Appendix M State Significant Impact Assessments

M.1 NSW IMPACT ASSESSMENT

An assessment of the impacts of the Project on species, populations and ecological communities listed under Schedules 1 and 2 of the TSC Act has been completed. The Project will be assessed under Part 5.1 State Significant Infrastructure of the EP&A Act. This impact assessment was undertaken in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC 2004) for vegetation communities, the Cumberland Plain Land Snail and Green and Golden Bell Frog.

The proposed footprint of the NWRL supports areas of native vegetation including five EECs, and potential and known habitat for a number of threatened fauna species. A full list of species recorded within a 10 km radius of the construction footprint is found in Appendix A, however not all of these species or their habitats are likely to be impacted by the Project. Potentially impacted species are listed below. Each species has been assessed for potential impacts that may result from the Project. Fauna species have been grouped based on fauna groups and / or the habitat they are likely to use within the NWRL development area.

Endangered Ecological Communities

- Blue Gum High Forest in the Sydney Basin Bioregion
- Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion
- Cumberland Plain Woodland
- Shale/Sandstone Transition Forest
- River Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin, and South East Corner Bioregions

Threatened Flora

- *Epacris purpurascens* var. *purpurascens*

Threatened Fauna

Invertebrates

- Cumberland (Large) Land Snail (*Meridolum corneovirens*)

Amphibians

- Green and Golden Bell Frog (*Litoria aurea*)

Parrots

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*)

- Gang Gang Cockatoo (*Callocephalon fimbriatum*) (includes vulnerable population)
- Swift Parrot (*Lathamus discolour*)
- Turquoise Parrot (*Neophema pulchella*)

Owls

- Powerful Owl (*Ninox strenua*)
- Barking Owl (*Ninox corneovirens*)

Woodland Birds –ground and mid-storey foraging (passerines)

- Scarlet Robin (*Petroica boodang*)
- Varied Sittella (*Daphoenositta chrysoptera*)
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)

Woodland Birds – canopy foraging (excluding parrots)

- Regent Honeyeater (*Anthochaera phrygia*)
- Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)
- Superb Fruit-Dove *(Ptilinopus superbus*)

Predominantly Tree-roosting Bats

- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- East Coast Freetail Bat (*Mormopterus norfolkensis*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)

Predominantly Cave-roosting Bats

- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)
- Large-footed (Southern) Myotis (*Myotis macropus*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)

Megabats

- Grey-headed Flying-Fox (*Pteropus poliocephalus*)

Mid-storey and log dependent Mammals

- Spotted-tailed Quoll (*Dasyurus maculatus*)

Migratory Terrestrial Species (EPBC Act)

- Fork-tailed Swift (*Apus pacificus*)

- White-throated Needletail (*Hirundapus caudacutus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Regent Honeyeater (*Anthochaera phrygia*)

Migratory Wetland Species (EPBC Act)

- Great Egret (*Ardea alba*)
- Cattle Egret (*Ardea ibis*)
- Latham's Snipe (*Gallinago hardwickii*)

M.2 SUMMARY OF IMPACTS

The following tables summarise the impacts to known or potential habitat for EECs and threatened fauna that are likely to be impacted by the proposed NWRL. The tables include (where appropriate) the community/species name; their conservation status at the state and federal level; an estimate of the amount of habitat likely to be directly or indirectly impacted; an estimate of the amount of habitat within the region; and the percentage of habitat to be lost as a result of the NWRL at the regional level.

Table 29: Summary of Impacts - Endangered Ecological Communities

VEGETATION COMMUNITY	TSC ACT	EPBC ACT	IMPACTED (HA)				TOTAL AREA IMPACTED (HA)	TOTAL AREA WITHIN ENTIRE DISTRIBUTION (HA)	% LOSS WITHIN ENTIRE DISTRIBUTION
			DIRECT IMPACTS		INDIRECT IMPACTS				
Blue Gum High Forest	CEEC	CEEC*	1.01		0.16		1.17	136 ha (SEWPaC 2011)	0.86
Sydney Turpentine-Ironbark Forest	EEC	CEEC**	0.32		0.43		0.75	1,484.38 ha *** 2,495 ha** (SEWPaC 2011)	0.05
Shale/Sandstone Transition Forest	EEC	EEC	0.78		0.38		1.16	9,950 ha (DECC 2005)	0.01
Cumberland Plain Woodland	CEEC	CEEC*	In GC	Outside GC	In GC	Outside GC	27.49	10,612 ha (DECCW 2010)	0.26
			11.22	13.88	1.07	1.32			
River Flat Eucalypt Forest	EEC	Not listed	In GC	Outside GC	In GC	Outside GC	4.13	5,313 ha (DECCW 2010)	0.08
			0.94	1.39	0.69	1.11			

Notes:

*Not all TSC listed vegetation patches meet the EPBC Act definition for STIF and CPW
**EPBC Act definition of STIF includes Blue Mountains Shale Cap Forest and Turpentine-Ironbark Forest.

*** Has been calculated from NPWS 2002b and DECCW 2009

GC = NWGC

Table 30: Assumptions used during calculation of direct and indirect impacts to primary and secondary habitat – Threatened Fauna

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Cumberland Plain Land Snail	Requires fallen logs, leaf litter and bark usually at the base of trees in Cumberland Plain Woodland and River Flat Eucalypt Forest to breed and forage. Unlikely to use patches of habitat more than 350m apart (Clark and Richardson 2002).	Clearing of good condition Cumberland Plain Woodland and River Flat Eucalypt Forest.	20m from good or moderate condition and 10m from poor condition Cumberland Plain Woodland and River Flat Eucalypt Forest.	Breeding and foraging habitat are the same and have been covered under impacts to primary habitat.		Extent of good condition Cumberland Plain Woodland and River Flat Eucalypt Forest identified by NPWS (2002b)
Green and Golden Bell Frog	Riparian zones and water bodies (including farm dams) with well-established fringing vegetation adjacent to open grassland areas for foraging, preferably not containing Gambusia.	Areas of 'potential breeding habitat' confirmed during target field surveys.	Mapped 'potential breeding habitat' within 50m of footprint	Areas providing 'potential movement corridors' confirmed during target field surveys.	Mapped 'potential movement corridors' within 10m of footprint	Not able to be determined by this study and not known from background research.
Glossy Black-cockatoo	Feeds exclusively on *Allocasuarina* and *Casuarina* species. Utilises large hollows for breeding.	Loss of any tree hollows 100-300mm within any native veg (excluding Cumberland Plain Woodland).	Any HBT 100-300mm within 50m of footprint within any native veg (excluding Cumberland Plain Woodland).	Loss of all native veg within the footprint excluding Cumberland Plain Woodland as it contains low densities of foraging trees	20m from good or moderate condition veg and 10m from poor condition veg (excluding Cumberland Plain Woodland)	Extent of the veg communities utilised for primary and secondary habitat within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Gang-gang Cockatoo	Breeds in tree hollows within Hornsby and Ku-ring-gai LGA's (Endangered Population). Otherwise, breeds in mountains and forages in the lowlands when non-breeding. Feeds on seeds of eucalypts and wattles; berries, fruits, nuts, insects.	Loss of tree hollows 100-300mm within footprint in Hornsby LGA	Any HBT 100-300mm within 50m of footprint in Hornsby LGA	Loss of all native veg throughout the entire footprint	20m from good or moderate condition veg and 10m from poor condition veg	Extent of the veg communities utilised for primary and secondary habitat within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Swift Parrot	Non-breeding winter migrant. Occurs in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.	None		Loss of any native veg throughout the entire footprint	20m from good or moderate condition vegetation and 10m from poor condition vegetation	Extent of the vegetation communities utilised for primary and secondary habitat within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Turquoise Parrot	Eucalypt woodland adjoining clearings. Spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Nests in tree hollows >50mm diameter in living or dead tree, fence stumps and posts.	Loss of tree hollows <100mm and 100-300mm within Cumberland Plain Woodland and River Flat Eucalypt Forest vegetation	HBT <100mm and 100-300mm within Cumberland Plain Woodland and River Flat Eucalypt Forest vegetation and within 50m of footprint	Cumberland Plain Woodland and River Flat Eucalypt Forest in good or moderate condition	20m from good or moderate condition Cumberland Plain Woodland and River Flat Eucalypt Forest	Extent of good or moderate condition Cumberland Plain Woodland and River Flat Eucalypt Forest on the Cumberland Plain (NPWS 2002b)
Powerful Owl	Old growth trees with large hollows and abundant prey items (including hollows and shrub layer as prey habitat).	Loss of hollows >300mm within Cheltenham and Cherrybrook sites.	HBT >300mm within 50m of Cheltenham and Cherrybrook sites.	Loss of any native vegetation at the Cheltenham, Cherrybrook and Epping sites.	50m from Cheltenham impact footprint (temporary impact)	Any good condition native vegetation >5ha patch size within Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009)

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Barking Owl	Old growth trees with large hollows and abundant prey items (including hollows and shrub layer as prey habitat).	Loss of hollows >300mm within Cheltenham and Cherrybrook sites.	HBT >300mm within 50m of Cheltenham and Cherrybrook sites.	Loss of any native vegetation at the Cheltenham, Cherrybrook and Epping sites.	50m from Cheltenham impact footprint (temporary impact)	Any good condition native vegetation >5ha patch size within Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009)
Scarlet Robin	Abundant logs and fallen timber. Insect feeder.	Loss of Cumberland Plain Woodland vegetation in good condition	20m from footprint in good condition Cumberland Plain Woodland	None – covered in primary habitat		Good condition Cumberland Plain Woodland vegetation (NPWS 2002b)
Brown Treecreeper	Dry open woodlands. Uncommon in coastal areas. Requires hollows in dead or live tree or tree stump for breeding. 80% diet is ants.	Loss of tree hollows 100-300mm within good condition Cumberland Plain Woodland and River Flat Eucalypt Forest	HBT (100-300mm) within 20m from footprint in good condition Cumberland Plain Woodland and River Flat Eucalypt Forest	Loss of good condition Cumberland Plain Woodland and River Flat Eucalypt Forest	20m from footprint in good condition Cumberland Plain Woodland and River Flat Eucalypt Forest	Good condition Cumberland Plain Woodland and River Flat Eucalypt Forest within the Cumberland Plain (NPWS 2002b)
Varied Sittella	Prefers rough-barked eucalypt species and mature smooth-barked gums with dead branches. Insect feeder.	Loss of any good condition vegetation within footprint	20m from footprint in any good condition vegetation	None – covered in primary habitat		Good condition vegetation within Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009)

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Black-chinned Honeyeater	Rarely recorded east of the Great Dividing Range. Nomadic and feeds on winter flowering gums.	None		Loss of Cumberland Plain Woodland, River Flat Eucalypt Forest or Shale/Sandstone Transition Forest vegetation	None	Extent of the vegetation communities utilised for primary and secondary habitat within the Cumberland Plain (NPWS 2002b).
Regent Honeyeater	Nomadic, non-breeding winter migrant. Feeds on winter flowering gums.	None		Loss of Cumberland Plain Woodland or River Flat Eucalypt Forest	20m from good or moderate condition Cumberland Plain Woodland or River Flat Eucalypt Forest and10m from poor condition Cumberland Plain Woodland or River Flat Eucalypt Forest	Extent of the vegetation communities utilised for primary and secondary habitat within the Cumberland Plain (NPWS 2002b).
Superb Fruit-dove	Unlikely to breed within study area. No primary habitat (rainforest); only marginal secondary foraging habitat	None		Loss of moderate or poor condition native vegetation	None	All native vegetation within the Cumberland Plain and SMCMA study areas (NPWS 2002b and DECCW 2009)
Yellow-bellied Sheathtail-bat	Roosts singly or in groups of up to six, in tree hollows and buildings. Forages in most habitats across its very wide range, with and without trees.	Loss of tree hollows <100mm	HBT <100mm within 20m of footprint	Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Eastern False Pipistrelle	Prefers moist habitats with trees taller than 20m. Roosts in tree hollows but has also been found roosting in buildings or under loose bark.	Loss of tree hollows <100mm	HBT <100mm within 20m of footprint	Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
East Coast Freetail Bat	Occurs in dry eucalypt forest, woodland, wet sclerophyll forests and forest edges. Primarily roosts in hollows or behind loose bark in mature eucalypts.	Loss of tree hollows <100mm	HBT <100mm within 20m of footprint	Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Greater Broad-nosed Bat	Associated with moist gullies in mature coastal forest, or rainforest. Forages along linear clearings (creeks, roads) in dense vegetation types. Usually roosts in tree hollows, but also found in buildings.	Loss of tree hollows <100mm	HBT <100mm within 20m of footprint	Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Eastern Bent-wing Bat	Wet and dry sclerophyll forests. Individuals use numerous roosts including mines, culverts, stormwater channels, buildings, and occasionally tree-hollows. Congregate in large numbers at a small number of nursery caves to breed and hibernate.	Cannot assess for cave-dwelling bats as do not have data (including potential man-made structures)		Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Large-footed Myotis	Will occupy most habitat types as long as they are close to water which is forages over for insects and small fish. Roosts in groups of 10-15 most commonly in caves, but also in tree hollows, amongst vegetation, under bridges, in mines, tunnels and stormwater drains.	Cannot assess for cave-dwelling bats as do not have data (including potential man-made structures)		Loss of water bodies	Water bodies within 50m of footprint	All water bodies within Cumberland Plain and SMCMA study area (NPWS 2002b and DECCW 2009).

