12. BIOPHYSICAL ENVIRONMENT

This Chapter outlines existing local characteristics (**Section 12.1**) and potential changes to the biophysical environment (**Section 12.2**) of the affected corridor as a consequence of the proposed SSFL, including geology and soils, contaminated/hazardous materials and waste, ground and surface water and biodiversity. **Section 12.3** describes proposed environmental management measures to avoid, minimise or mitigate potential biophysical impacts in the corridor. Precinct-specific issues are addressed (by exception only) in **Chapters 16** to **21**.

12.1 Local characteristics

12.1.1 Geology and soils

A detailed assessment of the existing geology and soils along the proposed SSFL alignment is presented in **Volume 2, Technical Paper 1, Section 1**. Key findings are presented in this Section.

The methodology for this assessment included a desk-top study of the SSFL alignment with reference to the published soil and geological maps and aerial photographs.

Geological units along the route

The 1:100,000 geological series sheets for Sydney, Penrith and Wollongong–Port Hacking indicate that the proposed SSFL route is underlain by unconsolidated Quaternary and Tertiary sediments and Middle Triassic age sedimentary rocks. The Middle Triassic Wianamatta Group is divided into two formations, comprising Ashfield Shale and overlying Bringelly Shale, separated by Minchinbury Sandstone. The Wianamatta Group lies over the Mittagong Formation and Hawkesbury Sandstone. The dominant geological units identified along the proposed route from south to north and the characteristics and general extent of the formations are detailed below in Table 12.1.

Soil landscape characteristics

The proposed SSFL route is underlain by a number of soil landscapes as identified by the NSW Soil Conservation Service. Soil landscapes are defined as 'areas of land that have recognisable and specifiable topographies and soils, that are capable of being represented on a map, and of being described by concise statements' (Chapman and Murphy, 1989; Bannerman and Hazelton, 1990).

The dominant soil landscape units identified along the proposed SSFL route and surrounding areas from south to north are described in Table 12.2.

Table 12.1 Terrain units along the proposed SSFL route

Geological unit	Description of geological unit	Macarthur to Casula Railway Stations	Casula to Carramar Railway Stations	Carramar to Sefton Railway Stations
Quaternary alluvium (Qpn)	• occurs along the main watercourses • nature of the alluvium varies considerably, depending on the lithology of the source material and the distance it has been transported • deposits comprising medium-grained sand, clay and silt • expected within the channel banks or flood plains associated with Prospect Creek, Cabramatta Creek and the Georges River	✓	✓	✓
Quaternary alluvium (Qha)	as above	✓	✓	
Quaternary alluvium (Qal)	as above	✓		
Tertiary sediments (Ta)	• overlie the Wianamatta Group and comprise Pilocene breccia, talus and clayey quatzrose sand alluvium		✓	
Bringelly Shale (Rwb)	• the uppermost unit of the Wianamtta Group and underlies the surface soils • up to 250 metres thick • predominantly comprises fine-grained sediments such as shale, carbonaceous claystone and laminate • thin layers of fine- to medium-grained lithic sandstones are scattered throughout, becoming thicker towards the top	✓	✓	✓
Minchinbury Sandstone (Rwm)	• a relatively thin layer that separates Ashfield Shale from the overlying Bringelly Shale • comprises a fine- to medium-grained lithic sandstone inter-bedded with dark grey siltstone and laminate	✓		
Ashfield Shale (Rwa)	• the lower-most unit of the Wianamatta Group • thickness varies from 45 metres to 62 metres • comprises a lower sequence of black to dark grey shale, claystone –siltstone, which coarsens upwards into fine-grained sandstone –siltstone laminate	✓	✓	✓
Hawkesbury Sandstone (Rh)	• comprises medium- to very course-grained quartz sandstone with minor laminated mudstone and siltstone lenses • beds range from 1.5 metres to 3 metres and occasionally up to 15 metres thick • generally massive or cross-bedded • relatively thin and laterally discontinuous layers of dark grey to black shale. • lenses of siltstone occur throughout, which constitutes approximately 5% of the formation thickness • widely spaced roughly orthogonal joint sets are common	✓		

Source: Based on **Volume 2, Technical Paper 1**

Table 12.2 Soil landscape units along the proposed SSFL route

Soil landscape unit	Geology and soil types	Macarthur to Casula Railway Stations	Casula to Carramar Railway Stations	Carramar to Sefton Railway Stations
Luddenham (lu) - Erosional soil landscape	This soil landscape is underlain by Wianamatta Group Ashfield Shale and Bringelly Shale formations. The Ashfield Shale comprises laminite and dark grey shale. Bringelly Shale comprises shale, calcareous claystone, and laminite. Between these two shale members is Minchinbury Sandstone comprising fine to medium-grained lithic quartz sandstone. Shallow dark podsolic soils or massive earthy clays occur on crests; moderately deep red podsolic soils on upper slopes; moderately deep yellow podsolic soils and prairie soils on lower slopes and drainage lines.	✓	✓	
South Creek (sc) - Fluvial soil landscape	Quaternary alluvium derived from Wianamatta Group shales and Hawkesbury Sandstone. Often very deep layered sediments over bedrock or relict soils. Where pedogenesis has occurred, structured plastic clays or structured loams are found in and immediately adjacent to drainage lines; red and yellow podsolic soils are most common on terraces with small areas of structured grey clays, leached clay and yellow solodic soils.	✓		✓
Blacktown (bt) - Residual soil landscape	Wianamatta Group – Ashfield Shale comprising laminite and dark grey siltstone and Bringelly Shale, which comprises shale, with occasional calcareous claystone, laminite and coal. This unit is occasionally underlain by claystone and laminite lenses within the Hawkesbury Sandstone, such as Duffys Forest Shallow to moderately deep red and brown podzolic soils occur on crests, upper slopes and well drained areas; deep yellow podzolic soils and soloths occur on lower slopes and in areas of poor drainage.	✓	✓	✓
Richmond (ri) - Fluvial soil landscape	Quaternary alluvium comprising sand, silt and gravels derived from sandstone and shale. Poorly structured orange to red clay loams, clays and sands. Texture may increase with depth. Ironstone nodules may be present.		✓	

Soil landscape unit	Geology and soil types	Macarthur to Casula Railway Stations	Casula to Carramar Railway Stations	Carramar to Sefton Railway Stations
Birrong (bg) - Fluvial soil landscape	Dominated by silt and clay sized alluvial materials derived from the Wianamatta Group. Deep yellow podzolic soils and yellow solodic soils occur on older alluvial (terraces); deep solodic soils and yellow solonetzic soils occur on the current flood plain.			✓
Disturbed Terrain (xx) - Disturbed soil landscape	Artificial fill. Dredged estuarine sand and mud, demolition rubble, industrial and household waste. Also includes rocks and local soil materials. Turfed fill areas are commonly capped with up to 40 centimetres of sandy loam or up to 60 centimetres of compacted clay over fill or waste material.			✓
Berkshire Park (bp) - Fluvial soil landscape	Soils are the result of three depositional phases of Tertiary alluvial/colluvial origin. All of the formations are derived from sandstone and clay. Erosion of the surface has led to exposure of all three formations in different locations.			✓

Source: Based on **Volume 2, Technical Paper 1**

Acid sulfate soils

Acid sulfate soils are acidic soil horizons or layers resulting from the aeration of soil materials rich in iron sulfides, primarily pyrite (FeS2) (van Breeman, 1982). They are generally likely to be present in marine and estuarine sediments of the recent (Holocene) geological age, in soils usually not more than 5 metres above mean sea level and in marine or estuarine settings (Environment Protection Authority, 1995).

Soils containing sulfate materials that have been oxidised generally have a pH of less than 4.0 and are termed 'actual acid sulfate soils'. 'Potential acid sulfate soils' are waterlogged soils rich in pyrite that are in an un-oxidised state. They are completely innocuous to the environment if kept un-oxidised or under water. Actual acid sulfate soils overlie potential acid sulfate soils in the Australian coastal and fluvial environment.

The 1:25,000 *Acid Sulfate Soil Risk Maps* (1995) published by the Soil Conservation Service for the Liverpool region indicate that where the proposed SSFL route comes into close vicinity with alluvial and estuarine plains and saturated low-lying areas along the Georges River, Cabramatta Creek and Prospect Creek, there is a risk that acid sulfate soils would be encountered within the soil profile.

There is a high probability of occurrence of acid sulfate soils:

- next to Liverpool Railway Station on the banks of the Georges River
- at Carramar where the existing rail line crosses the Prospect Creek.

There is a low probability of occurrence of acid sulfate soils:

- adjacent to the Georges River from Casula through to Liverpool
- where the existing rail line crosses the Cabramatta Creek.

There are no known occurrences of acid sulfate soils elsewhere along the corridor.

12.1.2 Contaminated/hazardous materials and waste

Contaminated/hazardous materials and waste management issues are assessed in detail in **Volume 2, Technical Paper 1, Section 2**. Key findings regarding existing contamination/hazardous materials in the study area are summarised in this Section.

Potential sources of contamination/hazardous materials in the rail corridor were identified through a desk-top review of ground level and aerial photography, video footage of the rail corridor taken from a train cabin, existing heritage reports, foundation conditions for proposed bridge structures, the ARTC's 'Greenline' database (which details minor environmental incidents between 1996 and 2004) and other relevant background information. RailCorp have advised that there are no known contaminated sites in the proposed construction area. However, this does not preclude the possibility of contamination occurring along the rail corridor.

Table 12.3 summarises potential contamination sources identified along the route of the proposed SSFL.

