <p>Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds and/or potential leaks and spills from construction equipment and plant is a potential impact during construction, if appropriate controls and handling procedures are not implemented.</p>	<p>Known to be present at concentrations above the relevant assessment criteria and widespread.</p>	<p>Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).</p>	<p>High</p>

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
C3 continued – Rockdale ventilation facility construction area (427 to 441 West Botany Street)	<p>The review of historical information indicates that properties at 427 to 441 West Botany Street, Rockdale have been used for potentially contaminating activities, are within land mapped as disturbed terrain and are mapped Class 3 for acid sulfate soil risk.</p> <p>The works would include bulk surface excavation for the construction of the ventilation shaft. Potential contamination pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Groundwater extraction and discharge to the receiving environment • Generations of odour during excavation and dispersion in wind <p>Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented.</p>	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium
C3 continued – Installation of water pipeline	<p>West Botany Street is surrounded by a range of potentially former potentially contaminating activities and is mapped as disturbed terrain and mapped Class 3 for acid sulfate soil risk.</p> <p>The works would include the installation of a temporary water pipeline from the Rockdale construction ancillary facility (C2) along West Botany Street to the Rockdale ventilation facility. The works would include excavation for the construction of a trench for the water pipeline. Potential contamination pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Groundwater extraction and discharge to the receiving environment • Generations of odour during excavation and dispersion in wind. 	Potentially present at concentrations above the relevant assessment criteria and widespread	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
C3 continued – Construction of the shared cycle and pedestrian pathways, including the shared cycle and pedestrian bridge over President Avenue	<p>The shared cycle and pedestrian pathway intersects Rockdale Bicentennial Park and disturbed terrain to the north and south. Potential contamination pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment • Generations of odour during excavation and dispersion in wind. 	Known to be present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	High
C3 continued – Demolition of houses	<p>The houses to be acquired along the northern side of President Avenue, would be demolished as part of the works. The buildings may contain hazardous building materials (asbestos and lead). Potential contamination pathways are through:</p> <ul style="list-style-type: none"> • Inhalation by construction workers • Off-site transport via dust. 	Hazardous building materials are potentially present.	Exposure pathway for human receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium
Demolition of the substation within St George TAFE	<p>The use of the substation could have resulted in localised PCB and hydrocarbon contamination of underlying soils. The substation may also contain hazardous building materials (asbestos, lead and PCBs). Potential contamination pathways from demolition of the substation are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete during construction (without implementation of appropriate controls).	Medium

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
Shared cycle and pedestrian pathways construction ancillary facilities (C4/C5) and shared cycle and pedestrian pathways (north)	<p>Potential for shallow soil contamination to be present due to:</p> <ul style="list-style-type: none"> • Historical use of the shared cycle and pedestrian pathway for agricultural purposes and the use of pesticides, herbicides and fertilisers • Former, current and surrounding industrial properties (chemical manufacturing, plastic, fertilisers, pesticides/herbicides) • Uncontrolled fill within Rockdale Bicentennial Park, Illinden Sports Centre and Civic Avenue and within soils underlying the corridor • Areas of high risk of Acid sulfate soils • Up-gradient service stations, motor and mechanical businesses <p>Potential pathways are through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to the receiving environment. <p>Use of the site as an ancillary construction facility also has the potential for leaks and spills from plant and machinery. Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds and/or potential leaks and spills from construction equipment and plant, is a potential impact during construction, if appropriate controls and handling procedures are not implemented.</p>	Potentially be present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	Medium
Princes Highway construction ancillary facility (C6)	<p>The 7-Eleven Service Station within the C6 boundary is currently under assessment by the NSW EPA for contamination. Petroleum soil and/or groundwater contamination is therefore known to be present at concentrations above the relevant assessment criteria. The works would require the excavation of soil for the removal of the underground storage tanks (USTs). Potential contamination pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff and discharge to receiving environment • Groundwater extraction and discharge to receiving environment • Generation of odour during excavation and dispersion in wind • Cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds is a potential impact during construction if appropriate controls and handling procedures are not implemented 	Known to be present at concentrations above the relevant assessment criteria.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	High