SPECIES	SPECIFIC HABITAT REQUIREMENTS	PRIMARY HABITAT (BREEDING) [1]		SECONDARY HABITAT (FORAGING) [2]		DEFINITION OF REGIONAL HABITAT [4]
		DIRECT	INDIRECT	DIRECT	INDIRECT	
Large-eared Pied Bat	Found in well-timbered areas containing gullies. Forages for small, flying insects below the forest canopy. Roosts in caves, crevices in cliffs, old mine workings and disused mud nests of *Hirundo ariel* (Fairy Martin). Females (20-40) will gather in maternity roosts such as roof domes in sandstone caves.	Cannot assess for cave-dwelling bats as do not have data (including potential man-made structures)		Loss of any native vegetation throughout the entire footprint	Any native vegetation within 50m of footprint	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Grey-headed Flying-fox	Forage widely on nectar and pollen of native trees, rainforest fruits and cultivated gardens and fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	None – no camps present		All native vegetation clearing	None – habituated to light and noise	All native vegetation within the Cumberland Plain and SMCMA studies (NPWS 2002b and DECCW 2009).
Spotted-tailed Quoll	Requires maternal den sites (logs with cryptic entrances; rock outcrops; windrows; burrows), an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage. Individual dens may include tree hollows; small caves, or rocky-cliff faces. Females occupy home ranges up to 750 hectares and males up to 3500 hectares.	None – unlikely to breed within study area		Native vegetation clearing at Cheltenham and Epping sites	None	Any good condition native vegetation >5ha patch size within SMCMA and Cumberland Plain studies (NPWS 2002b and DECCW 2009).

Notes:

1. Primary habitat is defined as habitat critical to the lifecycle of the species including nesting and breeding sites;
2. Secondary habitat includes the foraging habitat that is generally widespread and accessible to the species.
3. Figures in brackets represent habitat within the NWGCs (biocertified).
4. The assessment of regional habitat should be considered to be highly indicative. It is for broad assessment purposes only and based on available GIS data and an understanding of the species habitat requirements.
5. It is noted that the GGBF could forage across a broader area than just movement corridors however there are significant limitations in making an adequate assessment of broader foraging habitat and consequently this type of habitat has not been included in 'secondary habitat' for this species.

Table 31: Tree hollows directly impacted by the proposed NWRL

VEGETATION COMMUNITY	DIRECT IMPACT			INDIRECT IMPACT (DISTANCE FROM CONSTRUCTION FOOTPRINT)								
				WITHIN 10M			WITHIN 20M			WITHIN 50M		
	TREES WITH HOLLOWS OF VARYING DIAMETRE			TREES WITH HOLLOWS OF VARYING DIAMETRE			TREES WITH HOLLOWS OF VARYING DIAMETRE			TREES WITH HOLLOWS OF VARYING DIAMETRE		
	<100MM	100 - 300MM	>300MM	<100MM	100 - 300MM	>300MM	<100MM	100 - 300MM	>300MM	<100MM	100 - 300MM	>300MM
Blue Gum High Forest	1	1	0	0	0	0	0	0	0	0	0	0
Coastal Shale-Sandstone Forest	1	6	1	0	0	1	0	0	0	0	0	0
Cumberland Plain Woodland	27	6	1	1	2	3	2	0	0	1	0	0
River Flat Eucalypt Forest	4	1	2	3	3	3	2	6	0	4	3	0
Shale/Sandstone Transition Forest	3	5	0	4	3	1	3	1	0	7	3	0
Sydney Turpentine-Ironbark Forest	0	0	0	0	0	0	0	2	0	6	3	0
Planted/Exotic	16	21	7	1	3	2	5	10	2	5	1	1
Unmapped	6	3	0	0	5	1	0	0	0	5	6	3

Table 32: Summary of impacts – Threatened Fauna

SPECIES	TSC ACT	EPBC ACT	HABITAT IMPACTED (HA)				TOTAL IMPACTED (HA)	TOTAL DIRECT AND INDIRECT (HA)	AREA OF HABITAT WITHIN THE REGION (HA)	% OF HABITAT WITHIN THE REGION IMPACTED ED
			PRIMARY		SECONDARY					
			DIRECT	INDIRECT	DIRECT	INDIRECT				
Cumberland Plain Land Snail	E	-	0.63 (3.83)	2.43 (1.76)	Same as primary habitat		3.06 (5.59)	8.65	8519.73	0.10
Green and Golden Bell Frog	E	V	0.11 (0.50)	0.02 (0.00)	1.72 (1.53)	0.81 (0.20)	2.66 (2.23)	4.89	N/A	N/A
Glossy Black-cockatoo	V	-	13 (0) hollows	24 (0) hollows	4.83 (0.94)	3.24 (0.69)	8.07 (1.63)	9.70	33262.44	0.03
Gang-gang Cockatoo	V, E2	-	9 (0) hollows	8 (0) hollows	18.71 (12.16)	4.56 (1.76)	23.27 (13.92)	37.19	50009.98	0.07
Swift Parrot	E	E	None Known	None Known	18.71 (12.16)	4.56 (1.76)	23.27 (13.92)	37.19	50009.98	0.07
Turquoise Parrot	V	-	37 (0) hollows	24 (0) hollows	9.41 (5.22)	1.48 (0.79)	10.89 (6.01)	16.90	11474.3	0.15
Powerful Owl	V	-	2 (0) hollows	1 (0) hollows	2.39 (0.00)	2.32 (0.00)	4.71 (0.00)	4.71	17467.82	0.03
Barking Owl	V	-	2 (0) hollows	1 (0) hollows	2.39 (0.00)	2.32 (0.00)	4.71 (0.00)	4.71	17467.82	0.03
Scarlet Robin	V	-	0.63 (3.26)	0.00 (0.05)	Same as primary habitat		0.63 (3.31)	3.94	5250.71	0.08
Brown Treecreeper	V	-	0 (0) hollows	0 (0) hollows	0.63 (3.83)	0.00 (0.36)	0.63 (4.19)	4.82	8519.73	0.06
Varied Sittella	V	-	1.52 (3.83)	1.10 (0.36)	Same as primary habitat		2.62 (4.19)	6.81	19914.17	0.03
Black-chinned	V	-	None Known	None Known	16.05 (12.16)	None Known	16.05 (12.16)	28.21	43195.36	0.07
Superb Fruit-dove	V	-	None Known	None Known	17.19 (8.33)	None Known	17.19 (8.33)	25.52	50009.98	0.05
Regent Honeyeater	E	E & M	None Known	None Known	15.27 (12.16)	2.43 (1.76)	17.70 (13.92)	31.62	24785.67	0.13
Yellow-bellied Sheathtail-bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10

Eastern False Pipistrelle	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
East Coast Freetail Bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Greater Broad-nosed Bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Eastern Bent-wing Bat	V	-	None Known	Known roosting culvert under M2 at Cheltenham	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Large-footed Myotis	V	-	None Known	None Known	Foraging habitat comprises waterbodies such as small farm dams and creeklines which are not quantified.					N/A
Large-eared Pied Bat	V	V	None Known	None Known	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Grey-headed Flying-fox	V	V	None Known	None Known	18.71 (12.16)	None Known	18.71 (12.16)	30.87	50009.98	0.06
Spotted-tailed Quoll	V	E	None Known	None Known	1.38 (0.00)	None Known	1.38 (0.00)	1.38	17467.82	0.01

Notes:

Primary habitat is defined as habitat critical to the lifecycle of the species including nesting and breeding sites;

Secondary habitat includes foraging habitat that is generally widespread and accessible to the species.

Figures in brackets represent habitat/impacts within and exclusive to the NWGCs (biocertified).

The assessment of regional habitat should be considered to be highly indicative. It is for broad assessment purposes only and based on available GIS data and an understanding of the species habitat requirements.

M.3 ENDANGERED ECOLOGICAL COMMUNITIES

M.3.1 Blue Gum High Forest in the Sydney Basin Bioregion

Blue Gum High Forest in the Sydney Basin Bioregion is the name given to the ecological community listed as critically endangered in Part 2 of Schedule 1A of the *Threatened Species Conservation Act 1995*. Blue Gum High Forest is described as a moist, tall open forest community dominated by either *Eucalyptus pilularis* (Blackbutt) or *E. saligna* (Sydney Blue Gum). *Angophora costata* (Smooth-barked Apple), *A. floribunda* (Rough-barked Apple), and *E. paniculata* (Grey Ironbark) also occur depending on slope and soil characteristics (OEH 2011b). The midstorey comprises mesophyllous shrubs (particularly in gullies) and small trees, and the ground stratum is often dense, containing a mixture of herb, grass, and fern species (OEH 2011b). A list of flora species characteristic of the ecological community is provided by the Scientific Committee in the Final Determination for Listing (OEH 2011).

Blue Gum High Forest is found on the north shore and northern suburbs of Sydney and has a highly restricted and fragmented geographic distribution comprised of a series of small remnant patches. The area of extant Blue Gum High Forest remaining in 2005 was estimated to be 95ha consisting of small fragmented remnants (SEWPaC 2011). Highly modified relics persist as small clumps of trees without a native understorey, or which have an understorey largely replaced by woody exotic species or by increased abundance of native and exotic grasses (OEH 2011b). Small scale clearing, the influx of stormwater, and dispersal of weed propagules from nearby urban areas pose significant ongoing threats to the survival of Blue Gum High Forest (OEH 2011b).

Across the NWRL study area, Blue Gum High Forest has only been identified at the proposed Cherrybrook site (Tile 6). The direct and indirect impacts to Blue Gum High Forest as a result of the proposal are shown in Table 29. The following section responds to the questions of the Improve or Maintain test (DEC and DPI 2005).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable; Blue Gum High Forest is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal is likely to reduce the habitat for Blue Gum High Forest through clearing vegetation to construct the Cherrybrook Railway Station. Table 29 shows the amount of Blue Gum High Forest that will be removed for construction of the station and associated works, including the percentage that this clearing represents across the entire regional distribution of the community.

Apart from direct removal of the vegetation community, there will be indirect impacts to the community through a reduction of the remaining Blue Gum High Forest remnant size, creation of new edges to the vegetation, and potential disturbance to soils and hydrology resulting from the works. The level of impact from indirect sources has been estimated and is shown in Table 29.

Impacts to Blue Gum High Forest have been avoided where possible. The areas of Blue Gum High Forest in good condition are located to the north of the proposed Cherrybrook Station and will not be impacted by the proposal. The Blue Gum High Forest that will be impacted by the Cherrybrook Station construction is of degraded condition. Mitigation measures to protect the remaining stand of Blue Gum High Forest adjacent to the proposed Cherrybrook Station include sediment and erosion control, weed removal, and bush regeneration. For the areas of Blue Gum High Forest that cannot be avoided an Offset Strategy (Appendix N) has been prepared.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable; Blue Gum High Forest is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The species composition of a Blue Gum High Forest remnant will be influenced by the size of the remnant, recent rainfall or drought conditions and by its disturbance history (including fire) (SEWPaC 2011). The number, and relative abundance, of species will change with time since fire, and may also change in response to changes in fire regime (including fire frequency) (SEWPaC 2011).

The presence of urban development surrounding the Blue Gum High Forest at Cherrybrook has resulted in a fire regime of fire suppression, and there was no evidence of recent fires or arson (for at least 20 years). The recommended minimum fire interval for Blue Gum High Forest is 25-30 years (RFS 2006) to maintain maximum biodiversity.

The lack of fire has encouraged the dominance of native mesic species like *Pittosporum undulatum,* and exotic mesic species including *Tradescantia albiflora* and *Ligustrum* spp. in the understorey. Mitigation measures proposed to protect the remaining stand of a mix of poor and good condition Blue Gum High Forest north of the proposed Cherrybrook Station (outside of the construction footprint via site-specific Vegetation Management Plan) include active weed control and bush regeneration activities targeting invasive weeds, and thinning of mesic native species where required to promote a diversity of native understorey groundcovers and shrubs.

Blue Gum High Forest is restricted to deep clay soils derived from shale, within areas of high annual rainfall (816-1250mm) (SEWPaC 2011). The current drainage patterns at the site have been impacted by surrounding urban development, including the construction of an open stormwater drain along the western edge of the remnant backing onto a residential area. This stormwater drain is currently heavily infested with weeds.