Table 12.3 Potential contamination sources along the proposed SSFL route

Issue/site	Potential contaminant sources	Potential contaminants
Use of site as a rail corridor	Fuel and oil spills Engine emissions Rail corridor maintenance – unsealed areas (application of pesticides/herbicides) Brake linings Historical cable/pipework ducting	Heavy metals, hydrocarbons (TPH/BTEX/PAHs) Pesticides/herbicides, arsenic Asbestos Asbestos, heavy metals
Previous traffic incident at Narellan Road	Transformer oils	Hydrocarbons (TPH), PCBs
Disposal/deposition of ash within rail corridor	Ash from historical use of rail corridor by steam trains	Heavy metals, hydrocarbons (TPH/BTEX/PAHs)
Refuelling areas and storage of fuels in maintenance depots	Stored fuels	Hydrocarbons (TPH/BTEX/PAHs)
Existing signals	Asbestos cable trays	Asbestos
Historical filling of areas	Ash, imported fill and reworked locals soils	Heavy metals, hydrocarbons (TPH/BTEX/PAHs)
Historical coal storage	Coal	Heavy metals, hydrocarbons (TPH/BTEX/PAHs)
Demolition/deterioration of infrastructure	Older buildings	Asbestos, lead (from lead paint, PCBs, hydrocarbons (TPH/BTEX/PAHs)
Transformers adjacent to corridor	Leaks of transformer oils	Hydrocarbons (TPH), PCBs
Rail bridges and adjacent roadways and car parks	Motor vehicles	Heavy metals (predominantly lead), hydrocarbons (TPH/BTEX/PAHs)
Run-off from storage of diesel and hydraulic oils located in adjacent storage yards	Run-off from storage containers	Heavy metals, hydrocarbons (TPH/BTEX/PAHs)
Rail infrastructure maintenance	Grit blasting and painting of rail bridges	Heavy metals (particularly lead)

Source: Volume 2, Technical Paper 1

12.1.3 Ground and surface water

Assessment scope and method

Groundwater is present in multiple aquifers along the proposed SSFL alignment. Surface water resources along the proposed alignment comprise several major creeks and minor watercourses that cross the existing rail corridor, either by bridge or box or pipe culvert. For the purpose of this Environmental Assessment, PB reviewed preliminary information on local surface waterbodies, drainage structures, groundwater aquifers, their distribution and characteristics.

The scope of works included:

- review of the concept design drawings for the proposed SSFL works
- review of the existing drainage structures along the proposed route
- review of readily available information regarding the sub-surface condition of the track alignment (including topography, geology, and a Department of Natural Resources bore search)
- review of available geotechnical information compiled from geotechnical investigations for the track alignment
- review of the concept design study drainage report (Connell Wagner, 2005).

Local groundwater characteristics were identified through a desk-top review of the following available information:

- bore records within 1 kilometre of the proposed SSFL alignment, to determine the characteristics of groundwater in existing bores (searched on 2 August 2005)
- information regarding groundwater intersected during drilling associated with investigations of the project (bore logs from geotechnical drillings Connell Wagner, 2005)
- geological units present along the route and their characteristics as aquifers.

Surface water resources were assessed from topographic mapping available through the Central Mapping Authority of NSW. Catchment areas were defined from topographic maps. Characteristics of the catchments were also determined in terms of pervious and impervious areas. Rainfall intensities and catchment characteristics were determined from *Australian Rainfall and Runoff* (Institute of Engineers Australia, 1988), and flows from each catchment were determined using the rational method.

Groundwater characteristics

Forty-one registered bores were identified from Department of Natural Resources registered bore information within 1 kilometre of the rail alignment (for bore map see Appendix F). These varied in depth from 1.8 to 215 metres deep. Most of these bores were installed for groundwater monitoring purposes at industrial sites, with seven bores installed for irrigation purposes, three bores for waste disposal and two as test bores for groundwater supply. Groundwater characteristics interpreted from these bore results are described below.

Perched aquifers

Perched groundwater was not specifically noted in the bore search results. However, groundwater perched above the elevation of regional groundwater on layers of fill or clay is expected to be present in local fill materials and soils. In the shale areas of Western Sydney, perched groundwater is known to occur at the contact of soil overlying weathered shale (Department of Infrastructure, Planning and Natural Resources, 2005). Disturbed terrain (modified soil landscape) is mapped in the area extending from Canley Vale to Sefton Railway Stations, where fill material is expected to be present in significant amounts. Perched groundwater is likely to be variably present in this landscape.

Unconsolidated quaternary alluvium deposits

Groundwater may be hydraulically connected to surface water bodies around drainage lines and unconsolidated sedimentary deposits of medium-grained sand, clay/silt and local gravel. Quaternary alluvium deposits occur within the floodplains associated with creeks and/or rivers that are crossed by or adjacent to the proposed SSFL alignment. Surface water may recharge these alluvial aquifers. Groundwater seepage from these unconsolidated deposits may contribute to base-flow in surface water drainages.

Salinity hazard mapping in Western Sydney (Department of Infrastructure, Planning and Natural Resources, 2002b) shows that areas in the vicinity of drainage lines are the highest risk areas for accumulation of elevated salt concentrations in soil and seepage of saline groundwater. In these areas, groundwater is generally closer to the surface and changes in topography may allow seepage of groundwater at the surface, causing surface salinisation. Elevated concentrations of salts in soil and groundwater pose a potential risk of corrosion to building materials. Acid sulfate soils are often developed in these settings around creeks. Further information is provided in **Section 12.1.1** relating to the assessment of geology and soils along the SSFL route.

Alluvial sands are developed around the Bow Bowing Creek (Minto), Glenfield Creek, the Liverpool underbridge around the South Western M5 Motorway overbridge, the Georges River, Cabramatta Creek and around Prospect Creek along the proposed SSFL alignment.

Fractured rock aquifers – shale units

In western Sydney, the Permian weathered and fresh shales of the Sydney Basin stratigraphy (Wianamatta Group - Bringelly and Ashfield Shales) host groundwater aquifers within fractures in the rock. Limited groundwater quality information from the Department of Natural Resources registered bore records shows that groundwater in these aquifers can be moderately to highly saline (3,000–7,000 parts per million).

Fractured rock aquifers – sandstone units

The Hawkesbury and Minchinbury Sandstone units of the Sydney Basin stratigraphy form fractured rock aquifers. These units generally host higher quality, lower salinity groundwater than shale units (which are of marine origin); although, water quality and bore yields can be quite variable. However, limited water quality data from one bore (GW104349) drilled into sandstone within 1 kilometre of the rail alignment indicates that groundwater hosted in the sandstone may be moderately to highly saline (6300 milligrams per litre) in the area underlying the proposed SSFL.

Surface water characteristics

Local catchments

Several creeks and drainage lines are crossed by the proposed SSFL alignment. It is important to consider the upstream characteristics and water quality of these individual reaches. The current catchment characteristics can be broadly divided into two distinct types:

- From Macarthur to Casula, the catchments are a mix of urban and rural, with urban areas gradually replacing the pastures that previously formed the undeveloped land uses of the area.
- North of Casula the catchments are heavily urbanised, with both residential and industrial development contributing to the stormwater run-off characteristics.

River and creeks

Most catchments along the route ultimately drain to the Georges River, which is the major tributary of Botany Bay. Major watercourses within the study area include Bow Bowing, Fishers Ghost, Smiths, Bunbury, Glenfield, Cabramatta, Prospect Creeks and Duck River. Bow Bowing Creek has a constructed and a natural section. Duck River has a constructed form.

The proposed SSFL traverses Bow Bowing creek at three locations; although, most of the route runs parallel to Bow Bowing Creek. This creek joins the Georges River in Glenfield.

Between Casula and Liverpool, the SSFL alignment is close to the western side of the Georges River.

Drainage lines and infrastructure

The main drainage lines crossing the proposed SSFL alignment include Bow Bowing, Fishers Ghost, Smiths, Bunbury, Glenfield, Cabramatta, Prospect Creeks and Duck River. Many other minor crossings also exist and generally comprise of one of the following: single or multiple pipe culverts, single or multiple box culverts, arch culverts, or steel or concrete bridges. The hydraulic capacity at these locations would generally be maintained with the proposed SSFL, this would be achieved in most cases by matching existing drainage structure openings under the widened earth embankments.

Bow Bowing Creek crosses the proposed SSFL alignment at three locations. At the Narellan Road crossing the SSFL would overlay the creek and run parallel to the creek for approximately 250 metres. Campbelltown City Council has proposed straightening of the creek and construction of detention basins to reduce the flooding potential in this part of the catchment.

The SSFL would displace a drainage gully north of the Cambridge Avenue road bridge at Glenfield Junction.

12.1.4 Biodiversity

A detailed assessment of the existing ecology along the proposed SSFL alignment is presented in **Volume 2, Technical Paper 1, Section 2**. Key findings are presented in this Section.

Existing vegetation

Much of the vegetation within the rail corridor has been cleared. This vegetation is dominated by introduced grasses such as *Pennisetum clandestinum, Paspalum dilatatum, Chloris gayana* and *Cynodon dactylon*. Weedy herbs are also common, and remnant and planted trees are scattered within this area.

There are a number of patches of remnant or regrowth native vegetation, including 18 patches of endangered ecological communities. (Cumberland Plain Woodland and Sydney Coastal River Flat Forest) (National Parks and Wildlife Service, 2002a). However, most of the vegetation in these remnants is of low conservation significance due to the level of disturbance and weed encroachment.

