7.3 GROUNDWATER

7.3.1 Existing Site Conditions

The regional drainage pattern comprises a series of major drainage channels, including Eastern Creek, which flow in a northerly direction across the Cumberland Plain (Douglas Partners, 2005). The site is located to the west of Eastern Creek, and is bisected by Angus Creek a tributary of Eastern Creek.

Groundwater testing was undertaken at 4 bores on the site (Refer Technical Report No. 1). Measured groundwater levels indicate that the groundwater levels are a subdued reflection of the surface topography, with the depths to groundwater typically 1-2 m on the lower parts of the site and up to 7 m below the higher parts of the site. The direction of the flow of groundwater is to the south east, towards Angus Creek and then towards Eastern Creek.

Chemical tests on samples of groundwater indicate the groundwater is highly saline, typical of groundwater within the Wianamatta Group of rocks. Previous investigations in the western Sydney region have identified degraded water quality due to naturally occurring factors.

The overall salinity of the groundwater in western Sydney is well recognised with only a few water bores located east of the Nepean River. The low rate of leaching of the high salt concentrations would ensure that without treatment the groundwater in the region will remain unsuitable for agricultural, horticultural or farming use in the future.

7.3.2 Impact Assessment

Potential sources of groundwater contamination are from any existing contamination on site and spills and leakages into the soil of oils, fuel and other chemicals stored on site. The construction materials brought onto the site and distributed from it do not contain materials which could pollute the groundwater system.

No contaminated soil areas have been identified on the site so surface disturbance and excavation would not result in any release of contaminants which could be transported to the groundwater system.

All areas where potential contamination could occur during RDC operations would be sealed. These include areas on which oils, fuels and other chemicals are stored, the areas in the Concrete Batching Plant and Blending Plant / Pug Mill where spills of cement and other input materials are possible and the truck refuelling area and workshop. “Dirty” water would be reused and any which cannot be reused would be taken from the site for treatment or disposal. Only “clean” water would be discharged to adjoining areas where there is the potential to infiltrate to groundwater.

On this basis the proposed construction and operation of the proposed RDC does not have the potential to lead to groundwater contamination.

The local flow and level of groundwater in the general area of the site could be impacted by activities on the site. While the buildings, structures and paving on the site would result in lower infiltration of stormwater into the soil and potentially to groundwater, this would be small in comparison to other inputs to local and regional groundwater. As groundwater is not used locally for any purpose and is rarely used regionally, there would be no local impact.

Excavation for the rail unloading facility would most likely result in groundwater inflow to the excavated area. This would be pumped into a tanker and removed from the site by a licenced carrier or disposed to sewer. The excavated area would be sealed as soon as practicable. Pumpout facilities would be installed to control any surface flows into this area.

7.4 BIOLOGY

The proposed development site has been the subject of flora and fauna investigations undertaken by NECS and Biosis Research.

NECS conducted an assessment of the flora and fauna on the proposed development site during initial site investigations in 2002. Data sources for the assessment were collected via a literature review of all site-specific and regional studies, field assessments, map and aerial photograph interpretations, and from the NSW National Parks and Wildlife Service (NPWS) Atlas of NSW Wildlife database.

Further site investigations were conducted in October, November, December (2002); January, February (2003); and May (2004). During site assessments, vegetation communities and characteristic species were assessed using the random-meander method. A list of species identified on site is presented in Appendix C. Fauna species observed within the site during field investigations are also listed in Appendix C. Habitat searches involving actively searching likely fauna niches. Potential fauna niches searched include dense undergrowth, base of trees, tree hollows and branches, grassland, aquatic habitats, and beneath logs, rocks and debris. Opportunistic sightings of fauna species were also recorded whilst undertaking other site surveys. Fauna species recorded on the site were identified via scat, call, visual, track, and habitat analysis.

The investigations were not intended to detect every species that may periodically occur on the site. Instead, the study was designed to identify flora and fauna communities and assess the potential of the site to significantly contribute to the conservation value of the surrounding area. Nonetheless, the presence or absence of threatened species was specifically targeted during the survey.

This assessment confirmed the site contained two endangered ecological communities being Cumberland Plain Woodland and Sydney Coastal River-flat Forest. In addition site surveys identified the presence of the *Grevillea juniperina* ssp. j*uniperina* which is listed as vulnerable under the *TSC Act* and the Cumberland Plain Land Snail *Meridolum corneovirens* which is listed as endangered under the *TSC Act*.

In March 2005 Biosis Research were commissioned to undertake an assessment of the impacts of the proposed development on flora and fauna. This assessment included additional limited survey work. The results of that assessment are provided in Technical Report No 3.

7.4.1 Flora

Three vegetation communities have been identified within the proposed development site:

- Riparian forest;
- Woodland; and
- Cleared/disturbed areas.

The vegetation within the study area has been mapped by the DEC (2003) as Sydney Coastal River-flat Forest (Alluvial Woodland) along Angus Creek, with scattered patches of Cumberland Plain Woodland (Shale Plains Woodland). Cumberland Plain Woodland is listed as an Endangered Ecological Community (EEC) under Schedule 3 of the *TSC Act* and the Commonwealth *EPBC Act*. Sydney Coastal River-flat Forest was previously listed as an endangered ecological community under the *TSC Act* but has since been replaced by a number of listings, including River-flat Eucalypt Forest.

Riparian Forest (River–flat Eucalypt Forest)

Riparian Forest flanks the banks of Angus Creek in the southern section of the proposed development site (refer Figure 7.6). The Riparian Forest is generally in poor condition being dominated by exotic species.

The canopy was dominated by the exotic species *Ligustrum lucidum* and the native species *Casuarina glauca,* with *Angophora floribunda* and *Melaleuca decora* less dominant. The midstorey was dominated by the exotic species *Ligustrum sinense* and the understorey was dominated by the exotic species *Tradescantia albiflora*, with the native species *Commelina cyanea* less frequent.