The Environmental Management Framework for the proposed station and railway line will include strict sediment and erosion control measures to ensure the runoff from the construction site is diverted away from the Blue Gum High Forest remnant, so as not to impact the existing drainage patterns or soil conditions of the site.

The Blue Gum High Forest remnant has been mapped as degraded. Weed invasion is currently high and there is the potential for the proposal to result in the introduction of further invasive species. A number of mitigation measures have been proposed to prevent the introduction of weeds to the construction site. Weed monitoring, control, and progressive rehabilitation will help to reduce the potential for the remaining Blue Gum High Forest vegetation to be invaded by weeds.

Overall, the proposal is unlikely to alter the current disturbance regimes such that it would place the community at risk of extinction. Mitigation measures will protect the existing soil and drainage patterns and weed control will reduce the current level of weed invasion.

How is the proposal likely to affect habitat connectivity?

The proposal will reduce the size of the remnant patch adjacent to the Cherrybrook Station by removing the southern extent of the patch as detailed in Table 29. While the overall size of the patch will be reduced habitat connectivity is unlikely to be affected due to the vegetation to be cleared currently being mostly surrounded by urban areas.

The next closest patch of Blue Gum High Forest is located approximately 135m to the northwest and separated via an area of planted/exotic vegetation and Roberts Road. This small patch consists of canopy trees only. While Blue Gum High Forest has been mapped within the general locality of Cherrybrook by the CMA, it generally exists as small fragments and has not been validated by ELA staff. Given the existing level of fragmentation and small patch size of Blue Gum High Forest throughout the landscape, the amount being impacted both directly and indirectly by the proposed NWRL is unlikely to significantly decrease the level of habitat connectivity at the landscape level.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for Blue Gum High Forest.

M.3.2 Sydney Turpentine-Ironbark Forest

Sydney Turpentine-Ironbark Forest is an open forest, with dominant canopy trees including *Syncarpia glomulifera* (Turpentine), *Eucalyptus punctata* (Grey Gum), *Eucalyptus paniculata* (Grey Ironbark), and *E. eugenioides* (Thin-leaved Stringybark) (DECC 2005). In areas of high rainfall (over 1050 mm per annum) *E. saligna* (Sydney Blue Gum) is more dominant. The shrub stratum is usually sparse and may contain mesic species such as *Pittosporum undulatum* (Sweet Pittosporum) and *Polyscias sambucifolia* (Elderberry Panax) (DECC 2005).

Sydney Turpentine-Ironbark Forest occurs close to the Shale/Sandstone boundary on the more fertile shale influenced soils, in higher rainfall areas on the higher altitude margins of the Cumberland Plain, and on the shale ridge caps of sandstone plateaus. It is a transitional community, between Cumberland Plain Woodland in drier areas and Blue Gum High Forest on adjacent higher rainfall ridges (DECC 2005).

Sydney Turpentine-Ironbark Forest occurs at the eastern end of the proposed NWRL at the following sites (for more detailed information consult Appendix L – Site Profiles):

Epping (Tile 1) – small area of clearing in south west corner of Sydney Turpentine-Ironbark Forest patch (TSC Act and EPBC Act) for construction area. Tunnelling underneath the STIF is unlikely to impact the vegetation.

Cheltenham (Tile 2) – Good condition (TSC Act only); small amount of clearing for construction.

Hills Centre Station (Tile 10) – poor condition (TSC Act and EPBC Act); some clearing of Sydney Turpentine-Ironbark Forest within construction boundary.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable; Sydney Turpentine-Ironbark Forest is a critically ecological endangered community and is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposed railway alignment dissects through or underneath Sydney Turpentine-Ironbark Forest at Epping, Cheltenham, and the Hills Centre Station. The proposal is likely to result in the direct clearing of vegetation at each of these locations. Additional vegetation removal is required during the diversion of Cattai Creek for the underground tunnelling of the NWRL link between the Hills Centre Station and Norwest Station. The location of this appears to avoid Sydney Turpentine-Ironbark Forest vegetation. Table 29 indicates the amount of Sydney Turpentine-Ironbark Forest that will be removed for construction of the station and associated works, including the percentage that this clearing represents across the entire distribution of the community.

Apart from direct removal of the vegetation community, there will be indirect impacts to the community through a reduction in size and/or fragmentation of the remaining Sydney Turpentine-Ironbark Forest remnant. Indirect impacts include; the creation of new edges to the vegetation, and potential disturbance to soils and hydrology resulting from the works. The level of impact from indirect sources has been estimated and is shown in Table 29.

Impacts to the Sydney Turpentine-Ironbark Forest community have been avoided where possible. Two patches of Sydney Turpentine-Ironbark Forest in good condition are located north-east of the Cheltenham construction area (Tile 2 and 3), with a small area of the southernmost patch proposed to

be cleared for construction. For the areas of Sydney Turpentine-Ironbark Forest that cannot be avoided an Offset Strategy (Appendix N) has been prepared. Mitigation measures to protect the remaining area of Sydney Turpentine-Ironbark Forest include the preparation of a VMP for Epping (Tile 1), Cheltenham (Tiles 2 and 3), and the Hills Centre Station (Tile 10).

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable; Sydney Turpentine-Ironbark Forest is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

Direct impacts will result in the removal of Sydney Turpentine-Ironbark Forest from Epping, Cheltenham, and Hills Centre Station. Indirect impacts are also expected at each of these sites. The proposal is likely to affect the current disturbance regime on both the direct and indirect impacted Sydney Turpentine-Ironbark Forest communities.

The species composition of the Sydney Turpentine-Ironbark Forest remnants are influenced by the size of the remnant, recent rainfall or drought conditions, and by its disturbance history (including fire) (SEWPaC 2011). The number, and relative abundance, of species will change with time since fire, and may also change in response to changes in fire regime (including fire frequency) (SEWPaC 2011).

The presence of urban development surrounding the Sydney Turpentine-Ironbark Forest at each of the three sites has altered the natural fire regime. Fire suppression (>50 years since fire) can cause a loss of fire-dependant flora species. The best management practices for Sydney Turpentine-Ironbark Forest fire management recommend a fire frequency between 15 – 30 years to maintain maximum biodiversity (SMCMA 2008).

An absence of fire management within the Hills Centre Station, Epping, and Cheltenham study areas has provided suitable habitat for the establishment of exotic species such as *Cardiospermum grandiflorum* (Balloon Vine) and *Ligustrum lucidum* (Large Leaved Privet). Mitigation measures to protect the remaining stand of Sydney Turpentine-Ironbark Forest north of the proposed Epping and Hills Centre Stations, and Cheltenham study area include the implementation of a VMP incorporating weed control and bush regeneration.

Sydney Turpentine-Ironbark Forest occurs on fertile soils at the Shale/Sandstone transition, within areas of high rainfall (DECC 2005). Sydney Turpentine-Ironbark Forest community is prone to hydrological disturbances from urban development. Weed infestation, nutrient enrichment, accumulation of rubbish, and periodic flushing of creeks are considered current disturbances which affect the Epping, Cheltenham, and The Hills Centre Station study areas. Epping contains Sydney Turpentine-Ironbark Forest along a tributary that flows into Devlins Creek, and stormwater outlets off Castle Howard Rd contribute to the flow. Weed infestation is significant in this location. Similarly the hydrological flow along Cattai Creek at The Hills Centre Station has also been disturbed following the construction of urban infrastructure and the infestation of weeds. The current condition of Sydney Turpentine-Ironbark Forest at these locations is highly degraded. Hydrological flow plays a significant role in the species composition within the Sydney Turpentine-Ironbark Forest community, and the proposed NWRL alignment may further alter the current hydrological flow within these Sydney Turpentine-Ironbark Forest communities.

Mitigation measures to restore and rehabilitate the remaining STIF adjacent to the proposed NRWL construction areas will improve the condition of these areas through weed control and bush regeneration as described in a VMP. In addition, the Environmental Management Framework for the

proposed alignment of the railway and stations will include strict sediment and erosion control measures to ensure the runoff from the construction site is diverted away from the Sydney Turpentine-Ironbark Forest remnant, so as not to impact the existing drainage patterns or soil conditions of the site.

Weed invasion within the directly impacted areas of Sydney Turpentine-Ironbark Forest is currently high, and there is the potential for the proposal to result in the introduction and spread of further invasive species. A number of mitigation measures have been proposed to prevent the introduction of weeds to the construction site, and a weed control procedure will be developed as part of the Environmental Management Framework for the proposal, including use of clean plant and equipment. Weed monitoring, control, and progressive rehabilitation will help to reduce the potential for the remaining Sydney Turpentine-Ironbark Forest vegetation to be invaded by weeds.

Overall, the proposal is unlikely to alter the current disturbance regimes such that it would place the community at risk of extinction. Mitigation measures will protect the existing soil and drainage patterns and weed control will reduce the current level of weed invasion.

How is the proposal likely to affect habitat connectivity?

The proposal will reduce the extent of Sydney Turpentine-Ironbark Forest at the Epping, Cheltenham, and the Hills Centre Station (Table 29). According to the proposed alignment, the southern extent of Sydney Turpentine-Ironbark Forest will be removed from within the Epping study area (TSC and EPBC Act). Another smaller patch of Sydney Turpentine-Ironbark Forest (TSC Act only) occurs on the eastern side of Beecroft Road, and a small portion of the northern most extent of this patch will also be removed. The removal of Sydney Turpentine-Ironbark Forest from these two patches is unlikely to fragment the Sydney Turpentine-Ironbark Forest community at this location, but it will reduce the size of the current patches. Both patches are bounded by urban infrastructure and urban development, and their condition is mapped as poor (degraded).

Further reduction in the size of these patches of Sydney Turpentine-Ironbark Forest may reduce the resilience of native species within this community. Sydney Turpentine-Ironbark Forest has been mapped approximately 400m to the south-west of these patches in Boronia Park, Epping. It is separated by Carlingford Rd and urban development. The remaining vegetation surrounding the Epping Sydney Turpentine-Ironbark Forest community is also highly fragmented. Given the existing level of fragmentation and small patch size of Sydney Turpentine-Ironbark Forest throughout the landscape, the amount impacted both directly and indirectly by the proposed NWRL is unlikely to significantly decrease the level of habitat connectivity at the landscape level.

The loss of a small portion of a good condition patch of Sydney Turpentine-Ironbark Forest at Cheltenham will reduce the overall size of this patch, but will not fragment the community at this location. The STIF patch at this location fronts onto road and is surrounded on the other sides by Sydney Turpentine-Ironbark Forest and Coastal Shale-Sandstone Forest.

Sydney Turpentine-Ironbark Forest is present at the Hills Centre Station site as two separate patches connected via planted/exotic vegetation along Cattai Creek. The western most patch will be subject to indirect impacts, but the eastern patch will be cleared along its northern margin where it fronts a car park for the Council Works Depot. This patch is mapped as poor condition (TSC Act only) and is surrounded by industrial and residential development. While the extent of this patch will be reduced, given the already highly fragmented landscape, fragmentation between other areas of Sydney Turpentine-Ironbark Forest will not result.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for Sydney Turpentine-Ironbark Forest.

M.3.3 Cumberland Plain Woodland

Cumberland Plain Woodland occurs on soils derived from Wianamatta Shale throughout the driest part of the Sydney Basin. Good examples can be seen at Scheyville National Park and Mulgoa Nature Reserve. The dominant canopy trees of Cumberland Plain Woodland are *Eucalyptus moluccana* (Grey Box) and *E. tereticornis (*Forest Red Gum), with *E. crebra (*Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum), and *E. eugenioides* (Thin-leaved Stringybark) occurring less frequently. The shrub layer is dominated by *Bursaria spinosa* (Blackthorn), and it is common to find abundant grasses such as *Themeda australis* (Kangaroo Grass) and *Microlaena stipoides* var *stipoides (*Weeping Meadow Grass) (DECC 2005).

Cumberland Plain Woodland occurs at the following sites throughout the NWRL (For more information consult Appendix L – Site Profile);

Celebration Drive to Balmoral Road (Tile 14) – Poor condition (TSC Act only) and moderate condition (TSC Act and EPBC Act)

Balmoral Road to Burns Road (Tile 15) – poor, moderate and good condition (all TSC Act only)

Burns Road to Samantha Riley Drive (Tiles 15 and 16) - poor, moderate and good condition (all TSC Act only)

Samantha Riley Drive to Windsor Road (Tile 16) – poor condition (TSC Act only)

Windsor Road to Sanctuary Drive (Tile 17) – poor and moderate condition (TSC Act only)

Rouse Hill Station (Tile 18) – moderate condition (TSC Act only)

Area 20 Windsor Road Viaduct (NW Growth Centre) (Tile 18) – poor condition (TSC Act only)

Area 20 Windsor Road Viaduct to Tallawong Road (NW Growth Centre) (Tiles 18, 19, 20) – good condition (TSC Act and EPBC Act) and poor and moderate (TSC Act only)

Talllawong Road to First Ponds Creek (NW Growth Centre) (Tile 20) – poor and moderate condition (TSC Act only)

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable; Cumberland Plain Woodland is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal is likely to reduce the habitat for Cumberland Plain Woodland through clearing vegetation for the construction of NWRL including four stations, car parks, construction areas, and stabling yards. These areas are all located within the proposed construction footprint. Direct and indirect impacts to Cumberland Plain Woodland as a result of the NWRL construction are shown in Table 29. The impacts that occur within the Biocertified NWGC are shown in Table 29 in brackets.