Area	Potential contamination impacts associated with construction phase	Likelihood of soil or groundwater contamination to be present	Consequence	Risk ¹
Permanent power supply alignment	<p>There may be areas of contaminated soils encountered along the route in areas that have been filled or contaminated from surrounding land use. The soils would be excavated and groundwater dewatering may be required where shallow groundwater is encountered in trenches or directional drilling excavations. Potential pathways could be through:</p> <ul style="list-style-type: none"> • Direct contact, ingestion and inhalation by construction workers • Off-site transport via dust, vehicle/plant movements • Surface water runoff or groundwater discharge and discharge to receiving environment • Generation of odour during excavation and dispersion in wind. 	Potentially present at concentrations above the relevant assessment criteria and widespread.	Exposure pathway for human or ecological receptors likely to be present and complete either now, during or post construction (without implementation of appropriate controls).	Medium

Notes:

1 In accordance with National Environment Protection Council (1999) National Environmental Protection Measure (Assessment of site Contamination) (ASC NEPM), May 2013.

16.3.5 Tunnelling

A review of potential groundwater contamination sources along the alignment identified as medium or high risk based on the presence of potential current and former contamination sources and investigation results are listed in **Table 16-13**. All other areas along the tunnel alignment are considered to be a low risk for significant sources of groundwater contamination.

During tunnel construction, groundwater would be extracted from the tunnelling process, which would require disposal. The extracted water would be either:

- Treated onsite and then discharged to the Cooks River at Arncliffe and to the stormwater system at President Avenue under an EPL or to sewer under a trade waste agreement (TWA) from Sydney Water; or
- Transported to a liquid waste facility for offsite disposal.

There is potential for shallow tunnelling (such as near cut-and-cover tunnels, portals and adits) to encounter impacted groundwater from sources such as petrol stations with dissolved and undissolved petroleum hydrocarbon plumes or other industrial sources. The highest risk location for the project, due to the geology and large area of potential contamination sources, is the Rockdale industrial area and at Rockdale Bicentennial Park.

Dewatering during construction works may cause changes in the migration of plumes of contaminated groundwater, by changing groundwater gradients and drawing the contamination towards the tunnel. This is most likely in areas where the tunnels are shallow and approaching the surface such as the adit at West Botany Street, Rockdale, at Arncliffe (currently New M5 Motorway portal) and the cut-and-cover sections at Rockdale leading towards President Avenue intersection. Dewatering and its potential impacts are discussed further in **Appendix K** (Groundwater technical report).

Potential impacts on receiving water bodies and ecological receptors through the disturbance of contaminated sediments associated with the construction of new drainage outlets and drainage infrastructure adjustments and upgrades could occur at the following locations:

- Cooks River
- Muddy Creek
- Scarborough Ponds.

Potential impacts on workers include exposure to extracted contaminated groundwater from either direct contact or inhalation of vapours or vapours encountered during tunnelling. Impacts would be managed in accordance with protocols outlined in a site specific occupational health and safety plan and safe work method statement specific to the work activity being conducted.

The Arncliffe construction ancillary facility (C1) and the Rockdale construction ancillary facility (C2) would each have a construction water treatment plant to treat construction water and groundwater inflows encountered during tunnel construction. The President Avenue construction ancillary facility (C3) would also include a construction water treatment plant to treat groundwater that is extracted from the cut-and-cover structure during the excavation of the ramps at President Avenue. Construction wastewater from the Arncliffe construction ancillary facility (C1) would discharge to the Cooks River. Where feasible and reasonable, construction wastewater from the Rockdale construction ancillary facility (C2) and President Avenue (C3) construction ancillary facilities would discharge to Muddy Creek or the Cooks River to protect the more sensitive environment of Scarborough Ponds.

Discharge criteria is presented and discussed in **Appendix L** (Surface water technical report), along with further details on construction wastewater treatment. Where feasible and reasonable, construction wastewater would be treated such that discharge concentrations would be equal to or less than the discharge criteria set for the receiving waterways. The criteria have been developed in accordance with ANZECC (2000) as well as with consideration of the relevant NSW Water Quality Objectives.

