18. Geology, soils and site contamination

18.1 Overview

The geological conditions and soil profile of the Southern Expressway corridor were investigated along with the effects of the project on existing site conditions in erosion potential, blasting, site contamination and acid sulfate soils.

Current conditions were identified through a combination of desktop analyses, site walkover, a review of previous reports relevant to the project corridor. Investigations on existing ground conditions are also currently underway.

18.2 Legislative and policy requirements

Table 18.1 summarises key legislation relevant to geology, soils and site contamination issues associated with the project.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Description</th>
<th>Relevance to project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Protection Act 1993 (SA)</td>
<td>Overarching environmental legislation that deals with the protection of the environment and environmental offences; administered and enforced by the South Australian Environmental Protection Authority (EPA) Under Part 4 Section 25 of the Environment Protection Act a person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.</td>
<td>Construction and operation of the project must comply with the Act. DTEI has a ‘general environmental duty’ under the Act.</td>
</tr>
<tr>
<td>Environment Protection (Site Contamination) Amendment Act 2007 (SA)</td>
<td>Assigns responsibility for site contamination, establishes a statutory audit system for SA and gives the EPA powers to deal with site contamination</td>
<td>Construction and operation of the project must comply with the Amendment Act</td>
</tr>
<tr>
<td>Environment Protection (Waste to Resources) Policy 2010 (SA)</td>
<td>Provides the regulatory underpinning for South Australia’s Waste Strategy under the Environment Protection Act and promotes the implementation of the waste management hierarchy, improves resource recovery and reduces waste going to landfill</td>
<td>The project will use, where possible, construction materials to reduce volumes transported off site</td>
</tr>
<tr>
<td>Development Act 1993 and Planning Advisory Notice 20/02</td>
<td>Covers planning processes for development sites. A key responsibility of the planning authority is to ensure that a site is suitable for its intended use and does not pose an unacceptable risk to human health or the environment, taking into account the proposed use of the site.</td>
<td>Development must be undertaken in accordance with the Act and the advisory notice of 2001 which reminds planning authorities of their responsibilities for addressing site contamination through the Development Plan Amendment process</td>
</tr>
</tbody>
</table>
18.3 Assessment methodology

18.3.1 Geology and soils

The methodology employed for the assessment of geology and soils for the project was based on:

- desktop review of existing information relating to the regional geology and soils (including acid sulfate soils)
- review of the specialist technical reports and environmental reports prepared for both Stage 1 (Darlington to Reynella) and Stage 2 (Reynella to Old Noarlunga) of the existing Southern Expressway
- structural geological mapping and assessment of soil and rock cuts.

18.3.2 Site contamination

The methodology initiated for the site contamination assessment for the project was based on:

- desktop analysis of the project corridor by reviewing land use and Development Plan zoning, aerial photographs and past specialist technical reports prepared for Stage 1 (Darlington to Reynella) and Stage 2 (Reynella to Old Noarlunga) of the existing Southern Expressway
- kerbside site inspection
- assessment of potentially contaminating activities across the project corridor (based on results of the desktop analysis and site inspection).

18.4 Existing conditions

18.4.1 Physical environment

The Southern Expressway corridor extends from the Main South Road interchange at Darlington through to Reynella and on to Old Noarlunga in the southern region of Adelaide. It covers the foothills
and rocky slopes of the Adelaide escarpment, the Black Earth soils along the flat topped O’Halloran Hill area, rocky hillside slopes leading to Reynella, variable terrain at Panalatinga Road interchange, undulating slopes with rocky outcrops towards Moore Road and undulating slopes south of Moore Road towards Main South Road interchange at Old Noarlunga.

18.4.2 Geology

The 1:50,000 Noarlunga Geological Sheet indicates the area between the Main South Road interchange at Darlington and Moore Road is generally underlain by siltstone of the Tapley Hill Formation (of Proterozoic age and dark laminated siltstone) and various Quaternary sediments; the area south of Moore Road generally lies within the Noarlunga Embayment geological structure.