Apart from direct removal of the community, there will be indirect impacts through a reduction of the remaining Cumberland Plain Woodland remnant size, which is likely to further decrease the ecological integrity of the remnants. Clearing of Cumberland Plain Woodland to accommodate the NWRL will increase the level of fragmentation and isolation of remnants, which impacts on ecological processes including pollination, recruitment, and maintaining genetic diversity amongst populations.

Removal of Cumberland Plain Woodland vegetation in good to moderate condition has been avoided where possible. Some unavoidable good and moderate CPW is likely to be impacted as a result of the proposed activities. Consequently, an offset strategy has been prepared (see Appendix N).

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable; Cumberland Plain Woodland is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

Much of the distribution of Cumberland Plain Woodland occurs within privately owned properties and commercial lots. The vegetation condition of the Cumberland Plain Woodland varies from poor – good condition depending on the current and existing disturbance regime. These areas have succumbed to numerous disturbances including:

- Habitat fragmentation;
- Clearing of native vegetation;
- Mechanical mowing
- Alteration of natural fire regimes
- Weed invasion;
- Nutrient enrichment;
- Soil disturbance;
- Increased human and vehicle traffic; and
- Grazing and cultivation.

The presence and intensity of these current disturbances has strongly influenced the species diversity and abundance within the remnant patches of Cumberland Plain Woodland (DECC 2005). The most significant disturbance on Cumberland Plain Woodland is the isolation of patches. Urbanisation, agriculture and construction of infrastructure has created fragmented CPW habitat across the study area. The construction of the proposed NWRL is expected to increase the level of fragmentation of Cumberland Plain Woodland throughout the study area. Fragmentation of Cumberland Plain Woodland vegetation creates boundaries inhibiting the dispersal of flora seeds and the movement of their vectors (fauna species).

An absence of fire over much of the study area has occurred due to the close proximity of the Cumberland Plain Woodland and urban development. This may contribute to a loss of native species diversity, local extinction, and the successful establishment of exotic flora species (DEC 2005a). Best management practices for Cumberland Plain Woodland suggest a fire frequency of between 4-12 years (DEC 2005a). However, some annual or perennial exotic weeds, such as *Eragrostis curvula* (African Lovegrass) and *Lantana camara* (Lantana), are known to alter the natural fire intensity and cause adverse effect on native habitats. The proposal is unlikely to alter the existing fire regime.

Additional disturbance, such as weed invasion, is expected to occur regardless of the NWRL proposed activities. Areas of high weed invasion occurred along road verges and drainage lines or in areas completely cleared of native vegetation. The issues relating to weed invasion have been addressed in

the previous paragraphs. It is likely that the proposed NWRL may facilitate the dispersal of new exotic species into areas of remaining Cumberland Plain Woodland. While most of the remnant Cumberland Plain Woodland has been mapped as degraded, it is still of high ecological value based on the conservation status of the community as critically endangered. A number of mitigation measures have been proposed to prevent the introduction of weeds to the construction site, and a weed control procedure will be developed as part of the Environmental Management Framework to ensure that plant and equipment used are free of weed propagules.

Nutrient enrichment as a direct result of surface water runoff and horticultural practices is another likely cause of weed invasion. Soil disturbance through horticultural practices and vegetation clearing is also a contributing factor in the establishment of weeds within the study area. The proposed activity may increase the percentage of impermeable surfaces and thus increase the level of nutrients entering the remaining areas of Cumberland Plain Woodland. The Environmental Management Framework and landscape plan for the proposed station and railway line will include strict sediment and erosion control measures to ensure the runoff from the construction site is diverted away from the CPW remnant so as not to impact the existing drainage patterns or soil conditions of the site.

The aboveground section of the proposed NWRL has the potential to increase the amount of human and vehicle traffic impacting on the remaining areas of Cumberland Plain Woodland, post-construction of the railway, stations, and associated car parks. However, the primary aim of the North West Growth Centre is to increase the number of residents within the local vicinity and the landscape plan for the site must ensure that remaining areas of Cumberland Plain Woodland remain relatively inaccessible to the public to reduce the impacts of trampling and rubbish dumping.

How is the proposal likely to affect habitat connectivity?

The Cumberland Plain Woodland within the study area already occurs as highly fragmented patches. Some patches, such as Tile 17, are isolated from adjacent native vegetation by more than 500m. Fragmentation may limit the ability for flora species and their vectors to disperse between patches, and leads to an overall decrease in the resilience of vegetation patches.

The majority of Cumberland Plain Woodland mapped within the construction alignment occurs within previously privately owned properties. These lots have become fragmented over time due to different land management practices including grazing, underscrubbing, mowing, hobby farms, cultivation, and development. The extent of Cumberland Plain Woodland vegetation removal proposed by the NWRL is outlined in Table 29. The indirect impacts account for the fragmentation impacts on remaining patches of vegetation, including edge effects and increased levels of fragmentation and isolation. While the landscape is already highly fragmented, the removal of Cumberland Plain Woodland for the proposed NWRL will increase the level of isolation and fragmentation of remaining patches.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for Cumberland Plain Woodland.

M.3.4 Shale/Sandstone Transition Forest

Shale/Sandstone Transition Forest occurs at the edges of the Cumberland Plain, where clay soils from the shale rock intergrade with soils from sandstone, or where shale caps overlay sandstone (NSW Scientific Committee 2011). The main tree species include *Eucalyptus tereticornis* (Forest Red Gum), *E. punctata* (Grey Gum), *E. globoidea, E. eugenioides* (Thin-leaved Stringybark), *E. fibrosa* (Broad-leaved Ironbark), and *E. crebra* (Narrow-leaved Ironbark) (DECC 2005). Areas of low sandstone influence have an understorey that is closer to Cumberland Plain Woodland. High sandstone influence sites have poor rocky soils. In areas of high sandstone influence, or in the absence of fire regime, the shrub layer dominates the vegetation composition. Herbaceous species dominate vegetation communities that contain a low sandstone influence. The Scientific Committee Final Determination for Listing provides an extensive floristic list for Shale/Sandstone Transition Forest community (OEH 2011).

Prior to European settlement Shale/Sandstone Transition Forest occurred at the eastern limits of Cumberland Plain Woodland (NPWS 2004). Today, much of the habitat has been cleared for urban development and agriculture (NSW Scientific Committee 2011). Representative patches of Shale/Sandstone Transition Forest vegetation community can be found in Hawkesbury and The Hills Shire Council and western Sydney LGA's (DECC 2005). Small remnant communities are protected in conservation reserves including Gulguer Nature Reserve (DECC 2005).

Shale/Sandstone Transition Forest occurs at the Hills Centre Station (Tile 10) as poor condition (TSC Act and EPBC Act) and will be impacted by direct clearing and indirect impacts (for more detailed information consult Appendix L – Site Profiles):

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable; Shale/Sandstone Transition Forest is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Shale/Sandstone Transition Forest was identified at the proposed Hills Centre Station site as six patches loosely connected by planted/exotic vegetation including treeless mowed areas. It is expected that Shale/Sandstone Transition Forest will be directly and indirectly impacted as a result of the proposed activities as detailed in Table 29.

Shale/Sandstone Transition Forest vegetation at the proposed location of the station is represented as large scattered *Eucalyptus racemosa* canopy surrounded by a highly disturbed understorey dominated by exotic herbs and regularly impacted by mowing. Other areas of Shale/Sandstone Transition Forest within the Hills Centre Station site, including the area mapped in the southwest corner of the study area, contained native species within the under/ midstorey. Weeds have established within this vegetation community and the vegetation is currently in a highly degraded (poor) condition.

Four of the six patches of Shale/Sandstone Transition Forest across the site will be impacted by the proposal through clearing of vegetation, which will reduce the overall extent of habitat at the site and increase the level of fragmentation and isolation.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable; Shale/Sandstone Transition Forest is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

The species composition within the Shale/Sandstone Transition Forest vegetation community reflects the current and historical disturbance regime within The Hills Centre Station site. These disturbances include:

- Regular mowing of the Shale/Sandstone Transition Forest community currently suppresses the growth and establishment of both native and exotic flora species, with impacts to the soil seed bank and the community's ability to regenerate;
- Existing fragmentation and isolation reduces the resilience of the vegetation community and encourages the dominance of exotic weeds;
- Altered fire regimes reduce the species diversity of the community; and
- Hydrological changes and soil disturbance from surrounding development and clearing.

The proposed NWRL is likely to affect the current disturbance regime as follows:

- An increase in the level of clearing and fragmentation of Shale/Sandstone Transition Forest across the site;
- No likely changes to the current fire regime;
- A reduction in weed growth due to the preparation of a VMP for the Shale/Sandstone Transition Forest vegetation along the creekline adjoining (and outside) the construction footprint that will describe weed control and bush regeneration works at the site to assist with restoration of Shale/Sandstone Transition Forest; and
- Sediment and erosion control measures will aim to divert runoff from remaining vegetation to minimise soil disturbance maintain current hydrological patterns.

How is the proposal likely to affect habitat connectivity?

Shale/Sandstone Transition Forest is poorly represented within The Hills Centre Station construction site. Only a few native representative species are scattered within each vegetation strata. The habitat condition is poor and highly fragmented from adjacent vegetation communities.

A loss of native vegetation is predicted as part of the construction of The Hills Centre Station. Removal of the large native canopy species may reduce the only 'stepping-stone' structure between vegetation patches, remnant trees, and adjacent vegetation patches.

Overall the extent of the Shale/Sandstone Transition Forest across the site will be reduced and the level of fragmentation will be increased.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for Shale/Sandstone Transition Forest.

M.3.5 River Flat Eucalypt Forest

River Flat Eucalypt Forest occurs on the river flats of the coastal floodplains of the NSW North Coast, the Sydney Basin, and the South East Corner Bioregions. It has a tall open tree layer of eucalypts, which may exceed 40m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (Forest red gum), *E. amplifolia* (Cabbage gum), *Angophora floribunda* (Rough-barked Apple), and *A. subvelutina* (Broad-leaved Apple). *Eucalyptus baueriana* (Blue Box), *E. botryoides* (Bangalay), and *E. elata* (River Peppermint) may be common south from Sydney, *E. ovata* (Swamp Gum) occurs on the far south coast, *E. saligna* (Sydney Blue Gum) and *E. grandis* (Flooded Gum) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain (DECC 2005).

A layer of small trees may be present, including *Melaleuca decora, M. styphelioides* (Prickly-leaved Teatree), *Backhousia myrtifolia* (Grey Myrtle), *Melia azedarach* (White Cedar), *Casuarina cunninghamiana* (River Oak), and *C. glauca* (Swamp Oak). Scattered shrubs include *Bursaria spinosa*, *Solanum prinophyllum, Rubus parvifolius, Breynia oblongifolia, Ozothamnus diosmifolius, Hymenanthera dentata, Acacia floribunda,* and *Phyllanthus gunnii*. The groundcover is composed of abundant forbs, scramblers and grasses, including *Microlaena stipoides, Dichondra repens, Glycine clandestina, Oplismenus aemulus, Desmodium gunnii, Pratia purpurascens, Entolasia marginata, Oxalis perennans,* and *Veronica plebeia*. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity, and other disturbance, and may have a substantial component of exotic shrubs, grasses, vines and forbs (DECC 2005).

River Flat Eucalypt Forest occurs within the western portion of the study area at the following sites (for more information consult Appendix L – Site Profile);

- Burns Road to Samantha Riley Drive (Tile 15 and 16) – poor and moderate condition
- Samantha Riley Drive to Windsor Road (Tile 16) – poor condition
- Windsor Road to Sanctuary Drive (Tile 17) – moderate condition
- Area 20 Windsor Road Viaduct to Tallawong Road (NW Growth Centre) (Tile 19) – good condition
- Talllawong Road to First Ponds Creek (NW Growth Centre) (Tile 20) – poor and moderate condition

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable, River Flat Eucalypt Forest is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will reduce the area of River Flat Eucalypt Forest through the direct clearing of vegetation to construct the proposed aboveground railway alignment, associated stations and construction areas. Table 29 shows the amount of River Flat Eucalypt Forest that will be removed for construction of the NRWL alignment.