Other exotic species recorded within the Riparian Forest include the midstorey species *Arundo donax, Olea europaea* ssp. *africana, Ricinus communis* and *Solanum* ssp. and the understorey species *Araujia hortorum, Asparagus* ssp., *Bidens pilosa, Cyperus eragrostis* and *Juncus acutus*. Native species were less frequent, but included the midstorey species *Acacia parramattensis* and the understorey species *Dianella revoluta, Lomandra longifolia, Oplismenus aemulus, Plectranthus parviflorus* and *Pratia purpurescens.*

The Riparian Forest within the proposed development site is consistent with the EEC River-flat Eucalypt Forest (refer Figure 7.6). The River-flat Eucalypt Forest within the study area continues off-site to the east and west of the study area, following the banks of Angus Creek.

Woodland (Cumberland Plain Woodland)

In the southern section of the site Riparian Forest grades into Woodland in better drained areas not directly influenced by Angus Creek (refer Figure 7.6). Scattered patches of woodland also occur in the northern section of the proposed development site and in the southern section in the vicinity of the railway.

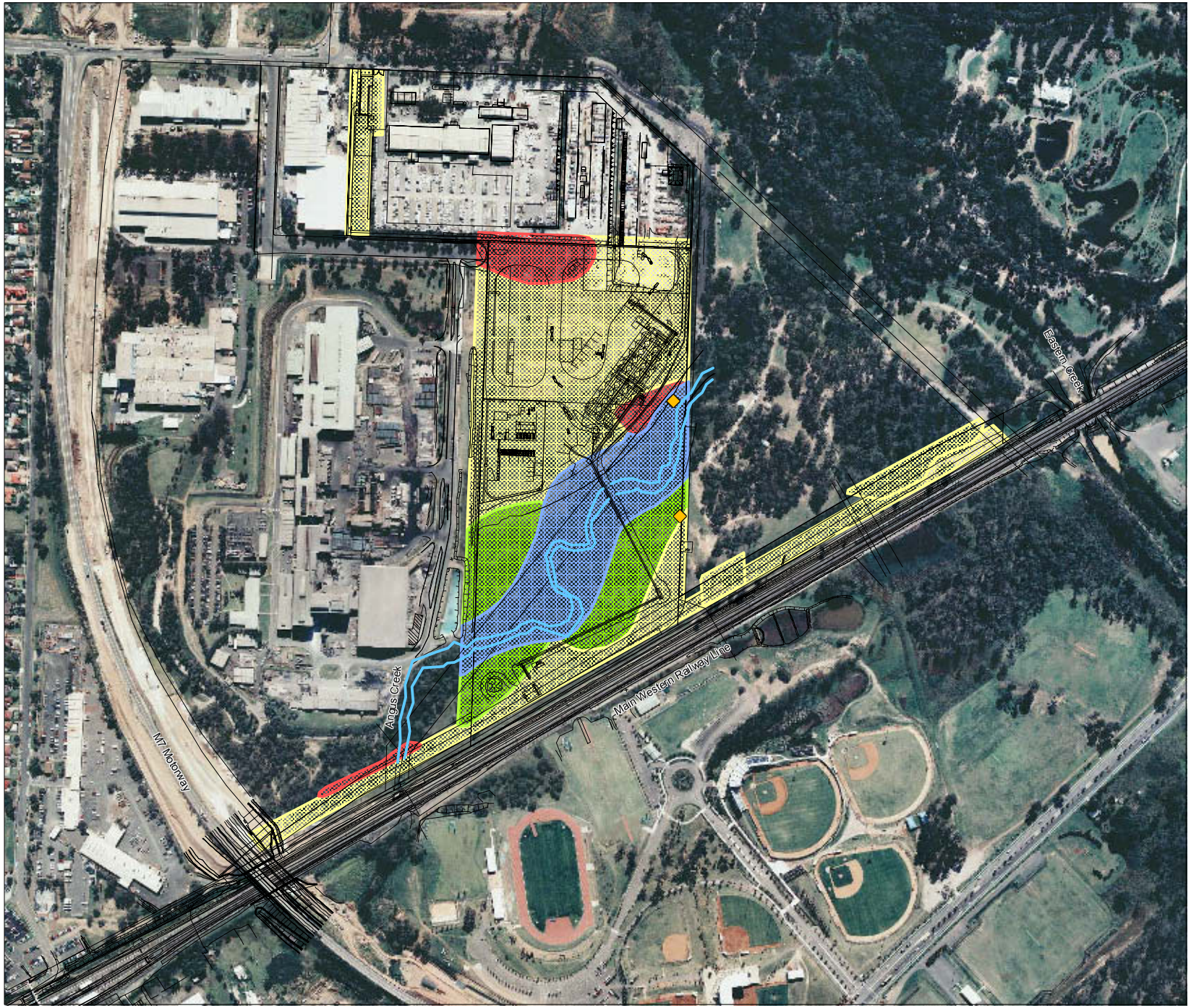
The woodland vegetation recorded was dominated by native canopy species *Eucalyptus tereticornis* with occasional *E. molucanna;* native midstorey species *Acacia parramattensis* and *Bursaria spinosa,* with occasional *Daviesia ulicifolia;* and native understorey species *Aristida vagans, Brunoniella australis, Dianella longifolia, Eragrostis leptostachya, Glyine ssp., Microlaena stipoides, Oxalis perennans, Themeda australis, Vernonia cinerea* and *Wahlenbergia gracilis.* The dominant exotic species recorded within the Woodland vegetation include the grass species *Eragrostis curvula, Pennesetum clandestinum, Paspalum dilatatum* and *Setaria gracilis.*

The Woodland varied in condition from moderate to poor (refer Figure 7.6). There were some large remnant trees within the Woodland, but most of the trees within the site appeared to be regrowth. Moderate quality woodland occurred in the southern section of the site. This area contained a high diversity of native species in the understorey despite disturbance such as weed invasion and tracks. Other woodland patches were in moderate to poor condition, with a higher incidence of weed invasion and fewer native species in the understorey. Dominant exotic species recorded in Woodland of poor condition included the grass species *Chloris gayana, Eragrostis curvula, Paspalum dilatatum, Pennisetum clandestinum* and *Setaria gracilis.*

The woodland recorded within the proposed development site is consistent with the EEC Cumberland Plain Woodland meeting the criteria listed in the Final Determination (NPWS 1997a), with 47% of the listed characteristic species recorded, including three of the listed characteristic tree species, and occurring on Wianamatta Shale.