The Proterozoic rocks are typically faulted, folded and at some locations may have been sheared. The Quaternary sediments range from Pleistocene age Hindmarsh Clay to recent alluvium on the slopes and floodplains.

The Eden–Burnside Fault is located at the northern end of the Southern Expressway corridor intersecting the area bounded by Warriparinga Triangle. South-east of the Noarlunga Embayment is the Clarendon Fault escarpment which forms the hills at Noarlunga. Thin widths of Quaternary alluvium are expected in the immediate vicinity of the Field River and its tributaries.

Quaternary sediments over Tertiary sediments of up to 20–50 metres deep were deposited over the Precambrian bedrock within the Noarlunga Embayment. Near surface geological strata comprise Quaternary slope and plain soil deposits (Christies Beach Formation) or, more commonly, older Quaternary deposits in the form of Hindmarsh Clay.

18.4.3 Regional soils

Based on published information and previous geotechnical investigations, variable subsurface conditions are expected along the Southern Expressway corridor.

The seven major subgrade materials likely to be encountered along the project corridor are: calcareous soils, Hindmarsh Clay, Blanche Point Marl, Tertiary Sand, Black Earth, alluvial soils and weathered siltstone.

The foothills of the Adelaide escarpment are generally underlain by alluvial red-brown earth soils and calcareous clays (RB3 to RB10), Rendzina soils and Terra Rossa soils of the Pooraka Formation which are in turn underlain by sandy clays and interbedded gravels. There are recent alluvial soils near Sturt River and pockets of highly reactive Hindmarsh Clay near Marion Road.

Continuing south along the Adelaide escarpment are skeletal soils over bedrock of the Tapley Hill Formation which comprises laminated siltstone, often pyritic. Further along, the O’Halloran Hill area is underlain by highly reactive Black Earth profiles with some Tertiary laterite overlying the Tapley Hill Formation.

Between Reynella and Moore Road, the project corridor passes through moderately undulating terrain that is underlain at shallow depth by weathered siltstone of the Tapley Hill Formation. A variable calcrete layer is likely to be present overlying the siltstone; Brighton Limestone may also occur in localised zones with thin skeletal soils or Terra Rossa soil profiles expected in these sections. Deeper alluvial soils are expected at locations along the Southern Expressway corridor near Field River.
The Rendzina and Terra Rossa soil profile generally continues from Reynella through to the Main South Road interchange at Old Noarlunga. North of Moore Road to the south of Sherriffs Road there is an increased amount of Black Earth present. South of Sherriffs Road the Rendzina and Terra Rossa soils are intermingled with Brown Solemnised soil profiles.

Calcareous soils encountered in the area may soften and collapse upon inundation when they are dry and of low density. The soils range from variably cemented calcrite of variable thickness and strength (both thickness and horizontal extent) to sandy clays of low plasticity. The calcareous soils also suffer from surface erosion due to their dispersive nature as demonstrated in numerous road and rail cuttings in the area.

Table 18.2 summarises the geological units along the project corridor. Figure 18.1 illustrates the geology and soil along the project corridor.