Cumberland Plain Woodland

Cumberland Plain Woodland is listed as an endangered ecological community under the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*

This community would have once covered the majority of the rail corridor, however, it now occurs as small disturbed patches of regrowth and remnant woodland with the most significant area within Leacock Regional Park.

Cumberland Plain Woodland is dominated by *Eucalyptus tereticornis* and *E. maculata*. This community has a moderate to high level of weed invasion in the corridor and remnants vary in condition from poor to moderate.

Sydney Coastal River Flat Forest

Sydney Coastal River Flat Forest is listed as an endangered ecological community under the *Threatened Species Conservation Act 1995*. This community occurs on alluvial soils adjacent to rivers and along minor watercourses. It occurs as narrow strips or patches of vegetation along the watercourses within the corridor including Bow Bowing Creek (north of Narellan Road), the Georges River (near Liverpool and south of Casula), adjacent to Cabramatta Creek south of Cabramatta and at Prospect Creek near Carramar.

Existing fauna habitats

Habitat features along the rail route generally include those associated with cleared areas, disturbed regrowth vegetation and riparian habitats. The habitats and species associations within the site are discussed below.

Maintained rail corridor

There are limited habitat features within the rail corridor as the vegetation has been cleared and/or maintained. Areas that have not been maintained may provide foraging habitat and refuge for common reptiles, as well as foraging and nesting habitats for small birds.

Isolated tall eucalypt trees may provide nesting habitats for generalist species of bird and arboreal marsupials, and roosting habitats for microchiropteran bats. These trees generally occur on the outer margins of the rail corridor.

Small open drainage ditches occur generally within track side gullies and other temporarily inundated depressions. In general, these areas are highly modified and have been invaded by introduced vegetation. However, common species of amphibian may occur in these areas.

Remnant vegetation

Small areas of remnant or regrowth vegetation occur at Sefton, Cabramatta, Casula and Glenfield, in the form of narrow, isolated linear strips. Remnant vegetation within the rail corridor at Sefton and Cabramatta occurs as narrow strips approximately 150 to 200 metres long. This vegetation offers limited foraging resources for birds and reptiles, and is unlikely to provide significant habitat for threatened species. Remnant vegetation at Sefton and Cabramatta provides fauna habitats that are in poor condition.

Remnant Sydney Coastal River Flat Forest south of Casula (adjacent to the Georges River) and Cumberland Plain Woodland at Leacock Regional Park (Glenfield) contain habitats that form part of larger areas of urban bushland in moderate condition.

Riparian habitats

Numerous creeks occur near or within the rail corridor between Sefton and Macarthur. Most of the creeks are highly disturbed and modified through weed invasion, rubbish dumping and drainage control works including concreting. The creeks that contain important habitat are:

- Glenfield Creek — poor to moderate condition
- Prospect Creek — poor to moderate condition
- Cabramatta Creek — poor condition
- Macarthur Dam and Creek — poor to moderate condition.

Aquatic ecology

The Georges River is adjacent to the railway corridor between Casula and Liverpool Railway Stations. All the creeks within the study area, including areas adjacent to the proposed SSFL, form part of the Georges River catchment. Most creeks and drainage lines are highly disturbed and modified through weed invasion, rubbish dumping, drainage control works (including concrete-lining) and pollutants from hard surface run-off.

Rivers and creeks containing better quality habitats include the Georges River, Prospect Creek, Glenfield Creek, Cabramatta Creek and the Macarthur Dam and Creek.

Species, populations and communities of conservation concern

A total of 35 threatened species of plant or their habitats have been recorded within 10 kilometres of the proposed SSFL, as identified in **Appendix A, Technical Paper 1**. Several plant species, populations and communities of conservation concern have been identified within the rail corridor, including vegetation communities adjacent to the SSFL. Table 12.4 lists the species and communities which are of conservation significance.

Table 12.4 Plant species and vegetation communities of conservation significance recorded within the rail corridor

Plant species	Significance
Cumberland Plain Woodland	• listed under the *Threatened Species Conservation Act 1995* • listed under the *Environment Protection and Biodiversity Conservation Act 1999*.
Sydney Coastal River Flat Forest	• listed under the *Threatened Species Conservation Act 1995*.
Acacia pubescens	• listed as vulnerable under both the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*.

Source: Volume 2, Technical Paper 1

Threatened plants

Only one threatened plant, *Acacia pubescens*, has been recorded within the rail corridor. Five populations of *Acacia pubescens* have been recorded in the rail corridor. The location of these populations are shown in Figure 9.1 and described in Table 12.5. The table also describes the conservation significance of each population and whether the population would be directly impacted by the proposal.

Table 12.5 *Acacia pubescens* populations

Location	Description	Conservation significance	Impact of the proposal
Between Warwick Farm and Liverpool Railway Stations	The population comprises three dense patches of *Acacia pubescens* within a fenced environmental management area.	High[1]	The proposed works would be in close proximity to this population, however the population would not be directly impacted by the proposal.
Regents Park Triangle	The population occurs on a steep embankment.	Low[1]	This population would need to be removed as part of the proposed works.
Sefton/Birrong	The population occurs within a narrow strip of regrowth vegetation approximately 4 metres wide along the boundary of the rail corridor.	Medium	This population would not be directly impacted by the proposal.

Location	Description	Conservation significance	Impact of the proposal
Birrong, east of Cooper Street	The population occurs as scattered individual plants.	Medium[1]	This population would not be directly impacted by the proposal.
Potts Hill, east of the water supply pipeline	The population comprises three patches of *Acacia pubescens*.	Medium[1]	Although some track work is proposed in the vicinity of this population, the three patches of *Acacia pubescens* would not be directly impacted by the proposal.

[1] Rail Services Australia, 2000
Source: Based on **Volume 2, Technical Paper 1**

Threatened animals

Forty-seven threatened fauna species have been recorded or have potential habitat within 10 kilometres of the SSFL, comprising 6 amphibians, 2 reptiles, 23 birds, 15 mammals and 1 invertebrate (see **Appendix B, Volume 2, Technical Paper 1**).

Two threatened fauna species have potential habitat within the study area: Green and Golden Bell Frog (*Litoria aurea*) and the Cumberland Plain Large Land Snail (*Meridolum corneovirens*). However, despite targeted surveys, these species were not detected within the proposed SSFL corridor (see Section 2.6.2 of **Volume 2, Technical Paper 1**).

Migratory species

Migratory species are protected under international agreements to which Australia is a signatory. Migratory species are considered to be matters of national environmental significance, and are protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

A total of 17 migratory bird species listed under these agreements have been recorded in the study area including areas adjacent to the proposal (see **Appendix B, Volume 2, Technical Paper 1**).

Three migratory species were recorded within the study area: Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*) and Masked Lapwing (*Vanellus miles*).

Critical habitat

Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*. Both the NSW and Commonwealth Director-Generals maintain a register of this habitat. No critical habitats are listed as occurring within the rail corridor.

Corridors and connectivity

Remnant habitats within the rail corridor, including areas adjacent to the proposed SSFL, have been highly fragmented as a result of clearing for industrial and residential development. Vegetation occurring immediately south of Casula Railway Station forms part of a series of fragmented Shale Gravel Transition Forest patches. The terrestrial and aquatic riparian zones of the Georges River that occur at Liverpool and Casula form part of a wider habitat corridor that is important for the regional movement of native animals. Other riparian zones and ephemeral drainage lines are also considered to be important for the movement of wildlife, especially those occurring throughout fragmented and urbanised landscapes.

Conservation significance

All remnant native vegetation within the rail corridor is consistent with a threatened ecological community, either Cumberland Plain Woodland or Sydney Coastal River Flat Forest (Sydney Coastal River Flat Forest is listed under the *Threatened Species Conservation Act 1995* as River-Flat Eucalypt Forest). However, most of the vegetation in these remnants is degraded and has been classified as 'other vegetation' — meaning that it is less than 10 hectares, is not critically endangered and is not a priority for conservation (National Parks and Wildlife Service, 2002b).

Some areas of higher conservation priority have been identified within the rail corridor. Vegetation adjacent to Prospect and Cabramatta Creeks has been identified as 'core habitat' (remnants greater than 10 hectares with canopy cover greater than 10%) and provide a viable network for conservation (National Parks and Wildlife Service, 2002b). Although the vegetation at these sites forms a continuous corridor along the creek it is very narrow and has a high level of weeds.

Vegetation south of Casula is mapped as 'support for core habitat', which means that it provides support to areas of high conservation significance by increasing remnant size, buffering from edge effects, and providing corridor connections. It has been identified as a priority area for conservation and restoration in the region (National Parks and Wildlife Service, 2002b).

The rail corridor also contains small patches of *Acacia pubescens*, a nationally threatened species. Areas containing *Acacia pubescens* or Cumberland Plain Woodland are of national conservation significance. Areas containing Sydney Coastal River Flat Forest are of state conservation significance. Areas containing remnant trees are at least of local conservation significance.

The proposed SSFL passes through Leacock Regional Park, which is of overall national conservation significance as it contains Cumberland Plain Woodland. However, the vegetation likely to be affected within the southern part of the park is in relatively poor condition.

Notwithstanding the above locations of conservation significance, the overall conservation significance of the rail corridor is low due to the limited, fragmented and degraded nature of native vegetation.

12.2 Changes to biophysical environment

12.2.1 Geology and soils

A detailed assessment of potential impacts associated with geology and soils along the proposed SSFL alignment is included in **Volume 2, Technical Paper 1**. This Section summarises the key findings of that assessment.