The patch of Cumberland Plain Woodland to the south of Angus Creek continues off-site to the east of the site (refer Figure 7.6).

The threatened plant species *Grevillea juniperina* ssp. *juniperina* was recorded in two locations, to the north and south of Angus Creek (refer Figure 7.6). Both locations were within disturbed areas adjacent to a Sydney water sewer pipeline route.



Legend

Vegetation communities

- Cleared - Disturbed
- Cumberland Plain Woodland - Moderate Condition
- Cumberland Plain Woodland - Poor Condition
- River-flat Eucalypt Forest - Poor Condition
- *Grevillea juniperina spp juniperina*
- Angus Creek boundary
- Proposed development

Acknowledgements: Biosis Research Pty Ltd

0 50 100 150
metres

Rooty Hill RDC

FIG 7.6 - Site Vegetation

Cleared/Disturbed Areas

Cleared/Disturbed Areas occur over the majority of the northern section of the proposed development site, including the buildings and car park area in Humes (refer Figure 7.6). The dominant species recorded in the Cleared/Disturbed Areas include the exotic species *Axonopus affinis, Briza maxima, Chloris gayana, Eragrostis curvula, Paspalum dilatatum, Pennisetum clandestinum* and *Verbena spp.* Native species were also recorded within the Cleared/Disturbed Areas including the tree species *Eucalyptus tereticornis* and *Casuarina glauca,* the small tree/shrub species *Acacia parramattensis, Melaleuca decora* and *Bursaria spinosa* and the understorey species *Fimbristylis dichotoma* and *Themeda australis.*

Drainage lines occurring within the Cleared/Disturbed Areas were dominated by *Cyperus eragrostis, Eleochaeris* spp., *juncus acutus* and *Typha* spp.

Significant Flora

One significant plant species was recorded on the site during the field surveys. This was *Grevillea juniperina subsp. juniperina* which is listed as vulnerable under the *TSC Act*.

Within a 10 km radius, there are twelve species that are listed as threatened under the *TSC Act* and ten species that are threatened under the *EPBC Act* that have been previously recorded. A total of 15 threatened species were considered as part of this assessment. These are listed in Table 7.4.

Table 7.4
Habitat Assessment of Flora Species that occur within a 10 km Radius of Site

Species	Conservation Status	Habitat	Potential habitat
Acacia bynoeana	E – TSC V – EPBS 3V – ROTAP	Sandstone ridgetop and Castlereagh Woodlands on sandy clay soil, often with ironstone gravels (NSW Scientific Committee 1999)	No
Acacia pubescens	V – TSC V – EPBC 3Va – ROTAP	Grows in open sclerophyll forest or woodland on clay soils (Harden 1991, Robinson 1994), usually on gravely clay containing ironstones (NPWS 1999a, Fairly & Moore 2000). This species typically occurs at the intergrade between shales and sandstones in Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest or Cumberland Plain Woodland (NPWS 2003b)	Yes
Cynanchum elegans	E – TSC E – EPBC 3Ei – ROTAP	Rainforest gullies scrub and scree slopes in Gloucester and Wollongong districts (Harden 1992)	No
Dilwynia tenuifolia	V&EP – TSC V – EPBC 2Vi – ROTAP	Occurs in the Cumberland Plain and Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Typically it forms large populations within a restricted distribution and specific habitat (Castlereagh Ironbark Forest) (Rymer *et. al. 2002)*	No. No Castlereagh Ironbark Forest within the study area.
Epacris purpurascens var. *purpurascens*	V – TSC 2K – ROTAP	Sclerophyll forest, scrub and swamps – from Gosford and Sydney districts (Harden 1992) specifically this species is thought to require	No

Species	Conservation Status	Habitat	Potential habitat
		wet health vegetation (T. James pers. comm..)	
Grevilles juniperina ssp. *Juniperina*	V – TSC	Found on clay soils in open forest on the Cumberland Plain (Robinson 1994). Grows in moist sites, usually near creek on acidic soils (Harden 1991).	Yes. Recorded within the study area during the current survey
Hypsela sessiliflora	E – TSC X – EPBC 2X – ROTAP	Grows in damp areas on the Cumberland Plain (Harden 1992)	No.
Marsdenia viridiflora ssp. *viridiflora*	EP – TSC	This species has a wide distribution in subcoastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney where it occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2003). Grows in woodland and scrub (Harden 1992) and is a characteristic species of Sydney Turpentine Ironbark Forest (NSW Scientific Committee 1998b).	No
Micromyrtus minutiflora	E – TSC V – EPBC 2V – ROTAP	Found on the Cumberland Plain within dry sclerophyll forest (Harden 1992) on old alluviums (Robinson 1994). OF the vegetation communities found on the Cumberland Plain, the species is listed as only occurring in Castlereagh Scribbly Gum Woodland in Tozer 92003).	No Castlereagh Scribbly Gum Woodland recorded within the study area
Persoonia nutans	E – TSC E – EPBC 3Ei – ROTAP	Grows in Woodland to dry sclerophyll forest in clay soils and old alluviums on the Cumberland Plain (Harden 1991, Robinson 1994). It is restricted to Castlereagh Scribbly Gum Woodlands and in Agnes Banks Woodland (NPWS 2001)	No Castlereagh Scribbly Gum Woodland or Agnes Banks Woodland within the study area
Pimelea curviflora var. *curviflora*	V – TSC V – EPBC	Restricted to coastal areas on sandstones (Harden 1990, Fairley & Moore 2000) and laterite where it is often found amongst dense grasses and sedges (NSW Scientific Committee 1998a)	No
Pimelea spicata	E – TSC E – EPBC 3Ei – ROTAP	In western Sydney it grows in Grey Box-Ironbark Woodland with an understorey of *Bursaria spinosa* and *Themeda australis*. In the Illawarra, it grows on clay soils in grassland or open woodland (NPWS 2000c)	No. No Ironbarks recorded within the study area
Pomaderris brunnea	V – TSC V – EPBC 2V – ROTAP	Open forest confined to the Colo River & upper Nepean River (Harden 1990), on clay & alluvial soils (Fairley & Moore 1995)	No
Pterostylis saxicola	E – TSC E – EPBC	Shallow soils over sandstone sheets often near streams – Picnic Point to Picton (Harden	No