**Table 18.2** Summary of geological units along the project corridor

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Geological symbol</th>
<th>Typical materials</th>
<th>Dominant soil type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial Deposits</td>
<td>Holocene</td>
<td>Qha</td>
<td>Interbedded clay, silt, sand and gravels, typically encountered adjacent to Sturt River and Field River</td>
<td>AL</td>
</tr>
<tr>
<td>Pooraka Formation</td>
<td>Upper Pleistocene</td>
<td>Qpp</td>
<td>Red-brown clay and sandy clay of medium to high plasticity to about 3 metres depth overlying brown sandy clay with interbedded gravel to a depth of at least 5 metres; the upper red-brown soils are calcareous in places with some rubbly calcrite horizons</td>
<td>RB5, RB3, RB3a, TR, BE</td>
</tr>
<tr>
<td>Undifferentiated Quaternary Deposits</td>
<td>Quaternary</td>
<td>Q</td>
<td>Pooraka Formation clays and red-brown earths; typically covered with a veneer of calcareous soils and calcrite on gently undulating terrain</td>
<td></td>
</tr>
<tr>
<td>Hindmarsh Clay</td>
<td>Lower Pleistocene</td>
<td>TpQlb</td>
<td>Up to 1 metre of black clay of high plasticity overlying green grey to light brown mottled clay of high plasticity which extends to depths of up to 4.5 metres; sandy in places with some calcareous inclusions; the grey green clay is highly fissured with numerous slickensided joints evident</td>
<td>BE</td>
</tr>
<tr>
<td>Port Willunga Formation</td>
<td>Tertiary</td>
<td>T</td>
<td>Sand and gravel to unknown depths (Tertiary Sand); generally dense and may be underlying Hindmarsh Clay; located south of Perry Road</td>
<td></td>
</tr>
</tbody>
</table>
Diamictite; siltstone; pebbly dolomite; orthoquartzite. Glaciomarine
Fluvial-marine sand, Paleocene-Eocene. Based on Te
Marine limestone, Eocene-Miocene. Based on Tn
Quartzite; siltstone; shale; calcareous in part
Sandstone, calcareous; sandy limestone.
Transgressive, shallow marginal marine
Siltstone, laminated; shale; sandstone, heavy mineral lamination, quartzose to fe
Tillite; sandstone; siltstone; arkose;
dolomite; quartzite; conglomerate; shale
Undifferentiated alluvial/fluvial sediments
Undifferentiated glaciogenic rocks
of Arckaringa and Troubridge
Basins, and Alpan

Geology and Soils

Figure 18.1
<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Geological symbol</th>
<th>Typical materials</th>
<th>Dominant soil type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tapley Hill Formation</td>
<td>Proterozoic</td>
<td>Nft</td>
<td>Siltstone: where unweathered comprises laminated dark bluish grey, slightly calcareous, often pyritic siltstone; bedding along alignment typically dips 25° to 35° to the south-west to north-west; the rock has a well developed cleavage (foliation) which typically dips 45° to 60° to the south-east; near the surface the material is weathered light grey brown; the Proterozoic rocks of the southern Mount Lofty Ranges are typically folded and at some locations contain sheared zones</td>
<td>SK, TR, RZ, RB4</td>
</tr>
<tr>
<td>Angepena Formation</td>
<td>Proterozoic</td>
<td>Pha</td>
<td>Siltstone, flaggy, reddish, greenish or grey with associated soil types as for Tapley Hill Formation; exposed near Christie Creek</td>
<td>SK, TR, RZ, RB4</td>
</tr>
<tr>
<td>Brighton Limestone</td>
<td>Proterozoic</td>
<td>Pfh</td>
<td>Limestone, oolitic with a dolomitic surface with associated soil types as for Tapley Hill Formation</td>
<td>SK, TR, RZ, RB4</td>
</tr>
</tbody>
</table>


18.4.4 Erosion potential

Soil erosion can be caused by a number of mechanisms, including:

- wind erosion of exposed soil surfaces
- physical erosion of exposed soil surfaces by surface water runoff, either by sheet flow or line flows
- dispersion of soil surfaces and subsurfaces, caused by surface water runoff and/or subsurface seepage for soils that have an inherent lack of coherence in the presence of water.

Batter slopes (i.e. embankments) in the Calcareous soils and Hindmarsh Clay materials are susceptible to long-term erosion and existing slopes are mainly vegetated or retained.

18.4.5 Site contamination

Historically the entire project corridor is likely to have been in use, at one time or another, as agricultural land. A preliminary review of aerial photographs from years 1949, 1959, 1969, 1979, 1989, 1999 and 2005 confirms the majority of the corridor has generally been undeveloped land mainly used for agricultural purposes.