Geotechnical risk

For most of the proposed SSFL route, conventional engineering methods of design and construction are proposed. However, where the proposed SSFL route passes through lower-lying areas, crosses watercourses or passes through disturbed terrain, a greater level of geotechnical investigation would be required.

A detailed geotechnical investigation would be carried out as part of the detailed design process to address the following issues:

- how easy/difficult soils are to excavate
- stability of excavation batters
- methods to retain excavations and design parameters
- foundation load capacity for the design of structures
- stability of embankments

- trench earthworks, including excavation methods and compaction of backfill
- geotechnical impacts on RailCorp's earthworks and drainage.

Geotechnical issues regarding proposed cut batters, embankments and bridge structures are described below. Further assessment of geotechnical risks associated with specific structures (such as the Glenfield flyover) is also provided below.

The detailed design of cut batters and embankments would be undertaken in consultation with RailCorp to ensure RailCorp's operations and maintenance requirements are addressed.

Cut batters

In order to maintain grade, cut batters at various depths and lengths would be required. The deepest would be the Sefton Park Junction underpass, which would extend to a depth of up to 13 metres.

Cutting profiles along the SSFL route would be designed with the objective of providing long-term stability and preventing slope instability. Local remedial protection measures for rock slopes — such as rock bolts, mesh and shotcrete — could be required, while slope flattening could be adopted in some locations if space permits.

Embankments

Large volumes of fill would be placed along the proposed SSFL route to widen embankments on which the new rail line would sit. Negligible settlement would be essential following construction, to provide acceptable ride safety and comfort levels at the design train speed.

Fill stability would be addressed by adopting fill batter slopes with a maximum grade of 2(horizontal): 1(vertical), and ensuring adequate compaction of the fill materials. Fill embankments would be keyed into the existing sloping ground by benching.

Potential instability in the fill foundation would be addressed by removing deleterious materials and any unconsolidated fill prior to filling, along with proof rolling.

Bridge structures

Bridge structures, such as the Glenfield flyover and other bridges for road or creek crossings, are proposed in a number of locations.

Some of the bridges would have abutments that comprise fill embankments (for example, the Glenfield flyover) where the embankment foundation could potentially comprise compressible alluvial soils. The design of the interface between these bridges and the embankments would need to be assessed during the detailed design stage to avoid or mitigate the potential for differential settlement.

Excavated soils

General construction activities for the proposed SSFL would involve extensive excavation and earthworks. Potential impacts of these excavations during construction include:

- potential effects on the integrity of existing structures from vibration
- lateral and vertical movement of ground and adjacent structures, in particular where existing batters are steep
- stockpiling, storage, transportation and management of spoil
- erosion of soil stockpiles.

Vibration issues and management measures are described in Chapter 11. Excavated soils would be stockpiled and separated into material types. Stockpiles would be bunded and, if required, covered to minimise any run-off or wind blown dust.

Impacts of excavated soils during operation of the SSFL would be negligible.

Acid sulfate soils

As described in **Section 12.1.1**, excavations along some of the proposed SSFL alignment could encounter acid sulfate soils. Potential impacts of this would be:

- disturbance and exposure of actual acid sulfate soils, leading to generation of acid and subsequent dissolved metals
- contamination of the environment and groundwater from leached acid and dissolved metals
- disturbance and exposure of potential acid sulfate soils through excavation or clearing of ground, resulting in oxidation of soils and release of acid into the environment
- adverse effects on man-made structures.

As long as sulfate sediments remain below the watertable where they cannot be oxidised, they would not pose a problem. However, if sulfate sediments were exposed to air — for example in periods of prolonged drought, or when the sediment is drained, excavated or after dredging — problems could occur due to the generation of sulfuric acid.

There is a risk that works conducted in areas containing acid sulfate soils would expose such soils. This includes stockpiled soils and exposed excavations. The overall risk of disturbing acid sulfate soils would be moderate to high at Carramar Railway Station, where there is a crossing of the Prospect Creek.

Localised occurrences of acid sulfate soils are possible along the proposed SSFL alignment, particularly in areas close to high probability occurrences. In these cases, the level of environmental risk would be highly dependent on the ground elevation and depth of occurrence.

Management measures to avoid and/or minimise potential impacts of acid sulfate soils during construction are detailed in **Section 12.3.1**. Potential impacts during operation of the SSFL would be negligible as upon completion of the construction works, any actual acid sulfate soils or potential acid sulfate soils would be stabilised as required by the Acid Sulfate Soil Management Plan that would be prepared to manage construction impacts — see **Section 12.3.1**. Acid sulfate soils disturbed during construction would also be monitored following completion of construction works as described in **Section 12.3.1**.

Erosion and sedimentation

Without careful management, the large volume of earthworks proposed for the project has the potential to cause erosion and sedimentation problems in areas close to rivers and streams. Methods such as drainage ditches, covers, terracing, contour cultivation, fences, soil stabilisation, and straw, hay or artificial turf would be used to control soil erosion and sedimentation during construction and operation of the proposed SSFL.

An Erosion and Sedimentation Control Plan would be prepared to describe these measures in detail. The Plan would be incorporated as a sub-plan of the overall Construction Environmental Management Plan (see **Section 12.3.1**).

Along the proposed SSFL route, there is potential for erosion and associated sedimentation of creeks and watercourses, particularly during the construction phase when carrying out activities such as: clearing of vegetation, construction of access paths, excavation for cuttings and foundations, stockpiling of soils and construction of fill embankments. Although the route has previously been cleared, there is potential to expose previously protected soil layers during clearing and grubbing, and excavation.

Potential impacts of erosion and sedimentation include:

- erosion of topsoil and exposure of buried structures
- reduction of air and water quality
- clogging of creeks and rivers
- increased turbidity levels in creeks and rivers.

A number of measures would be implemented to control soil erosion and sedimentation as detailed in **Section 12.3.1**.

Glenfield flyover/Glenfield Waste Facility

The proposed Glenfield flyover would be located on the site of the Glenfield Waste Facility, where it is understood that sand mining and building (and other non-putrescible) waste disposal currently occurs. The presence of this waste facility could have the following geology/soil implications for construction of the proposed Glenfield flyover:

- differential settlement of the landfill and embankments
- instability of the landfill due to load effects from construction activities
- difficulty with installation of piles due to negative skin friction
- disposal of potentially contaminated excavated material
- potential impacts on the integrity of the landfill lining and leachate management, if part of the landfill design.

Any soils removed and requiring re-use or disposal to landfill would require testing to determine their contamination status. As discussed in **Section 12.1.2**, there is a possibility that contaminated soils would be encountered adjacent to the Glenfield Waste Facility.

Operational impacts associated with the presence of the Glenfield Waste Facility next to the Glenfield flyover would be negligible.

Sefton Park Junction and other cuttings

A number of cuttings are proposed along the alignment of the SSFL. The deepest cutting would occur at the Sefton Park Junction underpass, particularly adjacent to Wellington and Tewin Roads. At that point the underpass would be excavated within batters falling at 1(horizontal):4(maximum vertical).

Potential impacts associated with the Sefton Park Junction excavation and other cuttings along the SSFL would include:

- intersections of the groundwater table
- contamination and pollution from adjacent land
- lateral and vertical movement of the ground and existing rail tracks
- spoil management issues.

To manage groundwater issues, groundwater levels in cuttings would be confirmed to assess the likely impact of excavations on the groundwater (see **Section 12.3.3**).

To manage contamination and pollution impacts, a Phase 1 Contamination Assessment would be undertaken (see **Section 12.3.2**).

The possible effects of lateral and vertical movement of the ground and existing rail tracks located adjacent to excavations/cuttings should be managed by the design and construction of adequate excavation support. Soil slopes should be supported by engineer designed retaining walls or laid back to stable grades, while rock cuttings should be supported by an application of shotcrete and/or rock bolts, where considered necessary.

Spoil is surplus material from excavations. Given the number of cuttings proposed, a large volume of spoil is expected to be generated along the route. This would have impacts associated with the storage and transportation of spoil. Storage of spoil would affect land required for stockpiling, may have potential sedimentation issues and could deteriorate air quality in some areas. Given the 97,000 cubic metres of spoil that would be generated from excavations, there would be associated truck movements in the local road network along the route, impacts of which are discussed in **Chapter 10**.

Where possible, spoil would be selectively stockpiled in areas where compressible soils exist and embankments are to be constructed, to pre-load the soils and reduce settlement issues.

North of Liverpool Railway Station

Between Liverpool Railway Station and the existing level crossing at Liverpool Hospital to the north, the proposed SSFL alignment is located close to the crest of a steep bank of the Georges River. The river bank at this location is likely to comprise alluvium, and falls at about 45 degrees with rock approximately 20 metres below surface level. At this location, the SSFL would be constructed on a slab wholly supported by piles founded on rock. There is a high probability of encountering acid sulfate soils in this area.

Potential impacts associated with construction activities at this location include:

- land instability due to loading the crest of the steep soil slope with construction equipment
- potential scouring of the embankment due to concentrated water flows, with associated erosion and sedimentation impacts
- disturbance and release of acid sulfate soils during piling activities.

The potential impacts during operation at this location include scouring of the river bank during a severe flood event, leading to undermining of the rail line. While this will not affect the operation of the rail line (as it will be built on a pile supported slab), the effects will be a reduction in the visual amenity and the possible release of acid sulfate soils into the river.