Table 16-13 Summary of key groundwater contamination sources relevant to proposed tunnelling

Tunnel section	Tunnel description	Identified potential contamination source sites/areas	Risk
New M5 Motorway tunnel to Forest Road Arncliffe to Bay Street, Rockdale	<ul style="list-style-type: none"> Underground connection to New M5 Motorway stub tunnels at Arncliffe in a south-westerly direction at a depth of about 75 metres below ground level (bgl) Installation of stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls (where required) Construction of required retaining structures Depth of mainline tunnels between C1 and C2 is about 60 to 110 metres bgl Ventilation tunnels at a proposed depth of 60 metres bgl 	Kogarah Golf Course and surrounding filled land to the south Former Tempe Bus Depot Up-gradient former and current commercial/ industrial properties (mechanics and workshops) along Princes Highway, Arncliffe	Medium Medium Medium
Bay Street Rockdale to President Avenue ancillary facility	<ul style="list-style-type: none"> Excavation of the construction access decline from the C2 site to the west of West Botany Street, to the Bunnings Warehouse Car Park on West Botany Street and south-west to the northbound entry ramp, from surface to a depth of about 50 metres bgl Installation of stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls (where required) Construction of required retaining structures Depth of tunnels between C2 and C3 is about 60 metres bgl to five metres above ground surface in the location of the north bound and south bound exit ramps Tunnel dive and cut-and-cover structures at the President Avenue ancillary facility (C3) The President Avenue ancillary facility, including entry and exit ramps to connect with the surface road network Stub tunnels to connect to the future stages of the F6 Extension 	Former Goodfellow Dry Cleaners Rockdale industrial area Rockdale Bicentennial Park and surrounding filled land	Medium Medium High

16.3.6 Cumulative impacts

Cumulative impacts on soils and contamination are generally related to the movement of contaminated soil and water across project boundaries. Construction of the project would occur at the same time as other significant projects underway and/or planned in the surrounding area, including:

- WestConnex program of works including the M4-M5 Link, New M5 Motorway and M4 East projects
- Sydney Gateway (project is currently in planning phase)
- Sydney Metro City and Southwest
- Bayside West Precinct
- Muddy Creek naturalisation
- Future stages of the F6 Extension.

Potential construction impacts for these projects are related primarily to the disturbance and management of existing land contamination and discharge of treated groundwater and stormwater. The EISs prepared for M4-M5 Link, New M5 Motorway, M4 East and Sydney Metro – Sydney to Bankstown all included assessment of contamination within the project footprints and provided management measures. These projects are not expected to generate significant new land contamination during construction. However, they are all likely to encounter and disturb existing contamination from past land uses that would require investigation, management and remediation.

The Bayside West Precinct is likely to be developed on a site by site basis and the requirement for contamination assessment under SEPP 55 would be determined during the development application process.

During construction there would be the requirement for remediation works which would result in the disposal of contaminated soil and/or acid sulfate soils to landfill. Further assessment of cumulative impacts associated with transport and waste are discussed in **Chapter 21** (Waste management).

Further assessment of cumulative impacts associated with contamination is in **Appendix J** (Contamination technical report).

16.4 Potential impacts – operation

16.4.1 Soil erosion

During operation of the project, there is potential for recently disturbed soils to be susceptible to erosion, particularly during initial periods of landscaping and re-establishment of vegetation. This may occur in areas where soft landscaping is proposed for the project, including adjacent to disturbed areas, along embankments and in the reinstatement of temporary ancillary facilities, including at Rockdale Bicentennial Park, where topsoil is settling and vegetation is establishing.

Soil stabilisation work may be required following construction to prevent further erosion, topsoil loss or soil migration. This work is likely to be required following severe storms. Measures to manage erosion will be included in the Operation Environment Management Plan (OEMP).