Existing and previous land uses that may provide a source of potential contaminants in the project corridor are summarised in Table 18.3.
Table 18.3  Existing and previous land uses that may provide a source of potential contaminants

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed control (verges)</td>
<td>Pesticides/herbicides – arsenic, lead, organochlorins, organophosphates, mercury, triazines</td>
</tr>
<tr>
<td>Transformers</td>
<td>Polychlorinated biphenyls, solvents, tin, lead, copper, mercury</td>
</tr>
<tr>
<td>Imported fill</td>
<td>Heavy metals, polycyclic aromatic hydrocarbons (PAHs), asbestos</td>
</tr>
<tr>
<td>Road activities</td>
<td>Total petroleum hydrocarbons (TPH), BTEX (benzene, toluene, ethylbenzene, xylenes), lead, heavy metals</td>
</tr>
<tr>
<td>Former railway line</td>
<td>TPHs, arsenic, phenolics, heavy metals, organochlorine pesticides, organophosphate pesticides, triazines</td>
</tr>
<tr>
<td>Works depots</td>
<td>BTEX, PAHs, heavy metals, organochlorine pesticides, organophosphate pesticides, triazines</td>
</tr>
<tr>
<td>Road construction activities</td>
<td>TPHs, PAHs, heavy metals, organochlorine pesticides, organophosphate pesticides, triazines</td>
</tr>
<tr>
<td>Brickworks</td>
<td>TPHs, BTEX, arsenic, PAHs, hydrocarbons, heavy metals</td>
</tr>
<tr>
<td>Sawmill</td>
<td>TPHs, PAHs, heavy metals, pentachlorophenol, asbestos</td>
</tr>
<tr>
<td>Various workshops</td>
<td>TPHs, BTE, PAHs, heavy metals, asbestos</td>
</tr>
<tr>
<td>Furniture manufacturer</td>
<td>Resins, phenols, formaldehyde, phthalates, asbestos</td>
</tr>
<tr>
<td>Paint manufacturer</td>
<td>Solvents, turpentine, kerosene, pentachlorophenol, PAHs, heavy metals, asbestos</td>
</tr>
<tr>
<td>Farming activities</td>
<td>Heavy metals, organochlorine pesticides, organophosphate pesticides, triazines, TPHs</td>
</tr>
<tr>
<td>Sand and metal depots</td>
<td>TPHs, BTEX, PAHs, heavy metals</td>
</tr>
<tr>
<td>Motorcycle maintenance workshop</td>
<td>TPHs, BTEX, arsenic, PAHs, heavy metals</td>
</tr>
</tbody>
</table>

18.4.6  Acid sulfate soils

Acid sulfate soils is the general name given to soils that contain iron sulfides (pyrite) in their natural state and when exposed to air by drainage or excavation, the iron sulfides oxidise and produce sulfuric acid. Potential acid sulfate soils are soils that contain pyrite but have not yet oxidised as they have not yet been disturbed. Actual acid sulfate soils are naturally pyritic soils that have been disturbed by dewatering and/or excavation and have generated sulfuric acid. The soil itself can neutralise some of the sulfuric acid but the remaining acid moves through the soil, acidifying soil water, groundwater and eventually surface water (Sammut 2000). Acid sulfate soils are widespread in coastal areas in South Australia.

The Atlas of South Australia (www.atlas.sa.gov.au) shows the landward extent of acid sulfate soils in Adelaide appears to be limited to the eastern edge of the coastal areas as well as around the Onkaparinga River. This means the project does not lie in the extent of the coastal acid sulfate soil mapping.
18.4.7 Construction materials

Materials excavated from the earthworks in the project corridor will be used as much as possible as construction materials to reduce volumes transported off site. Waste materials from other DTEI projects, including excavated ballast and subgrade materials from the Rail Revitalisation project (Noarlunga Line upgrade) may also be used on the project. All excavated materials taken from site and waste materials to be reused on site will be required to meet DTEI materials specifications and EPA classification for materials.