Species	Conservation Status	Habitat	Potential habitat
		1993). Occurs where vegetation up-slope of potential habitat is shale derived – preference for shale sandstone interface (T.James pers. comm)	
Pultenaea parviflora	E – TSC V – EPBC 2E – ROTAP	Occurs in dry sclerophyll forest in Wianamatta shale, laterite or alluvium (Harden 1991). Restricted to the Cumberland Plain where it grows in open forest on heavy shale soils (Robinson 1994) and tertiary alluviums (James *et. al.* 1999). It is known to occur in scrub/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest (NPWS 2002d).	No. No Castlereagh Ironbark Forest or Shale Gravel Transition Forest within the Study area.

E=Endangered; V=Vulnerable
TSC = Threatened Species Conservation Act; EPBC Environmental Protection and Biodiversity Conservation Act; ROTAP=Rare Or Threatened Australian Plants
Source: Biosis, May 2005

Suitable habitat exists within the proposed development site for the threatened flora species *Acacia pubescens* although this species was not recorded during field surveys undertaken by NECS and Biosis.

7.4.2 Fauna

The fauna habitat types within the proposed development site are riparian, woodland and disturbed grassland.

Riparian

The Riparian vegetation along the Angus Creek is dominated by exotic species, particularly *Ligustrum lucidum,* and native canopy species *Casuarina glauca,* with *Angophora floribunda* and *Melaleuca decora* and an understorey of *Ligustrum sinense* and *Bursaria spinosa.* These native tree species may supply direct (foliage, nectar and exudates) and indirect food (arthropods) for a range of bird species including Noisy Minor *Manorina melanocephalus,* Red Wattle Birds *Anthochaera carunulata*, Yellow-Faced Honeyeater *Lichenostomus chrysops* and Superb Fairy Wrens *Malurus cyaneus*. Isolated tree hollows were observed outside the development footprint in the larger *Angophora floribunda* specimens. These trees may provide nesting and roosting habitat for hollow-dwelling fauna (such as bats, possums and owls).

The ground cover within this habitat varied from fair to almost non-existent dependant upon the cover of *Liguistrum* sp. In the more open sections the ground cover consisted of fallen timber, urban rubbish, leaf litter, stormwater debris and extensive vegetation. The vegetation consisted of introduced *Tradescantia albiflora* and native *Commelina cyanea*, and various grasses. This ground cover provides refuge and nesting habitat for a range of common animals. Many reptiles rely on ground litter and debris for shelter and foraging. The Eastern Water Skink *Eulamprus quoyii* was particularly common near the creek lines.

The riparian area within the proposed development site was impacted by rubbish, exotic weeds and was considered to be in moderate to poor condition.

Woodland

The Woodland habitat was located in small patches between the riparian areas and the grassland/clear sections to the west, and south of the creek. The canopy species were dominated by regenerating native eucalypts, particularly *Eucalyptus tereticornis* to about 15 m with occasional larger trees. Tree hollows were observed in the larger trees within the woodland zones.

The understorey, has an open native shrub layer dominated by *Acacia parramattensis* and *Bursaria spinosa.* The midstorey species provide potential foraging resources (foliage, nectar, exudates) and shelter for a range of species including small birds (eg. Fairy Wrens, Brown Thornbills *Acanthiza pusilla* and White-browed Scrubwrens *Sericornis frontalis)*. The ground cover is predominantly grass and herbs including *Dianella revoluta, Lamandra longifolia.* This area has some fallen timber, bark and rubbish which provides habitat for reptiles, small animals and Cumberland Plain Land Snails *Meridolum corneovirens.*

This area consisted of regenerating woodland with scattered larger trees present. It was considered to be moderate-poor fauna habitat within the study site.

Grassland/Cleared Areas

The majority of the northern side of the site comprises a highly disturbed area dominated by exotic grasses, concrete rubble and mounds of fill from the adjacent development of the OneSteel site (NECS 2003). This area provides limited habitat for native fauna, such as Grass Skinks *Lampropholis guichenoti* and common native birds including the Australian Raven *Corvus coronoides,* but does provide habitat for introduced mammals such as the Brown Hare *Lepus capensis* and European Rabbits *Oryctolagus cuniculus* and introduced birds such as the Common Myna *Acridotheres tristis.*

This area was highly degraded and considered poor fauna habitat.

The grassland area north of the rail line contains a number of ephemeral drainage lines and associated sedges and drier areas of native and exotic grassland. This area provides habitat for frogs, skinks and snakes, and limited habitat for wetland birds such as White Faced Herons *Egretta novaehollandiae* and Lathams Snipe *Gallinago hardwickii.*

This area was considered poor to moderate fauna habitat.

Significant Fauna

During fieldwork, the Cumberland Plain Land Snail and *Gallinago hardwickii* (Latham's Snipe) were recorded at the site (refer Technical Report No 3). These species are both significant as the Cumberland Plain Land Snail is listed as endangered under the *TSC Act* and Latham's Snipe is listed as a migratory species. Migratory species are covered under migratory provisions on the *EPBC* Act.

Within a 10 km radius of the site there have been previous recordings of 25 threatened fauna species listed on the *TSC Act*, 12 threatened species under the *EPBC Act* and 9 migratory species listed on the *EPBC Act.* The assessment for the potential habitat for each species on the RDC site is shown in Table 7.5. It was determined that potential habitat exists for 12 species under the *TSC Act*, four species under the *EPBC Act* and five migratory species.