12.2.2 Contaminated/hazardous materials and waste

Contaminated/hazardous materials

Based on the review of available information, no specific contaminated sites have been identified. However, taking into account the existing concept design and construction methods, the major contamination issues during construction of the proposed SSFL would include:

- demolition, relocation or refurbishment of any existing buildings that may contain asbestos and/or lead paints and the associated management and disposal of associated hazardous materials
- removal or realignment of railway lines, ballast and infrastructure. (The ballast is likely to be contaminated with a range of petroleum hydrocarbons, metals and potentially asbestos.)
- demolition or upgrading of existing bridges that may have been treated with lead based paints
- addition of potentially contaminated fill to existing embankments and behind proposed retaining walls
- importation of potentially contaminated new ballast and fill
- leaks or spills during the protection or relocation of existing services and utilities (e.g. sewage, wastewater and gas)
- relocation or removal of existing signal cables, which may also have associated asbestos cable trays
- excavation of new drainage lines and pits, which may uncover subsurface contamination
- protection of the health of the public and construction workers
- management of excavated materials, including odours, dusts, run-off and sediment controls.

Vapours and odours in excess of those typically expected or present may arise in areas where contaminated materials are present, or areas adjacent to contaminating land uses (e.g. the industrial uses through the Campbelltown local government area).

The potential exists for contaminated material to be encountered along the proposed SSFL alignment. At this stage, and without laboratory analysis of soils or further site inspections, specific areas of contamination cannot be identified.

Based on the usual activities associated with the operation of a freight line, potential contaminated soils or hazardous materials impacts during operation of the proposed SSFL include:

- spillage of lubricants and fuels from engines and carriages
- possibility of major spillages from trains and maintenance plant and vehicles
- use of herbicides to control weeds along the railway line
- atmospheric deposition of particulates generated by emissions from maintenance plant and vehicles travelling along the maintenance access road or travelling on the railway line
- metals contamination from abrasion of wheels on tracks
- possible lead dust emissions from refurbishment or deterioration of buildings and infrastructure.

Measures to manage and minimise potential impacts are described in Section 12.3.2.

Generation of waste

Construction and operation activities have the potential to produce solid and liquid waste streams.

Approximately 158,775 cubic metres would require excavation as part of the works (Connell Wagner, 2005). The material would be sourced mainly from cuts within the Sefton to Cabramatta and also the Ingleburn to Macarthur sections of the corridor. Of this material, approximately 61,355 cubic metres would be suitable for re-use and 97,420 cubic metres would require disposal off-site (see Section 4.2.1).

All suitable earthworks cut would be re-used on-site as fill embankments and selected subgrade layers. Where practicable, geotechnically suitable materials would be re-used on-site for batter extensions. Topsoil would be re-used on-site for landscaping. The 97,420 cubic metres of unsuitable excavated material (comprising soil, clays and softer rock types which are unsuitable for use in formation construction) would be the major waste stream generated during construction.

A secondary waste stream during the construction phase would be green waste, generated from clearing and grubbing activities. The total volume of green waste generated is difficult to estimate as the vegetation cover varies over the proposed alignment. Initially, any areas of timber resources would be identified for harvesting. Material not suitable for harvesting would be mulched, chipped or re-used on-site for sediment filter fences, where appropriate.

Other forms of construction waste would include building waste generated from the limited demolition activities required. This is likely to include timber (some of which may be lead painted), scrap metal and packaging material.

Operational waste would comprise waste generated from maintenance activities and rail line users. Maintenance wastes such as oils and greases would be disposed of to an appropriate facility. Waste generated by rail users would be collected by the relevant maintenance organisation. Wastes would be either recycled, or disposed of to an appropriate facility.

A summary of typical waste streams associated with construction and operation of the proposed SSFL is provided in Table 12.6.

Table 12.6 Typical waste streams

Construction	Typical waste stream
Waste type	Concrete, green waste, asphalt and gravel, wood, assorted excavated material unsuitable for construction works, waste oil/grease, metals, paper/cardboard packaging, plastic wrapping/containers, food and other miscellaneous wastes. Building materials (including asbestos, lead painted timbers and wastes).
Estimated quantity	Unsuitable excavated materials — approximately 97,420 cubic metres Suitable building materials — approximately 61,350 cubic metres.
Operation	**Typical waste stream**
Maintenance activities	Pesticides, green waste, sediments and pollutants contained in water quality control ponds, oils and greases, paper, cardboard, plastic wrapping, containers and other miscellaneous wastes.
Freight line users	Gross pollutants and litter (aluminium cans, glass bottles, paper and cardboard packaging, food and other putrescible waste), heavy metals, oils, surfactants, toxic organics, nutrients.

Source: Volume 2, Technical Paper 1

Waste management and mitigation measures are described in **Section 12.3.2**.

12.2.3 Ground and surface water

Assessment scope and method

This section provides an assessment of potential impacts of the proposed SSFL on ground and surface water resources. The objectives of the groundwater assessment were to:

- identify any management issues relating to construction and operation of the proposed SSFL and potential impacts on groundwater
- identify requirements for additional investigation works to further characterise groundwater occurrences
- identify potential impacts from changes to the existing rail line configuration and measures to mitigate impacts.

The objectives of the surface water assessment were to:

- assess major impacts on surface water catchments caused by the construction and operation of the proposed SSFL
- assess surface water quality issues that may arise through construction and operation of the proposed SSFL
- identify mitigation measures, safeguards and further investigations that would be undertaken.

Potential impacts to groundwater were evaluated considering the implications of the proposed construction on likely groundwater occurrence.

For the surface water assessment, culverts were sized using standard culvert techniques for each major watercourse crossing the proposed SSFL. Surface water quality is of limited concern for railway lines during their operational phase, as there is generally limited opportunity for contaminants to discharge into the surface water environment. During construction, however, the extent of soil movement during the earthmoving operations would require careful management. The assessment, therefore, focuses on identifying water quality management requirements during construction.

Concept design strategy to manage local flooding

Local flooding due to the presence of the railway corridor is currently avoided by the installation of culverts, bridges or other drainage structures. The capacity of existing drainage structures and the need to upgrade these structures for the proposed SSFL was considered during the concept design development to manage local flooding issues. In general, the existing structures would need to be extended through the rail embankment to maintain existing capacity as part of the SSFL proposal. In some instances, an increase in the drainage capacity of existing drainage structures would be required to facilitate the increased flows caused by catchment development or changes in design criteria. Where the latter is necessary, the additional capacity would be constructed under the proposed SSFL line only, and the increase in capacity under the RailCorp section of the corridor would be the responsibility of RailCorp to undertake during future upgrading works.

Impacts during construction

Groundwater

Section 4.2.3 provides details on the construction of culverts and bridges over creek crossings are outlined in **Section 4.3.4**.

Prior to construction, impacts of changes to the groundwater system would be assessed by the installation of piezometers to establish water levels and evaluate water quality. An assessment of potential groundwater dependent ecosystems would also be undertaken to evaluate effects of construction in any such areas. Where groundwater is close to the surface, construction could also have implications for surrounding infrastructure.

The primary impact on groundwater during construction would probably be any de-watering required for deeper excavations for culverts, cuttings or bridge footings. As groundwater encountered may be of poor quality (with salinity of greater than 2,000 milligrams per litre of total dissolved solids), disposal of groundwater could require special consideration (such as permission from Sydney Water to dispose to the sewer).

Sulfates react with the hydrated calcium aluminate component of cement. Other salts do not react chemically with concrete but result in salt crystals that exort physical stress on concrete.

Saline groundwater can contribute to corrosion of building materials. Sulfate resistant cement would be considered for use in areas where concrete structures would be placed in contact with groundwater. Other general construction measures, as outlined in the Western Sydney Regional Organisation of Council's (2004) *Western Sydney Salinity Code of Practice*, would be consulted to assist construction design. The former Department of Infrastructure, Planning and Natural Resources has also produced a number of informative publications, such as *Building in a Saline Environment* (2003a), which would be consulted for advice regarding construction in areas of salinity risk.

Principal areas of concern in regard to salinity would be those areas where groundwater is generally closer to surface. Much of the proposed SSFL alignment is underlain by shale, so the general likelihood of shallow saline groundwater would need to be considered when selecting construction materials. The shale landscapes of western Sydney were classified by the former Department of Infrastructure, Planning and Natural Resources (2002b) as having a moderate salinity risk.

Construction of linear structures would aim to minimise obstruction to groundwater flow, to prevent raising the groundwater level closer to surface, water-logging of soils, corrosion of structures, and release of saline groundwater into surface water bodies. Adequate subsurface drainage would be provided to ensure that groundwater levels are not raised by newly constructed structures.

The Macarthur to Campbelltown boreholes, GW024351 and GW024354 (Department of Natural Resources bore search), intersected groundwater at 11 and 15 metres below ground in shale, with the suggestion of perched groundwater above. In the vicinity of the Georges River, north of Liverpool Railway Station, and north to Cabramatta Railway Station, groundwater is likely to be approximately 5 metres below the surface in sand and sediments around the river.

No groundwater information was available for areas adjacent to the proposed deep cutting at Sefton. However, this excavation may affect the groundwater standing water level, leading to a permanent change in the standing water level in the area surrounding the cutting. Attention would be given to any buildings/structures that could be affected by this change in groundwater level. Further investigation, including drilling, installation of piezometers to measure the standing water level, and sampling of groundwater for an assessment of water quality, would be conducted prior to excavation of the cutting. The investigation would determine the risk of construction impacting groundwater levels and adjoining structures. A dilapidation survey would be conducted in the vicinity of the cutting prior to excavation.