18.5 Effects of the project

18.5.1 Soils

Disposal of Black Earth soils will be difficult as these materials are generally unsuitable for use as engineered fill; the soils can be used in landscaping and noise mounds. Batter slopes for Black Earth soils are governed by erosion, dispersive soil behaviour and long-term maintenance but adequate drainage away from the face of the slope, a design height of less than 4.5 metres, and appropriate topsoil and revegetation will be adequate to protect the surface from erosion.

18.5.2 Erosion potential

The project is likely to have an effect on the erosion potential of the road corridor soils as extensive large scale bulk earthworks in the form of excavations and fills will be required. Dry, loose, fine sand is susceptible to wind erosion and these soils types are not generally present in the surface fill and natural soil layers which tend to be clayey in nature. Wind erosion is likely during construction where vegetation has been removed, at loosely heaped stockpiles of soil or where fill of a susceptible type of soil is placed and not immediately compacted. Dust generation during construction will be managed and mitigated to prevent windblown dust and airborne dust settling great distances from the construction area (Chapter 16 – Air quality).

Erosion of soil by surface water runoff is likely to be a significant issue during the construction phase as there will be areas of unprotected earthworks in the form of stripped ground surfaces or excavated or filled slopes. Rivers, creeks and other drainage lines are areas of greatest risk to soil erosion as they are associated with concentrated flow and are more susceptible to gullyning.

The main impact of soil erosion by surface water runoff is loss of material along the project corridor resulting in potential runoff and siltation of downstream receiving environments, in particular surface waterbodies. Rill and gully formation in earthworks and local reduction in slope stability may also develop.

Dispersion of surface and subsurface soils may be an issue where dispersive soils, and surface water or subsurface seepage, are present. The main effect of erosion of dispersive soils are filling and gullying of the soil surface and piping through the soils along seepage lines. This may lead to slope instability and sinkhole formation.

Calcareous soils also have the potential to collapse due to moisture ingress from poor drainage or surface infiltration. Construction of good drainage systems and covering of exposed soils with vegetation or retaining structures reduces their potential for collapse. Calcareous soils under structures will require additional compaction to eliminate their collapse potential.
Test results of site soils from the previous investigations for the Southern Expressway corridor recorded a high number of complete dispersive and some dispersive soils. Once construction is complete the exposed surface area of susceptible soils would be reduced and protected by vegetation or covering, and the potential for erosion would be greatly reduced. The project is not expected to have any adverse effect on the dispersion potential of existing site soils.

18.5.3 Site contamination

As fractured rock hydrogeology is predominant along much of the project corridor, standing water levels in existing groundwater bores can be misleading depending on the connection of fractures in the aquifer and interception of fractures with the bore. Therefore, a substantial difference in the standing water levels can be observed in bores that are relatively close together.

In general, the hilly nature of the project corridor makes shallow unconfined groundwater more likely to be intercepted in low lying areas along the alignment during construction, particularly in close proximity to surface water features.

Based on past and present land uses across the project corridor, a number of areas of interest with the potential to contain site contamination, have been identified. Figure 18.2 illustrates the preliminary site contamination areas of interest. Further detailed contamination assessments are planned for these areas.

Depending on the results of these further contamination assessments, a number of sites may require further detailed investigation before construction.

18.5.4 Blasting

Generally rock cuts in medium to high strength rock will require blasting and cuts in very low to low strength rock are expected to be able to be achieved by a combination of blasting with ripping and dozing. Where the rock strength and weathering is near medium strength and moderately weathered, blasting may be required to loosen the rock to allow its removal.

Blasting may be required at several locations along the project corridor to excavate rocky outcrops. Many environmental effects must be considered, including ground vibration, air blast/noise, fly rock, dust, traffic and storage of explosive materials.