16.4.2 Permanent operational facilities

Potential contamination impacts associated with roads and permanent operational infrastructure such as motorway operations complexes and associated infrastructure (ventilation facilities, water treatment plants and substations etc.) are presented in **Table 16-14**. For the purpose of this assessment, identified operational impacts primarily relate to the potential contamination of soil, surface water and ground water arising from vehicle accidents, leaks and spills on constructed project roadways including tunnels.

The motorway operations complexes are located within the footprint of the construction ancillary facilities. The area of the construction ancillary facilities that are not anticipated to be used for motorway operations complexes would be rehabilitated at the end of construction (refer to **Chapter 14** (Property and land use)).

At the completion of F6 Extension – Stage 1 construction, the landscaping (where applicable) and residual land obligations detailed in the F6 Extension – Stage 1 conditions of approval would be carried out. As such there are no anticipated operational impacts of these construction ancillary facilities during operation and these are not discussed further in this section.

Site layouts showing operational infrastructure are shown in **Chapter 6** (Project description).

Table 16-14 Assessment of operational impacts – motorway operations complexes, shared cycle and pedestrian pathways (north) and permanent power supply

Area	Operation	Potential contamination impacts associated with operation
Arncliffe Motorway Operations Complex (MOC1)	<ul style="list-style-type: none"> • Arncliffe ventilation facility • Water treatment plant • Substation • Fire pump room and water tanks 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Minimal soil or groundwater contamination impacts would be expected from the operation of the substation. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance, if not stored and handled in accordance with regulations.
Rockdale Motorway Operations Complex (north) (MOC2)	<ul style="list-style-type: none"> • Operational Motorway Control Centre • Car parking • Deluge tanks • Workshop and office • Bulky equipment store • Pump station and pump room • Work yard 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance, if not stored and handled in accordance with regulations.
Rockdale Motorway Operations Complex (south) (MOC3) and road infrastructure	<ul style="list-style-type: none"> • Ventilation facility • Car parking • Two substations and power supply • Disaster recovery site • Roadway • Roads, entry and exit ramps and tunnel portals 	<ul style="list-style-type: none"> • Contamination impacts associated with the operation of the project include leaks and spills on constructed roadways from vehicles and vehicle accidents • Minimal soil or groundwater contamination impacts would be expected from the operation of the substation and ventilation facility. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance, if not stored and handled in accordance with regulations.
Shared cycle and pedestrian pathways	<ul style="list-style-type: none"> • Footpaths • Cycleway • Shared cycle and pedestrian bridge 	<ul style="list-style-type: none"> • No contamination impacts associated with the operation of the project.
Permanent power supply	<ul style="list-style-type: none"> • Power supply 	<ul style="list-style-type: none"> • Minimal soil or groundwater contamination impacts would be expected from the operation of the substation. Sources of contamination could be from small volumes of oils, fuels, solvents and other chemicals used for operation and maintenance, if not stored and handled in accordance with regulations.

16.4.3 Tunnels

During operation, groundwater seepage, stormwater drainage at tunnel portals, tunnel wash-down water, fire suppressant deluge or fire main rupture and spillage of flammable and other hazardous materials would be captured by tunnel drainage. The captured water would be treated and discharged to the receiving water bodies. If the discharged water is not treated to the required standard, there could be adverse impacts on water quality of the receiving environments.

As described in **section 16.2.6**, groundwater quality may be impacted along parts of the tunnel alignment due to overlying contamination sources impacting groundwater. As discussed in **Appendix K** (Groundwater technical report), the mainline tunnels have been aligned to minimise intersecting highly permeable material that could result in high groundwater inflows into the tunnels. The proposed tunnel alignment avoids the underlying palaeochannels and unsuitable geology that lies to the east of the project alignment. The horizontal alignment maximises the extent of the project within competent Hawkesbury Sandstone and minimises the alignment traversing immediately beneath sensitive environmental areas, creeks and wetlands to reduce the risk of surface water leakage.