Table 7.5
Habitat Assessment of Fauna Species that occur within a 10 km Radius of the Site

Species	Status	Preferred Habitat	Potential Habitat
Giant Burrowing Frog *Heleioporus australiacus*	V-TSC V-EPBC	Prefers sandstone ridgetop habitats and broader upland valleys, associated with small slow flowing to intermittent creeklines (NPWS, 2001b). Vegetation in these areas is typically woodland, open woodland and heath (NPWS, 2001b).	No
Green and Golden Bell Frog *Litoria aurea*	E-TSC V-EPBC	Inhabits marshes, dams and stream sides (NPWS, 1999c). Optimum habitat includes water bodies which are unshaded, free of predatory fish *Gambusia holbrooki*, have a grassy area nearby and diurnal sheltering sites available (NPWS, 1999c).	No
Giant Barred Frog *Mixophyes iteratus*	E – TSC E- EPBC	Usually found in coastal riverine rainforest and upland areas such as the Border Ranges (Barker *et. al.* 1995)	No
Australian Painted Snipe *Rostratula benghalensis australis*	E – TSC V – EPBC	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant & Higgins 1993)	No
Barking Owl *Ninox connivens*	V-TSC	Primarily inhabits woodlands but also occurs in forests, partially cleared areas and occasionally near well-vegetated towns (NPWS, 1997a). Nests in tree hollows 20 m to 30 m high (Trounson, 1989).	Yes
Black-chinned Honeyeater (eastern subsp.) *Melithreptus gularis gularis*	V-TSC	This species occupies Eucalypt woodlands within an approximate annual rainfall range of 400-700 mm (NPWS, 2001c). Within NSW, this species is mainly found in woodlands containing Box-Ironbark associations and River Red Gum (NPWS, 2001c).	Yes
Black-faced Monarch *Monarcha melanopsis*	M – EPBC	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey 1983)	No
Latham's Snipe *Gallinoago hardwickii*	M- EPBC	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey & Knight 1997)	Yes
Regent Honeyeater *Xanthomyza phrygia*	E-TSC EM-EPBC	Occurs in temperate eucalypt woodlands and open forests, often in box-ironbark eucalypt associations and wet lowland coastal forests dominated by Swamp Mahogany, Spotted Gum and Riverine Casuarina woodlands (NPWS, 1999d). Semi nomadic	Yes
Rufous Fantail *Rhipidura rufifrons*	M – EPBC	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey 1983)	No
Satin Flycatcher	M –	Migratory species that occurs in coastal forests,	Yes

Species	Status	Preferred Habitat	Potential Habitat
Myiagra cyanoleuca	EPBC	woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey 1983)	
Speckled Warbler *Chtonicola sagittata*	V-TSC	Inhabits woodland areas with a grassy understorey, often on ridges or gullies, nesting on the ground in grass tussocks, dense litter and fallen branches (NPWS, 2001d).	Yes
Square-tailed Kite *Lophoictinia isura*	V-TSC M - EPBC	Inhabits riverine forests, well-wooded areas, scrub and heathland near open country (Trounson, 1989; Simpson & Day, 1996).	Yes.
Swift Parrot *Lathamus discolor*	E-TSC EM-EPBC	Inhabits eucalypt forests and woodlands with winter flowering species (NPWS, 1998e). Nests in tree hollows 6-18 m high (Trounson, 1989).	Yes
Turquoise Parrot *Neophema pulchella*	V-TSC	This species is typically an inhabitant of eucalyptus woodlands and open forests of the steep, rocky ridges and gullies, valleys and river-flats and the nearby plains of the Great Dividing Range (NPWS, 1999e).	Yes
White-bellied Sea Eagle *Haliaeetus leucogaster*	M – EPBC	A migratory species that is resident to Australia. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes (English & Predavec 2001)	No
White-throated Needletail *Hirundapus caudacutus*	M – EPBC	An Aerial species found in feeding concentrations over cities, hilltops and timbered ranges (Pizzy 1983)	No
Brush-tailed Rock-Wallaby *Petrogale penicillata*	V – TSC V – EPBC	Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices (Eldridge & Close 1995)	No
Eastern Bentwing-bat *Miniopterus schreibersii*	V-TSC C - EPBC	This species roosts in caves and utilises a variety of habitats including rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, *Melaleuca* forests and open grasslands (Churchill, 1998).	Yes
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V-TSC	Inhabit sclerophyll forests ranging from the Great Dividing Range to the coast of NSW (Churchill, 1998). They prefer wet habitats where trees are more than 20 m in height and generally roost in the hollow trunks of eucalypt trees, although they have also been recorded roosting in old wooden buildings and in the Jenolan Caves (Churchill, 1998).	Yes

Species	Status	Preferred Habitat	Potential Habitat
Eastern Freetail-bat *Mormopterus norfolkensis*	V-TSC	Inhabits open forests foraging above the canopy and along the edge of forests. Roosts in tree hollows, under bark and buildings (Australian Museum, 2002a).	Yes
Greater Broad-nosed Bat *Scoteanax rueppellii*	V-TSC	This species roosts in hollow trunks and branches of trees growing primarily in gullies of mature coastal forest or rainforest communities that exist between the Great Dividing Range and the coast (Churchill, 1998). This species is generally only found at altitudes below 500 m in NSW and has also been found in gullies associated with open woodland and wet and dry sclerophyll forests (Churchill, 1998).	Yes
Grey-headed Flying Fox *Pteropus poliocephalus*	V-TSC V-EPBC	Exist within a variety of habitats including rainforest, woodland, wet and dry sclerophyll forest, *Melaleuca* swamps, mangroves, heaths and cultivated areas (NPWS, 2001e & Churchill, 1998). Camps are commonly formed in gullies, typically close to water and in vegetation with a dense canopy (Churchill, 1998).	Yes
Koala *Phascolarctos cinereus*	V – TSC	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends in the size and species of trees present, soil nutrients, climate and rainfall (Reed & Lunney 1990, Read *et. al.* 1990)	Yes
Large-eared Pied Bat *Chalinolobus dwyeri*	V-TSC V-EPBC	Roost in caves, mines and unused bird nests (Australian Museum, 2002b).	Yes.
Large-footed Myotis *Myotis adversus*	V-TSC	Live in most habitat types that exist near water including mangroves, *Melaleuca* swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open Woodland and River Red Gum (*E. camaldulensis*) woodland (Churchill, 1998).	Yes
Long-nosed Potoroo *Potorous tridactylus*	V – TSC V – EPBC	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater then 760 mm. Requires relatively thick ground cover where the soil is light and sandy (Johnston 1995)	No
Spotted-tailed Quoll *Dasyurus maculatus*	V – TSC E – EPBC	Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman & Read 1992). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Churchill 1998)	No
Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*	V – TSC	Restricted to tall mature forests in regions of high rainfall. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999f)	Yes