Ground vibration from blasting is the radiation of the mechanical energy created by the explosives in a rock or soil mass. This energy is reflected, refracted, attenuated and scattered through the different rock strata, defects and soil profiles, resulting in a ground vibration at the surface.

Air blast is the pressure wave (sound) generated by the blast which is transmitted through the air and heard by people (and animals). These pressure waves may be reflected by ground structures as well as by atmospheric conditions. Air blast is normally heard after the ground vibration due to the different speeds of the vibration waves. The frequency of the air blast generated also affects people’s perceptions of a blast: low frequency air blasts may not be audible but may cause indoor vibrations; high frequency air blasts may be louder but may generate less indoor vibration.

Australian Standard 2187.2-2006 Explosives – Storage, Transport and Use – Use of Explosives contains guidelines for ground vibration and air blast levels for human comfort and control of damage to structures. The values for human comfort have been chosen by regulatory authorities as used in overseas standards and guidelines.
Areas of interest for further investigation

Preliminary site contamination areas of interest

Figure 18.2
Fly rock is the discharge of fragments (large and small) of rock from the blast which flies outside the area of the blast and may cause damage to people or structures when they land. The control area during a blast, cleared of personnel and equipment, is usually the extent of any potential fly rock.

Dust from blasting is derived from the discharge of fine particles into the air from the blast which may carry outside of the area of blast. The dust may only cause visual impact but in extreme cases may carry large volumes of fine dust particles away from the construction site and deposit dust onto the surrounding surfaces. Blasts conducted in high winds or very dry conditions would be more susceptible to fugitive dust. Best practice blast design and operations will reduce the potential for dust emissions during construction.

The rock formations expected to be blasted in the project area have very low quartz contents and as such dust generated by these blasts are not expected to have high fine grained “free silica” contents (low silicosis potential).

Blasting operations during construction may also increase traffic disruptions, with road closures for the immediate area during blasting periods (30 minutes to one hour per blast).

Blasting for construction works will be generally more controlled, of smaller volumes and of less impact to the surrounds than blasting works for bulk excavations such as mining. The close proximity of the project corridor to nearby houses and stakeholders requires extensive design, planning, management and liaison for all blasts to minimise their impacts.

Areas of potential blasting along the project corridor are highlighted in Figure 18.3.

### 18.5.5 Construction materials

The reuse of excavated materials from the project will reduce the likely importation of virgin or waste materials and the exportation of waste materials from the project corridor. This will reduce traffic movements to and from the construction site, with reduced impacts such as noise, dust, traffic volumes and potential road damage.

All excavated materials to be reused on site will be required to meet DTEI materials specifications and EPA classification for materials. Material won from the excavation works or imported to the site may be crushed, screened and stockpiled in the project site for construction needs.

### 18.6 Mitigation measures to minimise effects

#### 18.6.1 Principles and measures to minimise effects during planning and design

##### 18.6.1.1 Soil management and reuse

Before construction, a comprehensive geotechnical investigation along the length of the project corridor will include boreholes, in situ testing and laboratory geotechnical testing. Assessment of the results will allow a better understanding of the effects on the project of the site soils.

##### 18.6.1.2 Erosion potential

A number of measures will be implemented during the planning and design phase to minimise construction phase erosion impacts. These measures may include:

- specifying that dispersive materials are not to be used in earthworks
- designing permanent surface water drainage systems of adequate hydraulic capacity and with suitable scour protection along flow paths
- minimising flow path gradients and the lengths of any steeply graded flow paths over unsealed surfaces
- designing suitable surface protection measures to any earth slopes, such as a quick growing vegetative cover or a geosynthetic erosion protection product.

18.6.1.3 Site contamination

Activities to quantify the magnitude and extent of any contamination will be assessed during the planning and design phase of the project in order to minimise problems during construction. This will include more targeted intrusive investigations in higher risk areas. An appropriate soil testing program will be undertaken to delineate these potential risks.

Where it is considered possible that an area in the project corridor has been affected by contaminating activities, an appropriate soil testing program will be undertaken to determine the extent of these potential risks.