As shown in Tile 16, a moderate condition patch of River Flat Eucalypt Forest extends a very small portion into the construction area, so that the majority of the patch will be retained. As shown in Tile 17,

the construction boundary has closely followed the mapped extent of a patch of moderate condition River Flat Eucalypt Forest along Caddies Creek, to minimise any clearing required. To the north, a patch of River Flat Eucalypt Forest that extends along a drainage line will have the western-most extent next to Windsor Road removed to allow for construction. The River Flat Eucalypt Forest to the east of the footprint will continue along this drainage line and connect with larger areas of vegetation to the east.

The largest patch of good condition River Flat Eucalypt Forest is shown on Tile 19 along Second Ponds Creek. The railway will intersect this patch, removing the riparian vegetation, and fragmenting this patch.

At the very western extent of the NWRL footprint, a small linear strip of poor condition River Flat Eucalypt Forest will be removed near First Ponds Creek. A larger area of moderate condition River Flat Eucalypt Forest to the west and along the creekline will be retained.

Apart from direct removal of the community, there will be indirect impacts through a reduction of the remaining River Flat Eucalypt Forest remnant size, which is likely to further decrease the ecological integrity of the remnants. Indirect impacts are also shown in Table 29.

As a mitigation measure for these indirect impacts, a VMP will be prepared for the areas of retained River Flat Eucalypt Forest along Caddies Creek outside of the construction footprint and within the riparian zone (refer to Tile 17).

Direct impacts to River Flat Eucalypt Forest vegetation have been avoided where possible. However, a Biodiversity Offset Strategy has been prepared to compensate for the loss of River Flat Eucalypt Forest as a result of the NWRL aboveground construction. These offsets will be managed in perpetuity in order to meet the 'improve or maintain' standard.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable; River Flat Eucalypt Forest is not a threatened species or population.

How is the proposal likely to affect current disturbance regimes?

Historical clearing of River Flat Eucalypt Forest vegetation is evident throughout the study area. At present, River Flat Eucalypt Forest located within the construction footprint is currently affected by the following disturbance regimes:

- Habitat fragmentation;
- Clearing of native vegetation;
- Weed invasion;
- Nutrient enrichment;
- Soil disturbance;
- Rubbish accumulation; and
- Grazing and mowing of adjacent vegetation.

The proposed construction of the NWRL is likely to alter the current disturbance regimes in the following

ways:

- Increase the level of habitat fragmentation;
- Increase the level of River Flat Eucalypt Forest clearing;
- Reduce the level of weed invasion through mitigation measures proposed in the Environmental Management Framework (use of clean machinery and scrub down areas to prevent the introduction and spread of weeds) and the preparation of a VMP for the patches of River Flat Eucalypt Forest on Caddies Creek;
- Nutrient enrichment and soil disturbance will be minimised through strict sediment and erosion control measures detailed in the Environmental Management Framework. This will be of particular importance close to riparian areas that contain River Flat Eucalypt Forest; and
- A likely reduction in grazing and mowing of adjacent vegetation as landuse changes from private hobby farms to infrastructure.

How is the proposal likely to affect habitat connectivity?

Habitat connectivity will be reduced through a reduction in the size of River Flat Eucalypt Forest remnants as a result of clearing and the loss of contiguous vegetation within some patches of River Flat Eucalypt Forest, particularly along Second Ponds Creek, where the railway line will cross the creek and require the clearing of River Flat Eucalypt Forest. This will effectively create two separated patches of River Flat Eucalypt Forest at this location of the creek.

Reducing habitat connectivity and creating new edges to vegetation patches reduces the resilience of vegetation and encourages weed growth.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for River Flat Eucalypt Forest.

M.4 THREATENED FLORA

M.4.1 *Epacris purpurascens* var. *purpurascens*

M.4.2 *Epacris purpurascens* var. *purpurascens*

Epacris purpurascens var. *purpurascens* is reported as being restricted to the Sydney Basin bio-region and occurring from Gosford south to the vicinity of Avon Dam, and from Narrabeen west to Silverdale (NPWS 2002c). The species is reported as being found in a range of habitat types, and these habitats frequently have a strong shale influence (NPWS 2002c). The *Guide to the Berowra Regional Park* states that the species is strongly associated with Sydney Turpentine Ironbark Forest and Shale/Sandstone Transition Forest (Friends of Berowra Valley Regional Park 2004). The M2 upgrade project found *Epacris purpurascens* var. *purpurascens* located on translocated soils including earth mounds and rock armoured batter slopes (AECOM 2010).

Epacris purpurascens var. *purpurascens* has the potential to occur within Sydney Turpentine Ironbark Forest and Coastal Shale/Sandstone Transition Forest within the NWRL study area. It is considered unlikely that it would occur within the Shale/Sandstone Transition Forest within the Hills Centre Station construction footprint as this vegetation is heavily disturbed and consists of remnant trees with a mown groundcover layer.

Targeted searches conducted by ELA on 5/3/2012 found 6 plants in one location to the northeast of Cheltenham Oval, outside of the proposed construction footprint (see map below). This location is at the edge of vegetation mapped as Sydney Turpentine Ironbark Forest and is on a small slope situated above the level of Cheltenham Oval. The remnant vegetation in this small area is relatively undisturbed. It is understood from information provided by Hornsby Council that this localised occurrence is currently being managed by Council to maintain or improve the habitat of *Epacris purpurascens* var. *Purpurascens.* It is understood that this management area is approximately 0.03ha.

It is considered that there is potential habitat for *Epacris purpurascens* var. *purpurascens* in the open forest to the west of Cheltenham Oval. However, no individuals of this species were recorded in this area, either in areas that were recently burnt or in areas that were not recently burnt No individuals of *Epacris purpurascens* var. *purpurascens* were found elsewhere within the Cheltenham study site, or within other study sites.


2 Plants
1 Plant
6 Plants
SARACEN RD
OAKLANDS AVE
BAMBARA CR
BINGARA RD
MURRAY FARM RD
MERINDA AVE
PLUMPTON RD
KERRY AVE
DAWSON ST
MASON AVE
CASTLE HOWARD RD
BORONIA AVE
WYCOMBE ST
CHELTENHAM RD
BEECROFT RD
REDMILL CL
WINGROVE AVE
KENT ST
BAROMBAH RD
ROMFORD RD
ELA Study Area
Additional Cheltenham Study Area
Construction Boundaries as at 19/01/12
Parcels LPMA 2011
Contours (1m)
Potential Alignment as at 28/11/11
Aboveground
Underground
Epacris pulchella (Not Threatened)
Threatened Flora
Epacris purpurascens
NORTH WEST RAIL LINK
Survey Results - Threatened Flora
Tile 2 of 20
Cheltenham
GDA 1994 MGA Zone 56
0 25 50 75 100 m
06 MAR 2012

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

No known occurrence of *Epacris purpurascens* var. *purpurascens* occurs within the construction footprint of the NWRL. Six individuals of *Epacris purpurascens* var. *purpurascens* occur to the northeast of Cheltenham Oval, outside of the construction area and would not be impacted by the NWRL. This known occurrence is managed by the Hornsby Shire Council to remove threats, including weed control, closing all access and close monitoring of the site.

Potential habitat exists within the Cheltenham study area, west of the oval up to Kirkham Road, within Sydney Turpentine Ironbark Forest and Coastal Shale/Sandstone Transition Forest. Targeted surveys within this potential habitat were made on 5/3/12, but no individuals were detected. The species can be confused with *Epacris pulchella*, which also occurs on the site as shown in the map above. However, at the time of the survey, *Epacris pulchella* was flowering while *Epacris purpurascens* var. *purpurascens* wasn't flowering. These species were also distinguished by *Epacris purpurascens* var. *purpurascens* having shorter and narrower leaves.

Therefore, given that no individuals would be removed, the proposal is unlikely to affect the lifecycle of *Epacris purpurascens* var. *purpurascens*. The construction boundary at Cheltenham would be located approximately 80m west and down slope of the known population and as such would avoid potential impacts such as changes to drainage and sediment/nutrient flow.

The proposal may reduce the area of potential germinating habitat (burnt and unburnt areas) of this species to the west of Cheltenham oval. This species is killed by fire and re-established from the soil seed bank. It is estimated that the species requires 2-4 years growth before a species produces seed and with a peak in reproductive maturity at 5-6 years (NPWS 2002c). Since no individuals were recorded in either burnt or unburnt areas of the site, it could be reasonably expected that the species does not occur there in the soil seed bank. Seed is dispersed by water, wind and gravity and this area is not likely to be receiving seed from the existing population to the east of the oval unless conditions such as timing of seed-set, wind and time since fire were all aligned. Therefore, the area to the west of the oval, while it is considered to be potential habitat, is not considered to be important habitat for the population of this species on the eastern side of the oval.

As a mitigation measure, additional targeted survey of *Epacris purpurascens* var. *purpurascens* will be conducted within the construction footprint prior to clearing. If any individuals are present, the species will be relocated into preferred habitat in consultation with Hornsby Council and OEH.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal may affect potential habitat for the *Epacris purpurascens* var. *purpurascens* between Cheltenham Oval and Kirkham Road as discussed above. No impacts to known habitat for the species are likely to result from the proposed NWRL.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Epacris purpurascens var. *purpurascens* is restricted to the Sydney Basin Bioregion in which it has been recorded from Gosford south to the vicinity of Avon Dam, and from Narrabeen west to Silverdale (NPWS 2002c). Therefore, the species is not at the limit of its known distribution within the NWRL study area.

How is the proposal likely to affect current disturbance regimes?

In general, *Epacris purpurascens* var. *purpurascens* is directly threatened by urban run-off leading to flooding, erosion, nitrification of soil substrate, altered pH, weed invasion, and introduction of plant pathogens. Other threats include altered fire regimes, uncontrolled vehicular access, soil compaction, fill and rubbish dumping, and trampling through inappropriate pedestrian access (NPWS 2002c).

The presence of urban development surrounding the Cheltenham study area has altered the natural fire regime. An absence of fire management has provided suitable habitat for the establishment of exotic species such as *Cardiospermum grandiflorum* (Balloon Vine) and *Ligustrum lucidum* (Large-leaved Privet). High weed infestation is present off Castle Howard Dr. and within the Coastal Shale-Sandstone Forest abutting Devlin Creek. Nutrient enrichment and the transportation of weed propagules may limit the recovery potential of native vegetative communities. Some revegetation work has been moderately successful along the riparian corridor although weeds are present.

Overall, the proposal is unlikely to alter the current disturbance regimes such that it would place *Epacris purpurascens* var. *purpurascens* at risk of extinction. Mitigation measures to protect the remaining stand of Sydney Turpentine-Ironbark Forest within the Cheltenham study area include the implementation of a VMP incorporating weed control and bush regeneration. This action, coupled with the existing management of the *Epacris purpurascens* var. *purpurascens* by Hornsby Shire Council should protect the species from disturbance resulting from the proposal. The fact that the location of the construction boundary is downslope and 80m from the known location of the *Epacris purpurascens* var. *purpurascens* will provide an adequate buffer from construction impacts. In addition, the Environmental Management Framework for the proposed construction works will include strict sediment and erosion control measures to ensure the runoff from the construction site is diverted away from the Sydney Turpentine-Ironbark Forest within the study area so as not to impact the existing drainage patterns or soil conditions within potential habitat for the species.

There is the potential for the proposal to result in the introduction and spread of further invasive species. A number of mitigation measures have been proposed to prevent the introduction of weeds to the construction site, and a weed control procedure will be developed as part of the Environmental Management Framework for the proposal, including use of clean plant and equipment. Weed monitoring, control, and progressive rehabilitation will help to reduce the potential for the remaining Sydney Turpentine-Ironbark Forest vegetation at Cheltenham to be invaded by weeds.

How is the proposal likely to affect habitat connectivity?

The proposal will not fragment the known habitat for *Epacris purpurascens* var. *purpurascens* within the Cheltenham study area. However, the clearing of potential habitat to the west of the known occurrence of *Epacris purpurascens* var. *purpurascens* will increase the distance between known and potential habitat areas.

How is the proposal likely to affect critical habitat?

Critical habitat cannot be declared for *E. purpurascens* var. *purpurascens* as it is not listed on Schedule 1 of the NSW *Threatened Species Conservation Act 1995*.

M.5 THREATENED FAUNA

M.5.1 Cumberland Plain Land Snail

Primarily inhabits Cumberland Plain Woodland with a very restricted distribution from Richmond and Windsor south to Picton, and from Liverpool west to the Hawkesbury and Nepean Rivers. Found under fallen logs, debris, and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass (NPWS 1997, DECC 2005). Urban waste may also form suitable habitat (NPWS 1997). A fungal feeding specialist and does not feed on green plants (DECC 2005).

The Cumberland Plain Land Snail has the potential to occur within Cumberland Plain Woodland and River Flat Eucalypt Forest within the NWRL study area. Targeted searches within the ELA access areas did not reveal any live snails or empty shells of Cumberland Plain Land Snail during the current surveys. However, the species has been previously found within, or close to, the study area by Baulkam Hills Shire Council 2007 and ELA 2010 (in Area 20).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Very little is known about the life history and biology of the Cumberland Plain Land Snail. It is hermaphroditic and lays clutches of around 20-25 small round white eggs in moist and dark areas, such as under logs. The eggs take 2-3 weeks to hatch and breeding is likely to occur year-round, where conditions are suitable (NPWS 2000).