Species	Status	Preferred Habitat	Potential Habitat
Broad-headed Snake *Hoplocephalus bungaroides*	E – TSC V – EPBC	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitat they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996, Webb Shine 1998)	No
Cumberland Plain Land Snail *Meridolum corneovirens*	E-TSC	Inhabits remnant eucalypt woodland of the Cumberland Plain, sheltering under logs, debris, clumps of grass, around base of trees and burrowing into loose soil (NPWS, 1999g).	Yes

E=Endangered; V=Vulnerable; M=Migratory provisions; C=Conservation dependent
TSC = Threatened Species Conservation Act; EPBC Environmental Protection and Biodiversity Conservation Act
Source: Biosis, May 2005

7.4.3 Impact Assessment and Management

The proposed development site comprises an area of cleared/disturbed grassland directly north of the Main Western Rail line, an area of native woodland along Angus Creek, which crosses the site and a large area of cleared/disturbed land and scattered section of native vegetation bordering the adjacent Humes site. The woodland is comprised of moderate and poor quality Cumberland Plain Woodland and poor quality River-flat Eucalypt Forest both listed as Endangered Ecological Communities in Schedule 1 of the *TSC Act 1995*.

The proposed development would remove areas of approximately 1.6 ha of native vegetation. This includes 0.5 ha of moderate quality and 0.9 ha of poor quality Cumberland Plain Woodland and 0.2 ha of poor quality River-flat Eucalypt Forest.

Grevillea juniperina ssp*. juniperina* and the Cumberland Plain Land Snail were recorded on the study area. These are both listed as threatened species under the *TSC Act*. Both locations where these species were identified are outside the development area and would be protected as part of site management measures.

Proposed Mitigation Measures

To reduce impacts on the flora and fauna both within the site and the surrounding area, the following mitigation measures have been adopted:

- A Vegetation Management Plan (VMP) to be implemented which would detail the preservation and rehabilitation of the vegetation at all stages of the development. This would cover erosion control, weed management and revegetation. The VMP would also include recovery strategies for the threatened species Prickly Spider-flower *G. juniperina* ssp*. juniperina* including conservation, protection and monitoring. A weed management plan would assist in devising strategies to reduce weed infestations and reduce edge effects;

- Prior to construction, sedimentation and erosion control measures such as sediment fencing to be assembled to protect building runoff from entering bushland and creekline. These measures would be monitored throughout the construction phase;

- Erect fences to minimise construction disturbance to remnant vegetation patches;
- A 20 m vegetative buffer to be constructed around the two populations of Prickly Spider-flower. This is required to limit disturbance to this species;
- Revegetation through such measures as tubestock plantings to create links and buffer zones;
- Protect hollow-bearing trees within the site for fauna habitats; and
- To provide additional sheltering habitats, place native logs or bark within the site during the revegetation phase. This would assist in developing habitat for the Cumberland Plain Snail in addition to other ground-dwelling fauna.

***Threatened Species Conservation (TSC) Act 1995* Assessment**

Assessment to determine whether the RDC would have a significant impact on threatened species, populations or ecological communities listed under the *TSC Act* was undertaken by Eight Part Tests. The results from this test determine whether a Species Impact Statement is required. This is a statutory mechanism under Section 5A of the *EP&A Act* and is also required under the *TSC Act* for species potentially occurring within the study area. When potential habitat exists for a threatened species and even though no specimens have been recorded, Eight Part Tests are also required as the development is deemed to have a potential impact on such species.

Flora

The study area contains CPW and RFEF which are both listed as Endangered Ecological Communities (*TSC Act*, 1995). Therefore Eight Part Tests were prepared for these communities (refer Technical Report No 3) It is unlikely that the development would significantly impact these communities so Species Impact Statements are not required. The proposed development has been designed to minimise impact on these communities and to protect areas of higher conservation value. The area of Cumberland Plain Woodland where the Cumberland Plain Land Snail was located would be protected and enhanced as part of the overall management of the site. In addition the location of the proposed conveyor/road bridge creek crossing on Angus Creek was based on using a previously disturbed area.

With regard to specific flora species, only one vulnerable plant species, *Grevillea juniperina subsp. juniperina*, was recorded while the potential habitat for the vulnerable species *Acacia pubescens* was noted. A 20m buffer would be established around the *Grevillea juniperina subsp. juniperina* to ensure protection.

Eight Part Tests were undertaken for these two species (refer Technical Report No 3). The tests indicated that is it unlikely that the development would significantly impact these species. consequently Species Impact Statements are not required.

Fauna

The study area contains one endangered fauna species, the Cumberland Plain Land Snail. Potential habitat exists for the vulnerable species Koala. There is limiting habitat for the Cumberland Plain Land Snail which is contained within a patch of Cumberland Plain Woodland that would be retained and protected under the proposed development. Although primary and secondary feed trees exist on the site for the Koala, the habitat is disturbed and considered as a limiting foraging reserve for the potential habitat for Koalas. The nearest record of a Koala is from 1990, approximately 8 km to the west of the site with no habitat connectivity to the site.

Eight Part Tests were prepared for these species (refer Technical Report No 3). It is unlikely that the development would significantly impact these species so Species Impact Statements are not required.