The vertical tunnel alignment dives beneath palaeochannels where possible to reduce groundwater and surface water inflows into the tunnels. Where the project intersects palaeochannels and alluvium, the tunnels would be tanked (undrained) to prevent groundwater inflow in these areas. As such, where present, contaminated groundwater would be unable to enter the tunnels at those locations due to tanked sections. In addition, the proposed depth of the tunnel alignment within the Hawkesbury Sandstone would increase the rock cover and reduce the risk of significant groundwater inflows from potential hydraulic connections with the palaeochannels and surface water systems.

Assessment on the potential impacts on surface water receiving environments and proposed treatment and management is provided in **Appendix L** (Surface water technical report) and **Chapter 18** (Surface water and flooding).

An assessment of the expected groundwater seepage rates and groundwater drawdown which may have an effect on existing or future groundwater contamination plumes is provided in **Appendix K** (Groundwater technical report). Given the tunnel depth, location of the tunnel in relation to the contaminant sources and low predicted inflow rates, the risk of intercepting contaminated groundwater within the Hawkesbury Sandstone is considered to be low. The risk of contaminated groundwater ingress from the alluvium is also considered low because the tunnel is to be tanked in the alluvium, restricting groundwater movement from the alluvium.

16.4.4 Cumulative impacts

The following projects were considered in the qualitative assessment of potential operational impacts:

- WestConnex program of works including the M4-M5 Link, New M5 Motorway and M4 East projects
- Sydney Gateway
- Sydney Metro City and Southwest
- Bayside West Precinct
- Muddy Creek naturalisation
- Future stages of the F6 Extension.

Provided the projects are completed in accordance with conditions of approval, legislation under the CLM Act and in accordance with the NSW EPA guidelines, the projects should reduce the risks of existing land contamination within the project boundaries. Land within these projects is required to be assessed on a site by site basis.

A Phase 2 ESA was completed for the New M5 Motorway Arncliffe Construction Compound¹⁹. Contamination impacts, arising from works undertaken as part of the New M5 Motorway project, are being managed by the implementation of mitigation measures in the Arncliffe Construction Compound Construction Area Plan to manage asbestos in fill and elevated ammonia and methane concentrations identified in groundwater. The mitigation measures being adopted for the New M5 Motorway Arncliffe Construction Compound would be assessed during detailed design to confirm applicability to the construction works.

Further assessment of cumulative impacts associated with contamination is discussed in **Appendix J** (Contamination technical report).

16.5 Management of impacts

The mitigation and management measures provided in **Table 16-15** would be implemented during construction and operation of the project to reduce or minimise the potential impacts discussed in **section 16.3** and **section 16.4**. Further details on the environmental management measures are provided in **Appendix J** (Contamination technical report) and **Appendix L** (Surface water technical report).

These measures will be included in the Construction Environmental Management Plan and Operation Environmental Management Plan for the project and refined during the course of detailed design to further minimise impacts.

Table 16-15 Environmental management measures – soils and contamination

Impact	Reference	Environmental management measures	Timing
Impacts on site workers and/or local community through disturbance and mobilisation of contaminated material	SC1	<p>A Construction Soil and Water Management Plan (CSWMP) will be prepared for the project. The plan will detail the process and measures to manage and monitor soil and water impacts associated with the construction works, including contaminated land.</p> <p>The CSWMP will:</p> <ul style="list-style-type: none"> Describe measures to minimise and /or manage sediment and erosion within the project footprint, including overland flow, including requirements for Erosion and Sediment Control Plans (ESCP). Describe stockpile management measures, including location restrictions, separation of waste types, stabilisation and sediment controls Describe measures for managing waste, including spoil classification and handling Describe procedures for managing unexpected contamination finds Describe procedures for managing groundwater impacts including treatment requirements Describe procedures for dewatering accumulated water on site and within sediment basins, including discharge criteria and sign off Describe spill management procedures including requirements for locating and maintaining spill response materials such as spill kits Detail surface water and groundwater monitoring requirements, including discharge criteria. <p>Measures are to be consistent with the Blue Book (Landcom 2004) and relevant Roads and Maritime guidelines.</p>	Prior to construction