18.6.1.4 Acid sulfate soils

It is unlikely that acid sulfate soils will be unearthed during construction. Should they be encountered during construction, an acid sulfate soil investigation and risk assessment will provide a basis for consideration of acid sulfate soil issues for the project.

18.6.1.5 Blasting

A building condition inspection is to be undertaken at all nearby properties identified as sensitive to blasting. This survey will assess key features at each dwelling and associated infrastructure potentially affected by the construction process. The emphasis of the inspections is to assess and prepare an inventory of current observed conditions or pre-existing damage.

DTEI will continue to implement a community engagement program to advise of blasting activities and residents who may be impacted by blasting and other general construction activities. The properties for dilapidation surveys will be finalised following detailed design and before construction.

18.6.2 Specific actions to minimise effects during construction

A construction environmental management plan (CEMP) will be developed by the appointed contractor to document environmental controls and measures to be implemented during the construction phase of the project. The CEMP will contain information on environmental controls and measures for soil erosion, blasting, contaminated land management and acid sulfate soil management.

18.6.2.1 Erosion potential

Before construction begins, the contractor will develop an SEDMP, as part of the project’s CEMP, in accordance with the EPA Stormwater Pollution Prevention Code of Practice for Local, State and Commonwealth Government.
Potential blasting areas

Figure 18.3
It will be the responsibility of the contractor to design, construct, operate and maintain drainage and temporary erosion control measures. This will require the contractor to:

- plan and carry out the whole of the construction works to minimise the effects of runoff and erosion on the site and downstream areas (e.g. avoid unnecessary ground disturbance and provide for the proper control of stormwater runoff at every stage)
- ensure that all required runoff, erosion and sediment control measures are in place and comply with their SEDMP before earthworks begin
- establish sediment control structures around all areas prone to erosion including stockpiles, batters and drainage lines, and locate stockpiles away from drainage lines and areas least susceptible to wind erosion or use existing stockpile sites where available
- install temporary measures after completion of earthworks (including batters, drains, cut or fill areas) to prevent erosion and/or control sediment.

All proposed temporary erosion and sediment control measures must be documented in the SEDMP.

As a minimum, the contractor must implement the following measures in order to minimise wind erosion and dust generation from unsealed and disturbed sites in the construction area:

- stabilisation of soil to be stockpiled for longer than a period of one month by grass seeding, covering or other appropriate means
- watering of unsealed work areas by use of a water cart that is available on site at all times, or using wetting agents or polymer binders
- avoidance or minimisation of dust generating activities during dry and windy conditions
- minimisation of the extent of exposed, stripped ground surface until covered with appropriate fill material.

18.6.2.2 Site contamination

For contamination identified during the site investigations and where a potential risk to human or environmental receivers exists, the contractor will develop and implement a contamination management plan (CMP) as part of their CEMP. The CMP will be based on the DTEI specification for managing environmental issues during construction activities, which is in turn based on the EPA Guidelines for Environmental Management of On-Site Remediation.

Where significant site contamination is identified, the CMP must ensure the management strategy adopted is consistent with environmental protection standards.

Typically, for site contamination, the CEMP and CMP will be required to address:

- systems to stockpile and assess any areas of contamination discovered during the construction phase
- management of potentially odorous emissions from wastes or contaminated soil
- provision to protect areas with appropriate sediment and stormwater controls for the stockpiles while they are awaiting sampling and characterisation
- reuse of waste derived fill at off-site locations (in accordance with EPA Standard for the Production and Use of Waste Derived Fill (January 2010))
- occupational health and safety requirements for workers directly involved in excavation of contaminated soils
- provisions to ensure that contaminated soil is not transported off site
- surface water drainage controls to ensure that contaminants are not mobilised off site and surface water resources are protected
- consideration of potential adverse impacts to groundwater quality
- handling and possible disposal of potentially hazardous waste materials
- off-site disposal of contaminated soil to licensed waste repositories
- potential locations for on-site encapsulation agreed with the EPA and documented.