Cumberland Plain Land Snail is a fungal feeder and is generally active at night. Little is currently known about rates of fecundity, life span, dispersal patterns and distances moved by individuals (DECC 2005).

The taxonomy of the species is in question, as a PhD by Clark (2005) suggested that the Cumberland Plain Land Snail (*Meridolum corneovirens*) belongs to a new genus. This study also found that:

- Populations of *Meridolum corneovirens* show large levels of intrapopulation variation and low levels of interpopulation variation;
- Most populations showed high levels of inbreeding;
- The *Meridolum* group show narrow-range endemism, with all species found in parapatry (populations immediately adjacent) / allopatry (populations occurring in non-overlapping ranges) with little apparent sympatry (overlapping ranges); and
- The relative isolation of populations is leading to adaptive radiation, where allopatric speciation is occurring through genetic drift and different selective pressures acting on populations.

Clark and Richardson (2002) found that significant movement of *Meridolum corneovirens* individuals within a single generation is limited to about 350m. Therefore, a gap of greater than 350m between suitable habitat through which animals could pass but which was not suitable for breeding cannot be crossed by this species. Fragments larger than 350m are likely to contain individuals belonging to different genetic neighbourhoods (defined as the distance travelled by an individual from birth to where it breeds) and thereby increase the local population's ability to respond to local extinctions by recolonising former or newly created habitat. On the other hand, once a population is completely surrounded by urban or industrial development, it will not be recolonised if local extinction occurs (Clark and Richardson 2002).

As fragments become more isolated with no corridors interconnecting them, rates of local extinction will increase with time (Clark and Richardson 2002). Therefore, interconnected patches of Cumberland Plain Woodland greater than 350m in size and not more than 350m apart, that contain suitable breeding habitat within the fragment and within the corridors connecting the fragments, are necessary to conserve the species within the Cumberland Plain.

The proposal may impact on the life cycle of the Cumberland Land Snail by reducing the amount of primary habitat (Cumberland Plain Woodland) available to the species. The NWRL will be above ground along the final 7km of the western section from Kellyville to Schofields. It is unknown as to whether the snails will cross the track to reach habitat on the opposite side, given that the railway will create a concrete/rock substrate that may be considered a barrier to movement of Cumberland Plain Land Snail. Using the precautionary principle, we have assumed that the NWRL will create a 7km linear barrier effectively separating Cumberland Plain Land Snail either side of the track.

To determine what areas of Cumberland Plain Woodland comprise potential primary habitat either side of the proposed railway line, the study by Clark and Richardson (2002) has been used. That is, areas of Cumberland Plain Woodland that are currently more than 350m apart and that do not contain suitable breeding habitat (i.e. moist logs and leaf litter) between patches are not considered to be contiguous potential primary habitat for the species.

The loss of potential primary habitat through both direct impacts (clearing) and indirect impacts (fragmentation causing loss of habitat connectivity) are listed in Table 32. Direct impacts will remove potential habitat including breeding, foraging/shelter and dispersal habitat. Indirect impacts will separate areas of potential habitat, assuming that the species is unlikely to cross the railway line. Table 32 also shows the total amount of primary habitat that will be impacted at the regional level. As foraging and breeding habitat of the species are essentially the same, there is no secondary habitat considered for this species.

This loss of habitat is likely to impact the lifecycle of Cumberland Plain Land Snail by creating smaller fragments of Cumberland Plain Woodland for the species to inhabit. Based on the work by Clark (2005), this is likely to increase the level of inbreeding and increase the level of allopatry amongst the *Meridolum* species group at a landscape level. As a result, isolated populations have a reduced capacity to recolonise a patch of Cumberland Plain Woodland following a disturbance event such as fire or underscrubbing. As such, creating small isolated patches of Cumberland Plain Woodland will increase the rates of local extinction with time (Clark and Richardson 2002).

The magnitude of disturbance from noise, light and vibration during the construction and operation of the NWRL on the lifecycle of the Cumberland Plain Land Snail is unknown. Given that Cumberland Plain Land Snails are nocturnal and forage at night, it is possible that the species will be disturbed by light and vibration to the point that they will avoid patches of habitat along the edges of the railway track and stations.

While the proposal will result in the removal of potential primary habitat for the Cumberland Plain Land Snail, the proposal will seek, in the first instance, to avoid vegetation clearing of Cumberland Plain Woodland to retain the maximum amount of habitat possible. In areas of habitat that cannot be avoided, mitigation measures during the construction works will include the relocation of logs into adjacent areas of potential habitat, or stockpiling logs and redistributing into rehabilitated Cumberland Plain Woodland, so that such sheltering habitat can be retained on the site.

A Biodiversity Offset Strategy is also being prepared to compensate for the loss of habitat as a result of the NWRL. These offsets will be managed in perpetuity in order to meet the 'improve or maintain'

standard.

As the impact of the proposal on the life cycle of the Cumberland Plain Land Snail will depend on whether the species was present within or near vegetation to be removed, it is recommended that additional surveys be conducted to establish the locations of Cumberland Plain Land Snail within the NWRL development area prior to vegetation clearing. If the species is found, the OEH should be consulted to determine the most appropriate method for relocation in consultation with ELA. The most appropriate areas for relation will include patches of Cumberland Plain Woodland containing thick leaf litter and logs, particularly around the base of tress. The patch should be at least 350m wide and be connected with other similar sized patches.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Primary habitat for the Cumberland Plain Land Snail within the NWRL includes Cumberland Plain Woodland and River Flat Eucalypt Forest fringing Cumberland Plain Woodland located west of the Hills Centre Station. These patches contain leaf litter and logs. Areas of woodland/forest that have been totally underscrubbed have not been included in the calculation of potential habitat (i.e. poor condition Cumberland Plain Woodland and River Flat Eucalypt Forest have been excluded). No secondary habitat has been considered, as breeding and foraging habitat are similar for this species.

Table 32 outlines the likely impacts to the Cumberland Plain Land Snail both through removal of habitat (direct impacts) and increased isolation of likely habitat (indirect impacts). Table 32 also shows the percentage loss of potential habitat for the species at a regional level. Further discussion of the impacts to Cumberland Plain Land Snail habitat likely to result from the proposal is discussed above in question one.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Cumberland Plain Land Snail has a very restricted distribution within the Cumberland Plain, bounded by Cattai to the north, Picton to the south, Prospect Reservoir to the east, and Yarramundi to the west (NPWS 2000). The most eastern record of Cumberland Plain Land Snail on the NPWS Wildlife Atlas was recorded in 2010, 2km north of the proposed Hills Station. Hence, all Cumberland Plain Woodland and River Flat Eucalypt Forest along the NWRL that occurs to the west of this point will be considered potential primary habitat for the species.

Therefore, the western half of the NWRL occurs within the eastern limit of the known distribution for the Cumberland Plain Land Snail within the locality although the study area would now represent the overall geographical limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

The proposed NWRL will pass through several patches of Cumberland Plain Woodland and River Flat Eucalypt Forest at the western extent of the proposal. The current condition of the vegetation ranges from good to degraded. The current disturbance regime within these patches varies on a site by site basis, but collectively includes the following disturbances:

- No signs of recent fire;
- Underscrubbing – including the removal of leaf litter and logs, soil disturbance (this effectively removes habitat for the Cumberland Plain Land Snail);

- Grazing by sheep, goats, cows, horses;
- Cultivation;
- Clearing of woodland (understorey and canopy);
- Weed invasion; and
- Rubbish dumping.

Most of these identified disturbances will remove or significantly degrade habitat for the Cumberland Plain Land Snail. However, the species has been occasionally found to shelter under rubbish (DECC 2005).

How is the proposal likely to affect habitat connectivity?

The impact to habitat connectivity is discussed in question one, which addresses the likely impacts to the lifecycle of the Cumberland Plain Land Snail. As the species is only likely to move 350m during its lifetime, fragmentation of habitat can occur through even small scale clearing. Indirect impacts to this species are included in Table 32 which includes habitat fragmentation.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for this species.

M.5.2 Green and Golden Bell Frog

The Green and Golden Bell Frog has been observed utilising a variety of natural and man-made water bodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches, and any other structure capable of storing water (DECC 2005). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DECC 2005). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes – *Typha* sp. and spikerushes – *Eleocharis* sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1993). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (DECC 2005).

The species was not observed during field survey by ELA 2011, despite optimal weather conditions and survey season. A nearby population / reference site at Riverstone had movement activity and calling at the same time as the survey, indicating likely detectability if species were present. The survey identified primary habitat areas consisting of water bodies likely to support GGBF breeding. Secondary habitat in the form of movement corridors was also mapped (Appendix H).

The most recent and closest sighting of Green and Golden Bell Frog was undertaken by ELA in 2007 as part of the BioCertification process for Riverstone East precinct. This study found that Green and Golden Bell Frog were concentrated at a single location at Riverstone (approximately 3km from the Schofields Road end of the NWRL corridor), where a semi-captive colony exists. Other records of GGBF in the vicinity were likely to be dispersing individuals emanating from this focal point at Riverstone. This Riverstone Green and Golden Bell Frog element is part of the Western Sydney GGBF Key Population, as identified in the Draft Recovery Plan for GGBF (DEC 2005b).

In terms of immediate proximity to the site, the most recent sighting of Green and Golden Bell Frog was in 1975.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Green and Golden Bell Frog was not detected at the site of the NWRL corridor despite targeted surveys in optimal conditions and season. Failure to detect the species is therefore likely to have been the result of true absence for the species from the targeted survey sites. However, this does not preclude the possibility of the species utilising habitat at these locations at other times or transiently moving through these areas during dispersal.

The lifecycle of the species involves the following (SEWPaC 2011):

- The Green and Golden Bell Frog is known to breed during late winter to early autumn, but generally during September–February with a peak around January–February after heavy rain or storms
- Optimal breeding sites consist of still, relatively unshaded water bodies that are low in salinity, usually smaller than 1000m², less than a metre deep, either ephemeral or fluctuate substantially in water level, are free of predatory fish, and have emergent aquatic vegetation;
- Green and Golden Bell Frog has high fecundity with an average clutch size of about 3700 eggs. Spawn is laid among aquatic vegetation and has been observed in December, January and February;

- Eggs hatch within 2–5 days after ovipositing/fertilisation and metamorphosis can take 2–11 month, however six weeks appears to be an average duration in the field; and
- Green and Golden Bell Frog is highly mobile, and may move among breeding sites. They are capable of moving long distances in a single day/night of up to 1–1.5 km. Observations suggest movements of up to 5km may be common, and the frog may possibly disperse as far as 10km. Isolated occurrences of Green and Golden Bell Frogs have been reported several hundred metres from major drainage lines or other water bodies.

Seven water bodies located between First Ponds Creek and Samantha Riley Drive have been identified as potential primary (breeding) habitat for the Green and Golden Bell Frog. The NWRL has will impact on potential primary habitat as outlined in Table 32. Direct impacts will involve filling or modifications to potential breeding water bodies and will result in the minor reduction of potential breeding habitat, particularly for dispersing Green and Golden Bell Frog from the Riverstone group. Indirect impacts to primary habitat will include any mapped potential breeding habitat within 50m of the construction footprint. These indirect impacts include noise, vibration, artificial light, and potential modifications to the ground surface as a result of changes to drainage patterns. However, sediment and erosion control measures will contain soil to within the construction footprint and drainage will be diverted away from potential breeding habitat. However, indirect impacts are unlikely to cause too much disturbance to the species which has been known to breed in excavation pits during construction works (e.g. St Marys Rugby League Club).

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Potential habitat for the Green and Golden Bell Frog occurs at the western end of the NWRL from the end of Celebration Drive, Bella Vista to the western extent of the line at Schofields Road. Potential breeding sites and movement corridors have been mapped within this area (Appendix H) and consist of seven water bodies and movement corridors along Caddies Creek and Elizabeth MacArthur Creek.

While the Green and Golden Bell Frog habitat on the site is relatively poor, the most suitable areas of habitat observed were artificial constructed earth walled dams along existing ephemeral/intermittent drainages or modified ox-bows and constructed detention basins. These structures have become vegetated to varying extents, with fringing emergent *Typha*, *Juncus, Cyperus* and *Eleocharus* spp. that are recognised for their values to the Green and Golden Bell Frog for shelter and foraging and potential basking areas. These structures may also provide breeding (primary habitat),as outlined above in the previous question, however the proliferation of the Plague Minnow (*Gambusia holbrooki*) and varieties of exotic Carp (*Cyprinus carpio*) decrease the potential breeding habitat values of these sites.