¹⁹ Golder (2016) Westconnex New M5 Phase 2 Environmental Site Assessment – Kogarah Golf Course, Marsh Street, Arncliffe, NSW

Impact	Reference	Environmental management measures	Timing
	SC2	A Hazardous Building Materials Management Plan will be prepared detailing measures to manage the removal of known and unexpected hazardous building materials, including asbestos within buildings and soil. The plan is to be prepared in accordance with relevant guidelines.	Construction
	SC3	<p>Detailed site (contamination) investigations will be undertaken in accordance with the NSW EPA (1995) <i>Sampling Design Guidelines</i> within the following ancillary facilities and construction sites prior to commencement of construction at these sites:</p> <ul style="list-style-type: none"> • Rockdale construction ancillary facility (C2) • President Avenue construction ancillary facility (C3), specifically Rockdale Bicentennial Park and 427 to 441 West Botany Street • Parts of the shared cycle and pedestrian pathways where earth works are required within Civic Avenue, Bicentennial Park, Rockdale Women's Sports Field, Greg Atkins Mini Field, CA Redmond Field and White Oak Reserve • Princes Highway construction ancillary facility (C6), the 7-Eleven service station at 734 Princes Highway, Kogarah • The substation within St George TAFE. <p>Where required, based on the results of the additional investigations, a Remedial Action Plan (RAP) will be prepared prior to construction.</p>	<p>Prior to construction</p> <p>Construction</p>
Impacts on soil and water quality through incorrect handling of contaminated material	SC4	<p>Construction water treatment plants will be established and operated at the Arncliffe Construction Ancillary Facility (C1), Rockdale Construction Ancillary Facility (C2) and President Avenue Construction Ancillary Facility (C3) to treat water from the tunnel works. Discharge from these plants will be managed to achieve the applicable ANECC criteria.</p> <p>Where feasible, water from the water treatment plants will be reused for construction activities.</p>	Construction
Acid sulfate soils	SC5	An Acid Sulfate Management Plan will be prepared detailing processes to manage actual and potential acid sulfate soils disturbed during construction.	Construction
Landfill gas and leachate	SC6	Further detailed investigation and assessment will be undertaken in Rockdale Bicentennial Park in order to develop management plans for leachate and landfill gas management. The purpose of the management plans will be to minimise nuisance odours to the surrounding area during excavation, and to prevent the accumulation of gases in buildings, basins and subsurface service trenches and pits associated with the project. The management plans may include measures such as excavation staging, leachate and gas management, and gas and odour monitoring.	Construction
Erosion and sedimentation	SC7	A soil conservation specialist will be engaged for the duration of construction to provide advice regarding erosion and sediment control.	Construction
Salinity	SC8	Prior to ground disturbance in areas of very high potential soil salinity, testing will be carried out to confirm the presence of saline soils. If saline soils are encountered, they will be managed in accordance with Site Investigations for Urban Salinity (DLWC 2002).	Construction

16.6 Environmental risk assessment

An environmental risk analysis was undertaken for soils and contamination and is provided in **Table 16-16** below.

A level of assessment was undertaken commensurate with the potential degree of impact the project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised (for example, through design amendments). Where impacts could not be avoided, environmental management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the impact after the proposed mitigation measures have been implemented. The methodology used for the environmental risk analysis is outlined in **Appendix O** (Methodologies).

Table 16-16 Environmental risk analysis – Soils and contamination

Summary of impact	Construction/operation	Management and mitigation reference	Likelihood	Consequence	Residual Risk
Impacts on soil and water quality due to disturbance of actual or potential acid sulfate soils and/or acid drainage discharge.	Construction	SC5	Likely	Moderate	Medium
Impacts on site workers and local community through direct contact, inhalation and/or ingestion of dust from contaminated soil or hazardous building materials exposed through ground disturbance and demolition of buildings.	Construction	SC2, HS2	Unlikely	Moderate	Low
Increased contamination in areas through cross contamination associated with the incorrect handling or disposal of spoil/unexpected finds and/or potential leaks and spills from construction equipment and plant.	Construction	SC1	Unlikely	Moderate	Low

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