***Environment Protection and Biodiversity Act (EPBC) 1999* Assessment**

Cumberland Plain Woodland, *Acacia pubescens* and Latham's Snipe were assessed under the *EPBC Act* Assessment of Significance as they are listed as Endangered, Vulnerable and Migratory respectively under this Act.

Currently approximately 4.2 ha of Cumberland Plain Woodland exist on the proposed development site. The proposed development would result in approximately 1.4 ha of Cumberland Plain Woodland being removed, representing a 0.01 per cent loss of the current distribution of the community within the Sydney Basin Bioregion. Cumberland Plain Woodland was assessed to be unlikely to be significantly impacted by the development of the RDC.

There were no sightings of *Acacia pubescens* within the site, however approximately 4.2 ha of potential habitat for *Acacia pubescens* occurs, with approximately 1.4 ha to be cleared for the RDC. This potential habitat is classified as moderate to poor condition. There is 6500 ha of potential habitat for *Acacia pubescens* within a 10km radius of the site and so although land clearance is listed as a Key Threatening Process (KTP) for *Acacia pubescens,* clearing for the RDC is unlikely to cause species decline. Potential habitat for *Acacia pubescens* was unlikely to be significantly impacted by the development.

Potential habitat exist on the site for the migratory species Latham's Snipe, Square Tailed Kite, Satin Flycatcher, Swift Parrot and Regent Honeyeater. Latham's Snipe was recorded during the field survey. These species were considered to be highly mobile and thus not entirely dependant on the resources within the RDC site. The site was not considered an important habitat for migratory species.

A Referral was made to the Australian Department of Environment and Heritage and it was determined the proposed development was not a Controlled Action.

7.5 AQUATIC ECOLOGY

Angus Creek flows through the proposed development site to the Nurragingy Reserve and into Eastern Creek. Eastern Creek drains an area of the reserve, urban and rural land to the west and north of Prospect Dam and flows north into South Creek, which then enters the Hawkesbury River at Pit Town, 25 km to the north. The site is located within the Hawkesbury Nepean Catchment.

An aquatic ecological survey of the site was undertaken by Biosis in 2005. The study assessed the conservation significance of the site in terms of threatened aquatic species, populations (and their habitats) or ecological communities that occur, or have the potential to occur on the site. The study concentrated on the potential impact on Angus Creek and downstream impacts on Eastern Creek.

The site was inspected in February and March 2005 and the general condition of the site was assessed and observations made of species and communities. Targeted surveys were undertaken at 2 sites on Angus Creek and one site on Eastern Creek.

The aquatic habitats were classified according to the DPI Fisheries Habitat Scheme which assesses the waterway on their potential for fish habitat. At each survey site an assessment was undertaken of the waterways and riparian condition. Water quality measurements were taken of the following parameters: pH; Dissolved Oxygen; Temperature; Electrical Conductivity and Turbidity. Macroinvertebrate sampling and fish sampling were undertaken at each site.

7.5.1 Aquatic Habitats

The aquatic habitats within the site were consistent with a disturbed lowland creek. Within the site, the dominant riparian species along Angus Creek included native species, for example *Casuarina glauca*, *Bursaria spinulosa*, *Angophera* sp. and *Eucalyptus* sp. Exotic species were common such as *Lingustrum* sp. and groundcover plants including *Commelina cyanea*, *Tradescantia flumensis* and *Microlaena stipoides*. Aquatic vegetation includes the exotic *Juncus acutus* and *Cyperaceae eragrostis* along with native *Eleocharis* sp. and *Lomandra longifolia*. The submergent species *Triglochin procera* and *Potamogeton* sp. occur in patches and algae is also present. Dense exotic pasture grasses such as *Cynodon dactylon* occur upstream of the proposed rail bridge.

Eastern Creek is a lowland turbid creek that has generally suffered the effects of urbanisation of the catchment.

The banks of Angus Creek are stepped and vegetated with regenerating native trees including *Cassurina sp., Acacia sp.* and *Ecalyptus sp.* trees up to 10 m high and scattered exotic shrubs. The understorey is predominantly exotic pasture grasses such as *Paspalum sp.* The lower section of the survey site was dammed by a large patch of *P. australis* and *Typha sp* and the bank side vegetation includes *P. australis, Cyperus eragrostis* and *J. usitatus* and small amounts of *Lemna sp.* were also present.

Aquatic habitat was assessed in accordance with the DPI Fisheries Fish Habitat Scheme, which assesses potential fish habitat and appropriate bridge designs when required. The creeks were also assessed under the Riparian Channel Environment (RCE) inventory which evaluates riparian land use, vegetation condition, channel structure, modifications and instream characteristics. A RCE score > 40 indicates an undisturbed habitat; scores < 20 signify a highly modified riparian environment.

At Angus Creek, Site 1 at the location of the proposed conveyor/road bridge was graded as a Moderate - Minor fish habitat under the Fish Habitat Scheme. This was due to the drainage channel being continuous and provided a connected habitat while refuges were present under the low flow conditions when assessment took place. The RCE indicated a moderate to lightly disturbed habitat with a score of 33.

Site 2 along Angus Creek adjacent to North Parade and the Main Western Railway Line where the proposed rail/road bridge would be located was assessed as a Moderate – Minor fish habitat according to the Fish Habitat Scheme. The RCE was scored at 28, indicating lower quality riparian vegetation compared to Site 1. This score was influenced by the low quality riparian vegetation above the existing Northern Railway and North Parade bridges.

The sampling site at Eastern Creek adjacent to the Main Western Railway line was assessed as a Moderate fish habitat which is attributed to the waterway size, the deep habitat available and the presence of native fish species. Although the site had good channel structure and revegetation of riparian species along the banks, the surrounding urban land use influenced the RCE result of 32.