No specific groundwater issues were identified at individual railway stations on the basis of the desk-top assessment.

Surface water

The impact of construction of the SSFL on each drainage crossing would need to be assessed during the detailed design phase of the project. Without careful management, construction activities could affect both water quantity and quality. Disturbance of the soil surface cover by earthworks would provide a high potential for soil loss during storm events, with contamination of watercourses potentially of greatest concern. Other water quality impacts during construction may include spillage of hydrocarbon fuels used for powering construction equipment. Control of both these impacts would be necessary through soil erosion management and run-off quality control devices as defined in the former Environment Protection Authority's *Soil and Water Quality Handbook No.4* and the NSW Department of Housing's *Managing Urban Stormwater: Soils and Construction* (Blue Book, 2004).

Other impacts on surface water during construction may include a temporary reduction in flow capacity during modifications to existing drainage structures. Hydraulic assessment of the capacity of any temporary structures would be necessary as part of the approval of the temporary structure.

Impacts during operation

Groundwater

The primary issues associated with groundwater would occur during construction. However, it is important to assess whether the construction of structures would have any ongoing impact on groundwater, such as:

- modification of groundwater flows to groundwater dependent ecosystems in areas of groundwater seepage
- changes to groundwater levels that could result in subsidence, or rising standing water levels that might contribute to salinisation or water-logging (with potential implications for corrosion of construction materials).

Areas where groundwater levels would be above sumps/excavations and foundations/footings, or where groundwater may potentially infiltrate to fill excavated areas, could cause corrosion. In conjunction with geotechnical investigations, groundwater levels and quality would be assessed to determine the risk to proposed structures. Corrosion resistant building materials would need to be used in those areas where a risk is identified.

Surface water

A major impact on surface water flows would result from the proposed alteration of both Bow Bowing Creek at Narellan Road and drainage gully north of the Cambridge Avenue road bridge at Glenfield Junction. The proposed rail alignment at Bow Bowing Creek at Narellan Road would overlay the existing creek requiring a diversion of the creek into a culvert for less than 50 metres and a realignment of the creek for a distance of approximately 250 metres to the north of Narellan Road. Similarly at Glenfield Junction, the proposed rail alignment will overlay the existing gully alignment. It is proposed to realign the section of gully for a distance of approximately 900 metres, including moving the gully from the eastern side of a power substation to the western side.

The principles for the detailed design of diverted and realigned creeks include:

- the hydraulic capacity and conveyance of the new channel would match the existing watercourse
- the channel would not cause flooding impacts to upstream or downstream properties
- the channel lining would incorporate natural form and materials (where feasible) and minimise risk of erosion
- bank stabilisation and vegetation of overbank areas would incorporate native species, where feasible
- consultation would occur with Campbelltown City Council and other relevant stakeholders.

Operation of the SSFL would have a limited effect on the surface water drainage systems that intersect the proposed SSFL alignment because of the existing Main South Line railway embankment. Once the existing drainage structures have been modified and the new drainage structures constructed, the operational issues would be limited to potential impacts during maintenance because the existing hydraulic capacity of all transverse waterway openings would not be altered.

At Prospect and Cabramatta Creeks, the top rail level would be above the 100 year average recurrence interval flood levels (reduced level 6.6 metres and 6.8 metres Australian Height Datum respectively).

While the SSFL would not cross the Georges River, it would be adjacent to the river between Casula and at Liverpool. The SSFL would also be adjacent to the existing Main South Line railway embankment. It has been estimated that the proposed SSFL embankment would occupy approximately 11 square metres out of a floodway cross sectional area of over 500 square metres for the 100 year average recurrence interval flood event. Therefore, there would be little afflux in the 100 year average recurrence interval event as a result of the SSFL. The 100 year average recurrence interval flood level on the Georges River in the vicinity of the SSFL at Liverpool is reduced level 9.25 metres Australian Height Datum. The SSFL level at this location is reduced level 10.9 metres Australian Height Datum so the SSFL would be above the 100 year average recurrence interval flood level.

There has been no quantification of the impacts of the proposed SSFL for flood events with a recurrence interval less than the 100 year average recurrence interval flood event.

The proposed SSFL railway embankment may also be located within the floodway area for the more regular flood events, such as the 5, 10 and 20 year ARI events. For these events, the proposed embankment between Casula and Liverpool may occupy a large proportion of the floodway area and hence have an impact (either local or wider) on flood levels for these events. It is recommend that further investigation of lower return period (more frequent) events be undertaken during detailed design.

Water quality controls during operation of the SSFL would be limited to monitoring of installed water quality devices and regular maintenance of these devices.

12.2.4 Biodiversity

Impacts of the proposed SSFL on threatened flora and fauna are likely to be minor due to the limited extent of native vegetation within the corridor, its highly degraded nature and ongoing threats from adjacent urban and industrial development. Two endangered ecological communities occur within the corridor, Cumberland Plain Woodland and Sydney Coastal River Flat Forest. The corridor contained one threatened species of plant (*Acacia pubescens*) and potential habitat for two threatened species of animal (Green and Golden Bell Frog and Cumberland Plain Large Land Snail). Consequently, impact assessments have been completed (see **Appendix B, Volume 2, Technical Paper 1**). These concluded that a significant impact on threatened flora and fauna is unlikely.

Threatened fauna species are considered unlikely to be significantly affected by the proposal for one or more of the following reasons:

- habitats were not recorded in the study area
- the area is outside the normal range of the species and records are likely to be of vagrants or invalid

- the species is considered locally extinct
- resources used by the species are unlikely to be adversely affected, or only likely to be minimally affected by the proposal.

Full details of species requirements and reasons for not considering impacts further are provided in **Volume 2, Technical Paper 1**.

Impacts on plant and animal species of conservation significance are discussed in Table 12.7.

Table 12.7 Summary of plant and animal species of conservation significance

Species	Impact
Cumberland Plain Woodland	• 0.4 hectares would be directly affected in Leacock Regional Park • vegetation is currently in a poor condition and subject to weed invasion • works are unlikely to have a significant impact on the long-term survival and recovery of the community • clearing of vegetation is not considered to be significant due to the condition, fragmentation and area of habitats to be cleared.
Sydney Coastal River Flat Forest	• 1.7 hectares would be directly affected in remnant vegetation at Bow Bowing Creek to the north of Narellan Road, adjacent to the Georges River at Casula and Liverpool, and at Cabramatta and Prospect Creeks • vegetation is currently in a poor condition and is subject to threats of weed invasion • works are unlikely to have a significant impact on the long-term survival and recovery of the community • clearing of vegetation is not considered to be significant due to the condition, fragmentation and area of habitats to be cleared.
Acacia pubescens	• five populations of this threatened plant were located in the rail corridor at Warwick Farm and Sefton • one population covering approximately 400 square metres would be removed at Regents Park 'Triangle'. This population consists of three mature individuals and seven juvenile shoots and is of low significance • detailed surveys are recommended and individuals marked and protected • further mitigation measures would be determined in consultation with the Department of Environment and Conservation, and RailCorp.
Green and Golden Bell Frog (*Litoria aurea*)	• marginal habitat located in the south of Leacock Regional Park • current habitat in poor condition • removal would not significantly effect these species • summer targeted surveys failed to detect this species.
Cumberland Plain Large Land Snail (*Meridolum corneovirens*)	• marginal habitat located in the south of Leacock Regional Park • current habitat in poor condition • removal would not significantly affect these species • summer targeted surveys failed to detect this species.
Migratory species	• the study area is not considered an important habitat for any migratory species • no impacts are expected.

Source: Volume 2, Technical Paper 1

Leacock Regional Park

The proposed SSFL will directly impact 0.4 hectares of Cumberland Plain Woodland at Leacock Regional Park south of Casula. A total of approximately 1.3 hectares of Leacock Regional Park would be acquired to accommodate the proposed SSFL.

Cumberland Plain Woodland is an endangered ecological community, that in this location has a moderate to high level of weed invasion. The area impacted is a linear portion of an already highly modified remnant, and does not constitute a significant impact to this community.

Key threatening processes

Key threatening processes are listed under Schedule 3 of the *Threatened Species Conservation Act 1995* and also under the *Environment Protection and Biodiversity Conservation Act 1999*. Those relevant to the proposal include:

- clearing of native vegetation
- removal of dead wood and dead trees
- alteration to the natural flow regimes of rivers, streams, floodplains and wetlands
- habitat fragmentation
- weed invasion.

Clearing of native vegetation

Native vegetation that would be removed within the corridor comprises of patches of regrowth and remnant vegetation. Most of the regrowth vegetation is highly disturbed and the areas of remnant vegetation to be removed are relatively small. A total of 2.1 hectares of native vegetation would be cleared by the proposal. Clearing of native vegetation is not considered to be significant due to the condition, fragmentation and area of habitats to be cleared.

Removal of dead wood and dead trees

The site is highly disturbed and contains few scattered dead trees or fallen dead branches. Removal of dead wood and trees within the site is unlikely to significantly affect threatened species.

Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands

The proposed SSFL involves the construction of a number of drainage culverts, underpasses and bridges. However, the impacts of increased velocity (such as erosion) are likely to be minimal as a majority of the creeks have concreted sides. There would be no alteration of natural flow regimes as existing structures would be duplicated.

Habitat fragmentation and edge effects

Vegetation within the area occurs as small isolated patches that are already subject to edge effects. The proposal is unlikely to significantly increase edge effects.

The function of important riparian habitat corridors for the movement of both terrestrial and aquatic wildlife would remain unaffected, as riparian vegetation and associated habitats would not be disturbed.