In more recent times, Green and Golden Bell Frog have been recorded more successfully breeding in ephemeral locations which are likely to be due to the absence of predatory fish (SEWPaC 2011) and frog chytrid cause by the pathogen *Batrachochytrium dendrobatidis*, which renders water bodies less suitable. Drying episodes in ephemeral water bodies is believed to eliminate the presence of the frog chytrid pathogen and predatory fish, increasing the chances of breeding success.

Impacts to potential breeding (primary) habitat and movement corridors (secondary habitat) as a result of the NWRL are detailed in Table 32. Potential direct and indirect impacts to primary habitat are discussed above under lifecycle. Impacts to secondary habitat resulting from the NWRL will include a reduction and disruption to the potential movement corridor habitat, particular east of, and at the confluence of Caddies Creek and Elizabeth MacArthur Creek. At this location, the presence of roads and other development already renders potential habitat values as low.

Foraging habitat for this species, which is usually considered secondary habitat for a threatened species, has not been estimated for the Green and Golden Bell Frog. Green and Golden Bell Frog could forage across a broader area than just movement corridors, however there are significant limitations in making an adequate assessment of broader foraging habitat and consequently this type of habitat has not been included in 'secondary habitat' for this species.

The percentage loss of potential primary and secondary habitat for Green and Golden Bell Frog at the regional level has not been estimated. The regional extent of habitat for this species has not been defined in previous studies and an attempt the estimate this is beyond the scope of this study. Any Green and Golden Bell Frog that will utilise potential habitat within the NWRL corridor will be part of the Western Sydney Key Population as discussed in the draft Recovery Plan (DEC 2005b). This population is considered to be small and somewhat tenuous in its persistence in the Sydney Region and is known only from three sites in relatively recent times:

1. Mt Druitt - from detention structures fringed with *Typha* within a power line easement corridor
2. St Marys Rugby League Club – from a pond/dam in the vegetated area east of the club facilities. The species bred in excavation works during construction on the site and additional habitat features were constructed as part of an initiative to improve the likelihood of the species persistence in the area. Subsequent surveys have failed to detect any ongoing utilisation of the site by the species.
3. Riverstone – from a residential property in Oxford Street where the species regularly breeds in ponds provided in the gardens, and from which it is believed dispersal takes place. This results in irregular records from surrounding residences, Riverstone High School, and rural properties between the breeding site and First Ponds Creek.

Other historical sites dating back to the 1970s were recently subject to targeted surveys but no colonies were detected persisting at any of these sites. Therefore, habitat loss for Green and Golden Bell Frog as a result of the NWRL is within areas not currently occupied by the species and which haven't been occupied since 1975. While the species may utilise the habitat on site as dispersing individuals from the Riverstone Green and Golden Bell Frog node, the breeding habitat is not optimal due to the presence of predatory fish and most likely the frog chytrid fungus within water bodies, and movement corridors to the east do not lead to areas of better breeding habitat, but rather to more tenuous, developed areas unlikely to provide habitat for the species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Green and Golden Bell Frog occurs mainly along coastal lowland areas of eastern NSW and Victoria. The most northern extent of the species distribution is from Yuraygir National Park near Grafton on the North Coast of NSW, while the most southern extent of the species' distribution is in the vicinity of Lake Wellington, just west of Lakes Entrance in south-eastern Victoria. In NSW, the Green and Golden Bell Frog has been recorded at 54 locations since 1990, at least nine of which are now considered extinct (SEWPaC 2011).

The extent of the Western Sydney Green and Golden Bell Frog Key Population is discussed above and consisted (most recently) of 3 sites at Mt Druitt, St Marys, and Riverstone. Riverstone is the only known active record of the Green and Golden Bell Frog within the vicinity of the proposed NWRL (approximately 3km northwest of the western end of the line at Schofields). While the species is distributed to the north and south of Western Sydney, given the transient nature and scattered centres

of what loosely comprises the Western Sydney Key Population, it could be considered that the GGBF is at the limit of its distribution at a local level.

How is the proposal likely to affect current disturbance regimes?

The proposed NWRL will pass through several patches of Cumberland Plain Woodland and River Flat Eucalypt Forest at the western extent of the proposal. The current condition of the vegetation ranges from good to degraded. The current disturbance regime within these patches varies on a site by site basis, but collectively includes the following disturbances:

- No signs of recent fire;
- Underscrubbing;
- Grazing by sheep, goats, cows, horses;
- Cultivation;
- Clearing of woodland (understorey and canopy);
- Weed invasion;
- Rubbish dumping; and
- Urban development.

The proposed NWRL is likely to change the degrading impacts of these disturbances within the proposed railway corridor by the change of landuse from largely private hobby farms to railway corridor. This has the potential to impact Green and Golden Bell Frog habitat through:

- Habitat removal;
- Habitat degradation (which includes siltation, changes to aquatic vegetation diversity or structure reducing shelter, increased light and noise);
- Habitat fragmentation;
- Reduction in water quality and hydrological changes (for example, pollution, siltation erosion and changes to timing, duration or frequency of flood events); and
- Introduction or intensification of public access to Green and Golden Bell Frog habitats.

Mitigation measures will aim to limit the amount of potential Green and Golden Bell Frog habitat removal and habitat degradation will be prevented/limited through strict sediment and erosion control measures. This will ensure that any potential breeding habitat and movement corridors within the study area will be protected from pollution and siltation.

In addition, the creation of ephemeral habitat for Green and Golden Bell Frog during design of the landscape plan for the NWRL should be undertaken. In most instances, habitat creation/enhancement can be incorporated into permanent drainage, detention structure design, and water sensitive urban design components of developments. It is recommended that such an approach be taken as part of this proposal regardless of the species apparent absence from the NWRL corridor. DECC 2007 has prepared a Best Practice Guide to habitat construction.

How is the proposal likely to affect habitat connectivity?

Whilst it is not possible to rule out an occasional presence of Green and Golden Bell Frog from time to time, it is unlikely that the species is present currently at the site of the proposed NWRL. The likelihood of occasional utilisation of the site is most reasonably determined by connectivity to the nearest known site. The extent of roads and other development between the subject land and the Riverstone distribution node, except via drainage lines, makes this consideration unlikely especially for the sites within the Caddies and Elizabeth MacArthur Creek component of the NWRL corridor.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for this species.

M.5.3 Cockatoos and Parrots

Glossy Black-cockatoo

The Glossy Black-cockatoo is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small endangered population in the Riverina (DECC 2005).

The Glossy Black-cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000m in which stands of she-oak species, particularly *Allocasuarina littoralis* (Black She-oak), *A. torulosa* (Forest She-oak) or *A. verticillata* (Drooping She-oak), occur (DECC 2005).

It feeds almost exclusively on the seeds of several species of She-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with its bill. The species is dependent on large hollow-bearing eucalypts for nest sites. One or two eggs are laid between March and August (DECC 2005).

The Glossy Black-cockatoo has been previously recorded within or close to the study area by BHSC 2007 and there are 34 records of the species within the 10km Wildlife Atlas search area. These records range from 1996 – 2006. Most of these records are concentrated in the north east corner of the search area, with only one record close to the NWRL at Cheltenham from 2000.

Gang-gang Cockatoo

Gang-gang Cockatoo occurs from southern Victoria through south and central-eastern NSW up to the Hunter Valley. In summer, they occur in dense, tall, wet forests of mountains and gullies and alpine woodlands (Morcombe 2004). In winter they occur at lower altitudes in drier more open forests and woodlands, particularly box-ironbark assemblages (Shields & Chrome 1992). They sometimes inhabit woodland, farms and suburbs in autumn/winter (Simpson & Day 2004).

The endangered population in the Hornsby and Ku-ring-gai Local Government Areas is believed to be largely confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra/South Turramurra to the east. It is the last known breeding population in the Sydney Metropolitan area. The population size is small and estimated to be between 18-40 pairs. Individuals of this population are likely to move outside the 'defined' population boundary in the general area and should still be considered of this population (DECC 2005).

Gang-gang Cockatoos feed on seeds of eucalypts and wattles; berries, fruits, nuts, insects and their larvae and favour old growth attributes for nesting and roosting breed in tree hollows (DECC 2005). Breeding pairs show a high fidelity to nesting sites, selecting hollows of particular shape, position and structure (DECC 2005).

Gang-gang Cockatoo has been previously recorded within or close to the study area by AECOM 2010. There are 52 records of the species within the 10km Wildlife Atlas search area ranging from 1990 – 2008. Most records occur in the north east of the search area in the Ku-ring-gai and Hornsby LGAs which contain the Endangered Population listed under the TSC Act.

Swift Parrot

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and South West Slopes.

This species migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (DECC 2005).

Favoured feed trees include winter flowering species such as *E. robusta*, *Corymbia maculata*, *C. gummifera*, *E. sideroxylon* and *E. albens*. Commonly used lerp infested trees include *E. microcarpa*, *E. moluccana* and *E. pilularis* (Blackbutt) (DECC 2005).

Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by *Eucalyptus globulus* (Tasmanian Blue Gum) (DECC 2005).

Previous studies in or close to the study area have not detected this species. There are 45 records of the species within the 10km Wildlife Atlas search area ranging from 1982 - 2010. Most records occur in the centre and south-west of the search area within the Cumberland Plain.

Turquoise Parrot

The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range.

The Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. They are usually seen in pairs or small family groups and have also been reported in flocks of up to thirty individuals. This species prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds of grasses and herbaceous plants, or browsing on vegetable matter.

The species forages quietly and may be quite tolerant of disturbance. Turquoise Parrots nest in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust (DECC 2005).

Previous studies in or close to the study area have not detected this species. There is only one record of this species within the 10km Wildlife Atlas search area. This record occurs near the location of where the NWRL intersects Caddies Creek and dates back to 1999.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Species with potential breeding habitat within the NWRL include the Glossy Black-cockatoo, Gang-gang Cockatoo and Turquoise Parrots. However, the scarcity of Turquoise Parrot records (only one) from the wider study area means that this species is unlikely to breed within the study area. These three species all require tree hollows for breeding. Table 30 describes the how potential impacts on breeding (primary) habitat were derived and Table 32 lists the likely impacts. Removal of hollows will reduce the availability of breeding habitat throughout the study area for these three species.

The Swift Parrot breeds in Tasmania, so no primary habitat will be impacted by the NWRL.

Apart from the direct removal of tree hollows, any hollows within 50m of the construction footprint that is a breeding site for these three species may be impacted through the disturbance during construction and operation of the NWRL. Noise, vibration, artificial light, and edge effects during both the construction and operation of the railway, stations, and construction areas may lead to the nest being abandoned during breeding, or the hollow not being selected as a breeding site. These impacts are described in Table 32 as indirect impacts on primary habitat. These indirect impacts have the potential

to reduce the breeding success of these three species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Primary habitat for these four species has been addressed in the question above. In terms of secondary (foraging) habitat, Table 32 describes the likely impacts to potential secondary habitat for these four species. Direct impacts to foraging habitat will result from the removal of vegetation within the study area. The vegetation types likely to provide foraging habitat vary for each species and are described in Table 30.

Glossy Black-cockatoos forage exclusively on species of *Casuarina* and *Allocasuarina*. Cumberland Plain Woodland has been excluded from the calculation of potential secondary habitat for this species, as it generally contains low numbers of foraging species. The species is also unlikely to nest within CPW due to the low abundance of food source.

Gang-gang Cockatoo may forage throughout the study area, but is only likely to breed within the Hornsby LGA, as per the Endangered Population (DECC 2005).

The Turquoise Parrot prefers open woodland, so is only likely to forage and breed within the vegetation on the Cumberland Plain including CPW and RFEF.

While the Swift Parrot does not breed within the study area, there will be a loss of potential foraging habitat by direct removal of vegetation from within the study area.

Apart from the direct removal of foraging (secondary habitat), indirect impacts on secondary habitat have also been calculated Table 32. This calculation aims to account for the indirect impacts of edge effects, noise, vibration, and artificial light that will be created during the construction and operation of the NWRL and is generally calculated as 20m from good or moderate condition vegetation and 10m from poor condition vegetation (Table 30).

The NWRL has attempted to avoid habitat for these threatened species where possible. Mitigation measures detailed in section 5 aim to reduce the impacts to these species including limiting clearing where possible, 'slow drop' techniques during tree clearing, sediment and erosion control, and weed management. In addition, VMPs will be prepared for specific areas of retained native vegetation within the study area the aim to protect, manage, and rehabilitate vegetation. Such areas will comprise potential breeding and foraging habitat for these species.

A Biodiversity Offset Strategy is provided in Appendix N to compensate for the loss of habitat as a result of the construction of NWRL. These offsets will be managed in perpetuity in order to meet the 'improve or maintain' standard.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Glossy Black-cockatoo is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small endangered population in the Riverina (DECC 2005). This species is not at the limit of it distribution in the NWRL study area.