All potentially contaminating materials used during construction will be listed in a Hazardous Materials Register, including storage location details and requirements, proper usage, safe handling procedures and appropriate disposal procedures. All chemical and fuel storage areas and bund facilities will be designed to comply with relevant Australian Standards. Fuels and other chemicals used during construction will be handled in accordance with these standards and accepted industry practice to minimise the risk of spills. Appropriate spill response and containment equipment will be kept at the site in proximity to storage and handling areas. Spills and leaks will be cleaned up and remediated promptly.

18.6.2.3 Acid sulfate soils

Any acid sulfate soils identified during construction will be appropriately managed to ensure no adverse effects on the local environment. If acid sulfate soils are encountered, the mitigation and management measures for controlling impacts will be developed in accordance with the Acid Sulfate Soil Manual (Stone et al. 1998), the EPA Guideline: Site contamination – acid sulfate soil materials (November 2007), and will include best practice in management and monitoring to ensure potential environmental impacts are minimised and controlled.

18.6.2.4 Blasting

Blast design strategies to minimise damage to structures/stakeholders and ensure safe blasting along the project corridor will be implemented.

As a minimum, the contractor will be required to implement the following measures to minimise the effects of blasting in the construction area:

- ground vibration and air blast monitors will be set up at the various points around each blast, at nearby structures and boundaries, to confirm compliance with the relevant Australian Standards, policies and guidelines
- fly rock will be contained in the project corridor using best practice blasting techniques
- fugitive dust will be contained in the project corridor. Blasting will be restricted at times of high wind, dry conditions or inclement weather to reduce the potential for dust to carry outside the project corridor. The free silica content of the dust is expected to be minimal
- traffic around the blast area will be cordoned off and restricted during blasting operations. Traffic disruptions will be limited for a short period around each blast
- no explosive materials will be stored on site during the construction works. Explosives for the blasting will be transported to the site for each blast, in appropriate transport vehicles meeting Australian Standards and local requirements.

18.6.3 Specific actions to minimise effects during post-construction and operation

18.6.3.1 Erosion potential

Measures to minimise erosion effects during operation of the duplicated carriageway will include:

- regular inspection and maintenance of any formal unsealed drainage paths and any earth slopes
- replacement of any degraded slope protection surfaces such as vegetative covers and geosynthetic products.
18.6.3.2 Site contamination

Any site contamination identified in the corridor after construction will require ongoing management and will be included in the operational specification for the road and DTEI’s contaminated materials database for future reference.

18.6.3.3 Acid sulfate soils

No impacts from acid sulfate soils are expected as a result of the operation of the project. Therefore, the only measure likely to be required during the operation phase is ongoing monitoring to ensure that any acid sulfate soil effects arising from construction phase activities (if they occur) are properly managed in the operation phase.

18.7 Conclusion

The main soil and geological hazard that may give rise to effects from the project are erosion and blasting of rock. Most erosion impacts will be associated with the construction phase of the project rather than the planning and design or operational phases.

Erosion may occur at locations of exposed and unprotected soil surfaces in the form of wind erosion, erosion by surface water runoff or subsurface seepage for dispersive soils. The effects may be loss of material and potential slope instability at the area of erosion and subsequent deposition of the eroded material. Erosion control measures will be addressed in the SEDMP, which forms part of the CEMP, and will be prepared by the contractor before construction begins.

A number of areas of interest with the potential to contain site contamination, have been identified. Further detailed contamination assessments are planned for these areas. Site contamination during construction will be addressed and managed in the CMP, which forms part of the CEMP, and will be prepared by the contractor before construction begins.

The majority of impacts resulting from blasting of areas of rock in the project corridor will be associated with the construction phase of the project. Blasting will occur under controlled conditions and management and mitigation measures will be addressed in the CEMP before construction begins.