7.5.2 Fish

The exotic species Gambusia (*Gambusia holbrooki*) was present at all three sampling sites in large numbers. This species is known to act aggressively towards small native fish. Along Angus Creek the Short-finned Eel (*Angullia australis*) was the only native fish species observed while at Eastern Creek two native species, Stripped Gudgeon (*Gobimorphus australis*) and the Flat-headed Gudgeon (*Philypnodon grandiceps*) were recorded. These two species feed on *G. holbrooki* as well as aquatic insects and are common in east coast drainages. The low diversity of fish species are an indicator that Angus and Eastern Creeks are degraded urban waterways.

7.5.3 Macroinvertebrates

The macroinvertebrates identified during the study were dominated by pollution-tolerant taxa. Low species diversity was recorded and the communities that exist in the creeks are characteristic of typical urban waterways. Dominant predators included dragonfly larvae, damselfly larvae and waterbugs while dominant herbivores and detrivores included snails and worms.

A SIGNAL2 index of water pollution was also recorded during the macroinvertebrates sampling. This is based on the tolerance/intolerance of biota to pollution with the SIGNAL2 score denoting the degree of water pollution. High water quality is shown by a high SIGNAL2 score (> 6) whereas a low SIGNAL2 score (< 4) indicates possible severe water pollution.

All sites recorded a pollution problem, with Angus Creek scoring a SIGNAL2 grade of 2.8 and 3.5 at Sites 1 and 2 respectively, while Eastern Creek recorded a SIGNAL2 score of 1.7.

7.5.4 Significant Fauna

No threatened aquatic species, populations or endangered aquatic ecological communities were recorded during the aquatic assessment. There are three freshwater fish species and one invertebrate species which occur or have the potential to occur within the Hawkesbury – Nepean Catchment that are listed as threatened under either the *Fisheries Management (FM) Act.* Of these two are on the *EPBC Act* (refer Technical Report No 4).

There are no known threatened aquatic populations or aquatic endangered Ecological Communities listed under the FM or EPBC Acts for the Hawkesbury Nepean Catchment.

7.5.5 Impact Assessment and Management

There were no recordings of threatened aquatic species, populations or endangered aquatic ecological communities within the development site. The proposed RDC would impact on the aquatic habitat through bridge construction and general site impacts.

Eight Part Test

An Eight Part Test is a statutory mechanism under Section 5A of the *EP&A Act* and is also required under the *Threatened Species Conservation (TSC) Act* for species occurring or potentially occurring within the study area.

Eight Part Tests or Assessments of Significance were not required as threatened aquatic species, populations or endangered aquatic ecological communities were not recorded at the proposed development site.

Five threatened species were listed as occurring in the Hawkesbury – Nepean Catchment, however as potential habitat for these species did not occur within the development site, Eight Part Tests were not required.

A Species Impact Statement or a referral was not required.

Key Threatening Process (KTP)

A Key Threatening Process (KTP) refers to identified impacts listed under the *FM Act*. A KTP is defined as an impact that could cause a species, population or ecological community to become threatened or is an impact identified for two or more listed threatened species, populations or communities. There are three KTPs that relate to impacts from the proposed RDC which are outlined below.

Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams

Bridges are generally exempt from this KTP if their design takes into account the flow regime of the affected waterway. The rail siding and conveyor bridges over Angus Creek are designed as minimum flow bridges and as such would not be a KTP.

Removal of large woody debris (LWD) from New South Wales rivers and streams

Angus Creek has limited LWD within the creekbed, however there a number of debris dams and smaller woody debris does occur that could provide potential fish habitat or refuge. Snags under the conveyer bridge would be retained where possible or modified by lopping or relocation. The removal of snags is considered as a last resort option. It is permissible to remove the concrete pipe under the conveyer route as this is not considered snag removal.

Degradation of native riparian vegetation along New South Wales water courses

The proposed development would result in the removal of approximately 0.2 ha of riparian vegetation, however this is not a significant proportion of the total riparian vegetation located on the site.

The NSW Fisheries 1999 *Policy and Guidelines Aquatic Habitat Management and Fish Conservation* recommend that a 50 m buffer should be maintained and that less than 40 m may be appropriate providing consultation is undertaken with DPI Fisheries. The DPI in the Director General's Requirements for the EIS has recommended a 20 m Buffer Zone.

The layout of the proposed RDC incorporates a riparian Buffer Zone of 20 m and where possible up to 40 m except at the location of 2 crossings of Angus Creek and portions of the rail unloading and conveyor system to the south of the Creek. The RDC has been designed to minimise impact on the riparian corridor while at the same time meeting design requirements. The EMP for the site includes regeneration and protective works in the Angus Creek Corridor.

General Impacts

Currently stormwater discharge highly impacts Angus Creek resulting in bank erosion, water quality degradation and deposits of rubbish along the creekline. The control of sediment, dust and water flow from the proposed development site would be managed appropriately to minimise the amount of sedimentation and runoff from the site infiltrating the waterways. Sedimentation and reduction in water quality are both listed as threatening processes by the Australian Society of Fish Biology (ASFB).

Salinity levels have risen since initial testing in 2003. Although the cause of this increase is likely to be related to effects outside the scope of the proposed development, possible additional pressures to the salinity problem by the RDC would be minimized.

Fish migrations may become restricted when barriers are constructed in creekbeds. This is a relevant impact as *Anguilla australis* and *Gobiomorphus australis*, which were found in Angus Creek, migrate up and downstream to breed. Temporary river crossings created during the construction phase are likely to occur and are likely to discourage fish movement, however such barriers are considered a short-term impact. The two bridges across Angus Creek would not be detrimental to fish provided they are designed not to impede river flow and fish passage. The designs for the bridges would be in accordance with the DPI Fisheries Policies and Guidelines on Bridges, Culverts and Causeways.

Gambusia holbrooki was the most common fish species found at all sampling sites. This introduced species is known to predate on frog and fish eggs as well as larvae. The *TSC Act* lists improvements of habitats for *G.holbrooki* as a threatening process. Within the site this species was

abundant on open, shallow, sunny pools. Protection of vegetation, instream structures and depth profiles would occur to limit the habitat for *G. holbrooki*.

The mitigative measures outlined in Section 6 would be implemented to reduce impacts on the aquatic zone.