The proposed works would be largely within cleared areas and any vegetation clearing would be linear and adjacent to the existing rail corridor. It is unlikely that the proposal would create any significant barriers to the movement of wildlife throughout existing corridors in the study area and the wider region.

Weed invasion

Vegetation within the area occurs as small isolated patches that are affected by edge effects and, as such, have relatively high levels of weed infestation. While the proposed SSFL is unlikely to significantly increase weed invasion, construction may result in transfer of new species of weeds.

Aquatic ecosystems

Fish passage along the Georges River system and associated tributaries and creeks at the subject sites would not be hindered as a result of the proposed SSFL.

Construction protocols and procedures would ensure that any temporary stockpiles created by excavation works and the construction of pier supports for bridges do not enter surrounding water bodies and creeks. Significant impacts on terrestrial riparian and aquatic habitats would, therefore, be avoided.

12.3 Environmental management

Environmental management measures would be developed and implemented through the Construction Environmental Management Plan having regard to the relevant requirements of the following plans, policies and strategies:

- Southern Sydney Catchment Blueprint (Department of Infrastructure, Planning and Natural Resources, 2003b)
- Greater Metropolitan Regional Environmental Plan No. 2 – Georges River Catchment
- relevant Council local environmental plans and floodplain risk management plans
- Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources, 2005).

12.3.1 Geology and soils

Detailed geotechnical investigations would be carried out as part of the detailed design for the proposed SSFL. This would confirm any geotechnical issues, which would be incorporated into the design to avoid potential impacts.

The detailed design of cut batters and embankments would be undertaken in consultation with RailCorp to ensure RailCorp's operations and maintenance requirements are addressed.

An important component of the Construction Environmental Management Plan would be the preparation of an Erosion and Sedimentation Control Plan and an Acid Sulfate Soil Management Plan. Key measures that would be included in these plans are outlined below.

Acid sulfate soils

An Acid Sulfate Soil Management Plan would be required for the construction phase of the project and would be prepared according to the NSW *Acid Sulfate Soil Management and Advisory Committee* guidelines. The Plan would be based on the outcomes of further investigation along the SSFL alignment to assess the extent and severity of acid sulfate soils in proposed construction areas. The Plan would include:

- an assessment of the presence of acid sulfate soils
- depth to groundwater
- measures to neutralise groundwater affected by sulfuric acid produced upon oxidation of pyritic materials.

A number of proven methods can be applied to manage acid sulfate soils to avoid significant adverse impacts. Typical mitigation measures are outlined in Table 12.8.

Management of acid sulfate soils during the construction works would involve a combination of some of the above methods. The Acid Sulfate Soil Management Plan would be prepared in consultation with the Department of Natural Resources. It would formulate site-specific management strategies and include details of further investigation to be undertaken to identify the extent of acid sulfate soils at high risk areas where excavation is required.

As details of the construction methods and design are finalised, specific measures to mitigate against acid sulfate soils would be developed prior to excavation. For areas with the highest potential risk, specific site testing would be conducted in advance of the construction works to categorise soils that may be affected by excavation activities.

Acid sulfate soils disturbed during construction would be monitored following completion of construction works as described in Table 12.8.

Table 12.8 Typical acid sulfate soil mitigation measures

Mitigation measures	Objectives	Associated action
Avoidance	Minimise the potential exposure of acid sulfate soils	
Oxidation prevention	Minimise the time of exposure	Stockpile and cover excavated material
Leachate collection and treatment	Determine the level of acidity in soils	
Acid neutralisation	Mix soils with lime to reduce acidity	Mix excavated acid sulfate soil material and surfaces with lime at a rate of 0.05 tonnes of lime per tonne of disturbed soil
Construction materials	Select corrosion resistant materials	
Monitoring	Determine the fluctuation of acidity	Monitor pH levels in surface and trench water throughout construction and annually at relevant locations along the route
Approval		Obtain approval of a detailed Acid Sulfate Soil Management Plan

Source: Volume 2, Technical Paper 1

Excavated soils

Excavated materials would be suitably stockpiled and separated into material types during construction. Stockpiles would be bunded to prevent transport of eroded material and, if required, covered to minimise any run-off or wind blown dust. In addition, measures would be established for the proposed worksites to minimise potential pollution of adjacent properties and environments associated with the excavation and management of soils.

Erosion and sedimentation

Construction of the SSFL would be carried out in accordance with an Erosion and Sedimentation Control Plan, which would be prepared to manage and control potential soil erosion and sedimentation. The Plan would be prepared in conjunction with NSW and national standards and guidelines including the Department of Housing's *Managing Urban Stormwater: Soils and Construction* (2004).

The Plan would generally contain:

- controls to prevent erosion during and after construction, specific to different slopes and soils
- diagrams of erosion and sediment control techniques and a description of when and where control measures would be used by the contractor
- site rehabilitation methods once the works are completed
- a timeframe for rehabilitation
- details of any training to be provided to staff to ensure awareness of erosion and sediment control issues and specific control measures.

All work would be carried out to avoid erosion and sedimentation of the site and surrounding areas. Erosion and sediment control planning and implementation would apply to all areas that may be disturbed. Inspections would occur after heavy rain and during periods of prolonged rainfall.

Following the completion of the works, all debris, building rubble and spoil would be removed from the site and construction areas rehabilitated.

General measures

General erosion and sediment control measures would include:

- establishing/implementing and inspecting erosion and sediment controls to ensure appropriate installation and operational control
- constructing earth bunds and similar diversion drains around the perimeter of any excavations to prevent surface water entering these areas
- controlling drainage from outside the construction areas by diverting surface run-off
- keeping areas of excavation to a minimum, along with the time that surfaces are exposed
- taking care when crossing creeks and installing graded banks for erosion and run-off control
- installing temporary erosion and sediment control structures to prevent the movement of sediment away from construction areas
- maintaining control measures in an effective condition for duration of the construction works
- minimising construction works during wet weather, or following wet weather when construction areas are muddy
- ceasing construction activities during flooding events
- controlling drainage from areas adjacent to construction areas using earth bunds and surface drains
- constructing graded contour drains and diversion channels to control the flow of storm run-off and diverting flows away from exposed areas of the construction sites
- revegetating all disturbed areas as soon as practical to prevent extended exposure to erosion, including revegetating part of the site access tracks following completion of construction
- minimising vegetation clearance, particularly in areas where soils are moderately to highly erodible.

Stockpiles

Stockpiles would be managed through the following measures:

- constructing erosion and sediment controls around stockpiles and immediately down-slope of any excavation areas to minimise siltation and sedimentation
- separating different soil and earth layers to minimise the opportunity for mixing of soil types
- watering (as required) soil and spoil stockpiles to keep them moist and minimise dust and wind erosion
- minimising the size of stockpiles and bunding or covering of stockpiles at the end of each day
- no stockpiling of materials near roadways or stormwater drains.

Vehicles

Vehicles would be managed through the following measures:

- removing soil from wheels and the undercarriage of vehicles prior to departure from site in wash-down bays
- minimising traffic in construction zones and using dedicated parking areas.

12.3.2 Contaminated/hazardous materials and waste

Contaminated/hazardous materials

It is proposed that Phase 1 Contamination Assessment be undertaken along the proposed SSFL route to determine the potential for contaminated soil to be present, in accordance with the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (1997). The Phase 1 Contamination Assessment would determine, if detailed field investigation is required.

To minimise any impacts on the surrounding environment during the proposed works and management of potentially contaminated soil and ballast, environmental controls would be included in the Construction Environmental Management Plan for the project. Control and monitoring requirements of relevance to the management of contaminated/ hazardous materials and wastes would be similar to the following:

- development of a specific Hazardous Materials Management Plan for proposed hazardous materials removal works to ensure all activities and waste disposal are undertaken appropriately
- minimisation of vapour or odour levels through control measures such as:
  - monitoring the atmosphere within any excavations and on the site boundary using portable monitoring equipment and comparing with the relevant occupational standards for specific chemicals, for example, methane, hydrogen sulphide
  - where necessary, collection of samples and laboratory analysis
  - ensuring adequate ventilation is supplied in areas where gases or fumes are likely to be present, for example where heavily fouled ballast is present, or in former refuelling areas
  - use of appropriate personal protective equipment
  - minimisation of the size and staging of excavations
  - covering and/or wetting excavated contaminated soils
  - applying odour suppressants.
- control of subsurface seepage, including (if excavations need to extend to the watertable), sampling of water within the excavation and analysis for potential contaminants of concern (Upon receipt of the analytical results, management and/or disposal options would be formulated, where required.)
- hazardous materials management measures, including:
  - an inspection of the rail corridor and sidings to identify possible hazardous materials (i.e. asbestos brake shoes and cable trays)
  - asbestos removal by an appropriately licensed contractor and in accordance with the *Occupation Health and Safety Regulations 2001* and the *Code of Practice for the Safe Removal of Asbestos 2nd Edition* [NOHSC: 2002 (2005)] (Air monitoring for asbestos fibres may also be required.)
  - removal of synthetic mineral fibres in accordance with the *Occupation Health and Safety Regulations 2001* and the guidelines of Worksafe Australia National Occupational Health & Safety Commission, *Synthetic Mineral Fibres: National Code of Practice and National Standard*, May 1990
  - lead-based paint removal in accordance with the requirements of Australian Standard AS 4361.1-1995 *Guide to lead paint management, Part 1: Industrial applications* and Australian Standard AS 4361.2-1998 *Guide to lead paint management, Part 2: Residential and commercial buildings*
  - removal of polychlorinated biphenyl containing capacitors by qualified electricians. (All metal cased capacitors housed in any fluorescent light fittings and polychlorinated biphenyls contaminated materials from leaking capacitors would be removed and placed in sealed, steel 200 litre drums).