The Gang-gang Cockatoo occurs from southern Victoria through south and central-eastern NSW up to the Hunter Valley. Therefore, in general, the species is not at the limit of its distribution within the

NWRL study area. However, the endangered population in the Hornsby and Ku-ring-gai Local Government Areas is believed to be largely confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra/South Turramurra to the east. It is the last known breeding population in the Sydney Metropolitan area (DECC 2005). Therefore, given the restricted distribution of the endangered "breeding" population, the south-western extent of this population occurs within the NWRL study area.

The Swift Parrot breeds in Tasmania during spring and summer and migrates to the mainland in the autumn and winter months, occurring from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW, the species mostly occurs on the coast and South West Slopes (DECC 2005). Therefore, the species is not at the limit of its distribution.

The Turquoise Parrot's range extends from northern Victoria through to southern Queensland, from the coastal plains to the western slopes of the Great Dividing Range. This species is not near the limit of its known distribution within the NWRL study area. However, the paucity of records suggests that the habitat contained for this species is very marginal.

How is the proposal likely to affect current disturbance regimes?

The current disturbance regimes operating within NWRL study area include:

- Weed invasion into native vegetation communities;
- Clearing and fragmentation of habitat associated with urban development, and to the west of the study area agriculture, underscrubbing and hobby farms;
- Noise, vibration and artificial light associated with typical urban areas including vehicle traffic;
- A general fire regime of fire suppression within bushland areas due to the close proximity urban areas;
- Highly modified natural drainage through the channelisation and piping of creeks. Where natural waterways remain, they are generally impacted by high weed growth and stormwater pollution including siltation and eutrophication; and
- Grazing by sheep, goats, cows, horses.

In relation to potential habitat for these species, the proposed NWRL is likely to affect these current disturbance regimes by:

- Potential introduction and further spread of invasive weeds. However, section 5 outlines mitigation measures to prevent weed spread and restore native vegetation;
- Increasing the level of habitat clearance and fragmentation;
- Increasing the level of noise, light and vibration as a result of the construction and operation of the NWRL;
- Impacts to riparian areas including clearing of some riparian vegetation; and
- A reduction or removal of grazing within the NWRL study area.

The reduction in potential breeding and foraging habitat for these species has been discussed above.

Fragmentation and degradation of foraging habitats may provide a suitable habitat for aggressive territorial honeyeaters such as the Noisy Miner (*Manorina melanocephala*). The Noisy Miner will actively harass and drive out other birds from a habitat. Changes in the vegetation through land clearing and an increase in human disturbances has allowed the Noisy Miner to dominate vast habitats within the study area. The proposal is likely to further fragment habitats causing an increase in the edge effects within foraging habitat for these species. There is potential that this may increase the direct competition between the Parrot species and Noisy Miners.

Little is known of how the four species will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances and forest and woodland edges. However, parrots often use edge habitat (Rowley *et al.* 1993). Further, there is evidence that habitat may be as or more important than noise in determining use of areas impacted by noise disturbances by some bird species (i.e. some birds will use areas impacted by noise if habitat was available; Warner 1992). Glossy Black-cockatoos and Swift Parrots are also often observed in urban or agricultural environments experiencing noise disturbance.

Thus, it is considered unlikely that the species will avoid edges or be disturbed by noise to the point that they will avoid remaining patches of habitat, at least while foraging.

Lights will be located at the construction areas and permanent lighting will be present at the railway stations. Given that lights will be screened and directed in such a way so as to minimise disturbance to the surrounding environment, it is considered unlikely that Glossy Black-cockatoos, Gang-gang, Swift and Turquoise Parrots will be detrimentally impacted while roosting and/or breeding (though they might choose to roost away from area disturbed by occasional artificial light).

How is the proposal likely to affect habitat connectivity?

While the proposal will increase the level of habitat fragmentation, all four species are highly mobile and their use of forest edges is discussed above. Glossy-black and Gang-gang Cockatoos are most likely to occur in the eastern part of the study are based on their habitat preferences and database records. The habitat within this portion of the NWRL will be less fragmented due to the railway being underground. Clearing of habitat within Epping and Cheltenham and is unlikely to result in the loss of habitat connectivity at a scale that will impact on the habitat of these species.

The Turquoise Parrot and Swift Parrot are more likely to occur in the western part of the NWRL study area where habitat fragmentation will be higher as a result of the railway being above ground. Therefore, these species are more likely to be impacted by fragmentation, but given their high mobility this impact is unlikely to be significant.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for these species.

M.5.4 Owls

Powerful Owl

In NSW the Powerful Owl is widely distributed throughout the eastern forests from the coast, inland to the tablelands within a wide range of wet and dry forest and woodland types. They require large tracts of forest or woodland, but can also occur in fragmented landscapes. A key habitat requirement includes a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. Birds comprise about 10% of the diet, with flying foxes important in some areas. As most prey species require hollows and a shrub layer, these are important habitat components for the owl.

By day, the Powerful Owl roosts in dense vegetation comprising species such as *Syncarpia glomulifera* (Turpentine), *Allocasuarina littoralis* (Black She-oak), *Acacia melanoxylon* (Blackwood), *Angophora floribunda* (Rough-barked Apple), *Exocarpos cupressiformis* (Cherry Ballart) and a number of eucalypt species.

Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). Large trees with hollows at least 0.5m deep (Environment Australia 2000), and diameter at breast height of 80-240 cm that are at least 150 years old are required for nesting. Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 ha. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters. Clutches consist of two dull white eggs and incubation lasts approximately 38 days.

During the field survey, there was no evidence of nesting by Powerful Owls. However, there are 163 records for Powerful Owl on the Wildlife Atlas within 10km of the proposed NWRL. Most of these records occur to the east and north of the proposal at Galston and Lane Cove National Park.

Barking Owl

The Barking Owl is found throughout Australia except for the central arid regions and Tasmania. It is quite common in parts of northern Australia, but is generally considered uncommon in southern Australia. It has declined across much of its distribution in NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains. It is rarely recorded in the far west or in coastal and escarpment forests.

The Barking Owl inhabits a variety of habitats such as savannah woodland, open eucalypt forests, wetland and riverine forest, including fragmented remnants and partly cleared farmland. This species is flexible in its habitat use and hunting can extend into closed forest and more open areas. It is sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils (DECC 2005).

The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by Melaleuca species in the tropics (DECC 2005). It usually roosts in dense foliage in large trees such as River She-oak (*Allocasuarina cunninghamiana*), other Casuarina and Allocasuarina, Eucalyptus, Angophora, Acacia and rainforest species from streamside gallery forests (Debus 1997). During nesting season, the male perches in a nearby tree overlooking the hollow entrance (DECC 2005). It usually nests near watercourses or wetlands in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).

The Barking Owl requires very large permanent territories in most habitats due to sparse prey densities. Territories range from 30 to 200 hectares and birds are present all year. Monogamous pairs hunt over as much as 6000 hectares; with 2000 hectares being more typical in NSW habitats (DECC 2005).

Two or three eggs are laid in hollows of large, old trees including *Eucalyptus camaldulensis*, *E. albens*, *E. polyanthemos* and *E. blakelyi*. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas). Nesting occurs during mid-winter and spring. Young are dependent for several months (DECC 2005).

It is unlikely that the species will breed within the study area, given the landscape is highly fragmented and disturbed and that the range of the species has contracted considerably in NSW, so that it is rarely found east of the Great Divide. The species has not been recorded by previous ecological surveys within the study area. However, there are 12 scattered records of the species within the 10km wildlife atlas search area. Most of these records occur in the eastern half of the study area and range from 1983 to 2010, with only 3 records in the last decade.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The proposal could impact on the lifecycle of the Powerful Owl and Barking Owl by reducing the amount of potential foraging habitat (secondary habitat) and roosting/breeding habitat (primary habitat). Table 31 lists the number of tree hollows within different size categories that will be directly impacted (cleared) or indirectly impacted (not removed but the environment modified adjacent to the hollow-bearing tree) by the proposal. Tree hollows with a diameter >300mm constitute potential primary (breeding) habitat for the Powerful and Barking Owl. Removal of such habitat may impact the lifecycle of the species by reducing the availability of breeding habitat, which will impact on species fecundity in the local area. Table 30 shows that only large hollows within the Cheltenham and Cherrybrook site are likely to be breeding/roosting habitat for both species and Table 32 shows that only a small impact on potential primary habitat is likely to result.

If a Powerful and/or Barking Owl nesting site occur within the study area, it may be impacted through noise, vibration and artificial light during the construction and operation of the NWRL. DECC 2005 recommend that a buffer of at least 200m of native vegetation should be retained around nesting trees or Powerful Owl. The species is known to be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Nesting occurs from late autumn to mid-winter, and disturbance during these stages may affect breeding success (DECC 2005).

Secondary (foraging and day-time roosting) habitat for the species will include forested areas containing a dense understorey and abundant hollows for prey species. Degraded woodland/forest with little or no understorey will be marginal foraging/day-time roosting habitat for the owls, yet they are known to occasionally hunt in open habitats (DECC 2005). Table 32 lists the amount of secondary habitat that will be impacted within the study area and at a regional level and Table 30 describes how this was determined. Loss of foraging habitat has the potential to reduce the availability of prey species within a mating pair's territory, which may force individuals to travel greater distances during hunting.

While the proposal will result in the removal of potential habitat for the Powerful and Barking Owl, the proposal will seek, in the first instance, to retain trees containing large hollows and areas of high quality foraging habitat. For areas of habitat that cannot be avoided, a Biodiversity Offset Strategy is being prepared to compensate for the loss of habitat as a result of construction of the NWRL. These offsets will be managed in perpetuity in order to meet the 'improve or maintain' standard.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will affect potential primary (nesting) habitat and secondary (foraging/day-time roosting habitat) both directly and indirectly as outlined in Table 32, which also described these impacts at a regional scale. Further discussion of impacts to Powerful and Barking Owl habitat is contained in the lifecycle question above.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria (DECC 2005). Therefore the site of the proposed NWRL is not at the limit of the species distribution.

The Barking Owl is found throughout Australia except for the central arid regions and Tasmania. It is quite common in parts of northern Australia, but is generally considered uncommon in southern Australia. It has declined across much of its distribution in NSW and now occurs only sparsely. It is not at the limit of its distribution at the site of the NWRL.

How is the proposal likely to affect current disturbance regimes?

The current disturbance regimes operating within areas of potential habitat for the Powerful and Barking Owl include:

- Weed invasion into native vegetation communities;
- Clearing and fragmentation of habitat associated with urban development, and to the west of the study area agriculture and hobby farms;
- Noise, vibration and artificial light associated with typical urban areas including vehicle traffic;
- A general fire regime of fire suppression within bushland areas due to the close proximity urban areas; and
- Highly modified natural drainage through the channelization and piping of creeks. Where natural waterways remain, they are generally impacted by high weed growth and stormwater pollution including siltation and eutrophication.

In terms of changes to these disturbance regimes as a result of the NWRL and the resultant impacts on the Powerful and Barking Owl, the NWRL:

- May increase the level of weed invasion by creation of small fragments with increased edges. Construction and operation of the railway has the potential to import and distribute weeds species. Mitigation measures will ensure that clean machinery only is used in order to reduce the likelihood of introducing weeds to the construction site. Weed removal is proposed as a mitigation measure to ensure vegetation communities either side of the NWRL are not degraded through weed invasion.
- Will increase the level of vegetation clearing and fragmentation, particularly in the above ground section of the railway at the western end of the line – however, the Powerful and Barking Owls primary and secondary habitat is most likely to occur in the eastern half of the study area where the railway will be underground and disturbance to potential habitat will be limited to vegetation

clearing around the stations and construction sites.

- Cause a temporary (during construction) and long-term (during operation) increase in noise, vibration and light along the length of the above ground section of the railway and at all the stations. This is only likely to impact the owls if a nesting tree is located with 200m of the line or a station.
- Is unlikely to change the fire regime of the area which is currently one of fire suppression. High frequency hazard reduction burning may reduce the longevity of individuals by affecting prey availability. A management action will be to apply low-intensity, mosaic pattern fuel reduction regimes within areas of Powerful Owl habitat. This cannot really be applied to this area, due to the presence of private land and urban and industrial development along a lot of the proposed NWRL. It is more applicable for natural area management in nature reserves and national parks.

How is the proposal likely to affect habitat connectivity?

The Powerful and Barking Owl both require large tracts of forest or woodland habitat but the Powerful Owl can occur in fragmented landscapes as well (DECC 2005). Pairs of mating owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 1400 to 2000 ha (DECC 2005). Given the species are highly mobile, the large area of the landscape that they can occupy and the already highly fragmented landscape within the study area further fragmentation as a result of the proposed NWRL is unlikely to result in the loss of previously connected habitat for the species.

However, fragmentation of foraging habitat has the potential to reduce the availability of prey species within a mating pair's territory, which may force individuals to travel greater distances during hunting.

How is the proposal likely to affect critical habitat?

Not applicable. Critical habitat has not been declared for these species.