Waste management and conservation

A Waste Management Plan would be prepared as part of the Construction Environmental Management Plan. This would include:

- identification and classification of major waste streams generated during construction
- details of how and where waste would be re-used, recycled, stockpiled or disposed of
- details of the receptacles used for storing identified waste before re-use, recycling, stockpiling or disposal
- details of how waste would be transported between generation, storage and points of re-use, recycling, stockpiling or disposal
- methods for monitoring implementation of the Waste Management Plan
- the waste management hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001*, with waste avoidance being the priority, followed by resource recovery and disposal
- compliance with relevant legislation, guidelines and approvals.

The contractor would maintain records to demonstrate that all surplus materials are recycled, re-used or disposed of in accordance with statutory requirements.

Opportunities available for waste minimisation and management are outlined in Table 6.4 in Volume 2, Technical Paper 1.

Waste avoidance techniques during the construction would include:

- ordering materials in sufficient but not excess quantities
- investigating the use of recycled products in construction works, where practicable
- balancing earthworks where possible, so that the volume of earth and rock which is excavated is equal to the volume of filling required, thereby minimising the transport and disposal of excess material and the importation of material
- ensuring that local roads affected by construction of the proposal would, where possible, remain intact to reduce the need for further, new paving materials
- erecting signs within the construction compound about waste minimisation and encouraging employees to avoid and reduce waste wherever possible.

The reuse of waste products during construction of the proposal would include:

- chipping and mulching of vegetation (excluding weeds and invasive species) that is cleared for construction purposes, and re-using the material for landscaping purposes (on this or other projects)
- using vegetation for sediment control, to provide habitat and to prevent access to the construction site
- re-using wooden packaging materials, such as pallets as formwork for concrete
- ensuring that where topsoil is present, it is stripped prior to the earthwork phase of the construction period and is made available for reuse. A topsoil management plan would be required for the project, developed in parallel with mapping of affected areas.

Recycling of waste generated during construction of the proposal would involve:

- providing on-site rubbish-sorting facilities, including for concrete, wood, waste paper, metals, glass, plastic and oil where practical, and identifying and negotiating collection or delivery to appropriate recycling facilities
- negotiating with suppliers of any oil and fuel used on site to return empty drums or have them collected for recycling by a drum reconditioning facility
- collecting and delivering concrete, asphalt and similar material to crushing and recycling plants, where practicable

- training of all employees and subcontractors in the Waste Management Plan
- recycling materials from the demolition of any affected buildings (e.g. bricks, timber, tiles etc.).

These measures would be incorporated into the Waste Management Plan. ARTC would also require that construction contractor develops and implements strategies for purchase and use of products that have recycled content. The contractor would be required to provide ARTC with periodic reporting of the purchase of materials with recycled content.

Where possible, the bulk of the excavated material would be re-used on-site. Rock and soil material found to be unsuitable for construction purposes (fill embankments and subgrade) would be incorporated into batter extensions, combined with topsoil for landscaping or stockpiled in suitable locations, restored and topsoiled.

Re-use would be adopted as the preferred strategy for managing excavated material.

The remedial and management options adopted for management of contaminated soils would depend on such factors as the type of contamination encountered, timeframe for remedial works and budget constraints. However, typical remedial options would include:

- excavation, on-site remediation and re-use
- excavation and off-site disposal
- excavation and on-site containment.

All excavated soils to be disposed of off-site as part of the works would require classification and management in accordance with Environment Protection Authority (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes*. Excavated materials would need to be suitably stockpiled and separated into material types, with samples collected from the materials. Samples would be tested for contaminants considered likely at the site.

It is possible that at greater excavation depths, excavated bedrock may be classed as 'virgin excavated natural material' (VENM) as defined in Table 1 of the above waste classification guidelines, in which case, sampling of these materials may not be required. This material is usually suitable for use as construction fill and would be utilised within the earthworks for the project.

12.3.3 Ground and surface water

Groundwater

Prior to construction, the impact of changes to the groundwater system would be assessed by the installation of piezometers to establish water levels and evaluate water quality. Water quality would be evaluated for salinity (total dissolved solids), major anions and cations and, where relevant for construction purposes, corrosivity. An assessment of potential groundwater dependent ecosystems should also be undertaken, to evaluate effects of construction in any such areas.

Surface water

During the construction phase, the following surface water management measures would be implemented:

- construction of temporary water quality control devices
- management of soil movement operations to limit the risk of spill into watercourses
- safe storage of chemicals and fuel used during construction to limit potential for contamination of watercourses.

Culverts and bridges (new and modified) would be appropriately sized during the detailed design phase to carry design flows. Permanent erosion and sediment control measures would also be implemented to meet Department of Environment and Conservation requirements.

Detailed hydraulic assessment would be undertaken to determine the existing capacity of Bow Bowing Creek and a drainage gully at Glenfield Junction, which are both to be realigned.

Refer also to the erosion and sedimentation measures identified in Section 12.3.1.

Where possible, encroachments into waterways at existing crossings would be minimised to ensure minimal changes to the flow area of the affected waterways and to comply with the *Southern Sydney Catchment Blueprint* (Department of Infrastructure, Planning and Natural Resources, 2003b).

Additional hydraulic capacity calculations for the SSFL need to be completed adjacent to the Georges River between Casula and Liverpool. These calculations are required to determine whether the proposed SSFL embankment widening would have an impact on flood levels for events more regular than the 100 year average recurrence interval flood event. Estimation of these impacts is a necessary component of managing the flood risk by considering the full range of flood events, in accordance with the principles of the *Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources, 2005).

12.3.4 Biodiversity

Avoid or minimise impacts

Where possible, impacts would be avoided or minimised. In particular:

- Native vegetation clearing and soil disturbance would be minimised particularly in the vicinity of threatened species or communities.
- Surveyors would map the *Acacia pubescens* population between Warwick Farm and Liverpool to accurately determine its location in relation to the proposed works and limit the construction zone in the vicinity of this population. If possible, the centre-to-centre track distance should be reduced in this area and access tracks should not be constructed at this point.
- Detailed assessment of potential impacts of the proposed bridge constructions on aquatic ecology would be undertaken.

Mitigate impacts

Mitigation measures proposed are provided in Table 12.9.

Table 12.9 Proposed biodiversity management measures

Management or mitigation measure	Location
Prior to any work commencing on-site, the maximum permitted widths of construction work areas would be delineated using colour tape or 'parawebbing' at appropriate locations that are visible to all equipment operators. If any tape is disturbed, it would be immediately reinstated along its original alignment.	Sites containing or adjacent to native vegetation.
All populations of *Acacia pubescens* would be clearly marked on the ground (using protective fencing) and on maps prior to commencement of work. Access to these areas by workers and equipment would be prevented. All contractors would be informed of the conservation significance of *Acacia pubescens* and the legal protection afforded to this species as part of general environmental inductions.	Sites in the vicinity of *Acacia pubescens* populations.
All contractors would have the contact numbers of wildlife rescue groups should animals be injured during clearing.	All sites

Management or mitigation measure	Location
Clearing protocols would be implemented for the removal of large trees containing hollows. These protocols would include shaking the tree using a bulldozer; slowly pushing the tree to the ground so that it remains largely intact; and leaving the tree in place once felled for at least one day/night before removing it, to allow animals to relocate to nearby vegetation.	All sites
Troughs/ditches/channels for cabling and general earthworks would be covered each night where possible to avoid animals becoming trapped.	Sites adjacent to bushland - mainly at Casula, Leacock Regional Park and Macarthur.
Where removal of threatened species is unavoidable, transplantation or translocation of the affected flora and fauna within the immediate site or another suitable donor site would be investigated. Any investigation would be undertaken in consultation with the Department of Environment and Conservation and RailCorp. Consideration would be given to the Department of Environment and Conservation's recovery plan and RailCorp's management plan for *Acacia pubescens*.	Sites in the vicinity of threatened species.
No materials, spoil or machinery would be stored or parked within the drip line of any trees.	All sites
When accessing construction sites, contractors would be required to use designated access tracks only.	All sites
Vehicles, boots, clothing and equipment would be cleaned of soil, seeds and vegetative material prior to entering or leaving a site.	All sites
Sedimentation controls would be implemented to prevent siltation or sedimentation of rivers, creeks and other waterways or waterbodies.	All sites
Soil stockpiles would be managed to avoid sedimentation loads to rivers, creeks and other waterways or waterbodies.	Sites near rivers, creeks and other waterways or waterbodies.
No stockpiles would be placed close to rivers, creeks and other waterways or waterbodies.	Sites near rivers, creeks and other waterways or waterbodies.
The design of waterway structures would be in accordance with the guidelines for design of fish and fauna friendly waterway crossings (Fairfull and Witheridge, 2003) and would be developed in consultation with NSW Fisheries.	Waterway crossings
Following completion of construction, disturbed areas would be rehabilitated and revegetated with locally indigenous species in accordance with RailCorp's guidelines. Revegetation and rehabilitation would be focussed on riparian corridors (particularly Cabramatta Creek, Prospect Creek and Georges River) and areas adjacent to more extensive vegetation (e.g. Leacock Regional Park).	All sites, but with a particular focus on riparian corridors, Leacock Regional Park and other sites adjacent to more extensive native vegetation