Appendix D Flora species recorded

The flora lists include species recorded from opportunistic surveys and biometric plots.

Table 27: Native flora species list recorded within the development site during the field survey

	Scientific Name	Common Name	Opportunistic	Biometric plots
1	*Acacia baileyana#*	Cootamundra Wattle		x
2	*Acacia decurrens*	Black Wattle	x	x
3	*Acacia longifolia* subsp. *longifolia*	Sydney Golden Wattle		x
4	*Acacia* sp. Could not be identified to species due to lack of suitable material		x	
5	*Acacia suaveolens*	Sweet Wattle		x
6	*Acacia terminalis*	Sunshine Wattle		x
7	*Allocasuarina torulosa*	Forest Oak		x
8	*Angophora costata*	Smooth-barked Apple	x	x
9	*Billardiera scandens*	Hairy Apple Berry		x
10	*Breynia oblongifolia*	Coffee Bush		x
11	*Bursaria spinosa*	Native Blackthorn	x	x
12	*Calochlaena dubia*	Rainbow Fern		x
13	*Callistemon* sp. Could not be identified to species level due to lack of suitable material and likely to be planted		x	x
14	*Cassytha glabella*			x
15	*Cassytha pubescens*			x
16	*Casuarina glauca*	Swamp Oak	x	x
17	*Centella asiatica*	Indian Pennywort		x
18	*Ceratopetalum gummiferum*	New South Wales Christmas-bush		x
19	*Cissus hypoglauca*	Water Vine		x
20	*Commelina cyanea*			x
21	*Corymbia gummifera*	Red Bloodwood	x	x
22	*Cotula australis*	Carrot Weed		x
23	*Cynodon dactylon*	Couch		x
24	*Dianella caerulea* var. *caerulea*	Blue Flax Lily	x	x
25	*Dianella caerulea* var. *protensa*			x
26	*Dianella longifolia* var. *longifolia*			x
27	*Dichondra repens*	Kidney Weed	x	x
28	*Dillwynia retorta*			x
29	*Dodonaea triquetra*	Large-leaf Hop-bush		x
30	*Echinopogon caespitosus*	Bushy Hedgehog Grass		x
31	*Echinopogon ovatus*	Forest hedgehog Grass		x
32	*Eleocharis* sp.		x	
33	*Elaeocarpus reticulatus*	Blueberry Ash		x
34	*Entolasia marginata*	Bordered Panic		x

	Scientific Name	Common Name	Opportunistic	Biometric plots
35	*Entolasia stricta*	Wiry Panic	x	x
36	*Eucalyptus botryoides*	Bangalay	x	x
37	*Eucalyptus crebra* possibly planted	Narrow-leaved Ironbark	x	
38	*Eucalyptus pilularis*	Blackbutt		x
39	*Eucalyptus piperita*	Sydney Peppermint		x
40	*Eucalyptus resinifera*	Red Mahogany		x
41	*Eucalyptus robusta*	Swamp Mahogany		x
42	*Eucalyptus saligna*	Sydney Blue Gum		x
43	*Eustrephus latifolius*	Wombat Berry		x
44	*Glycine clandestine*	Love Creeper		x
45	*Glycine tabacina*			
46	*Gonocarpus tetragynus*			x
47	*Goodenia hederacea*	Forest Goodenia		
48	*Hardenbergia violacea*	Purple Coral Pea		x
49	*Hibbertia scandens*	Climbing Guinea Flower		x
50	*Homalanthus populifolius*	Bleeding Heart	x	
51	*Hydrocotyle laxiflora*	Stinking Pennywort		x
52	*Imperata cylindrical*	Blady Grass		x
53	*Juncus continuus*			x
54	*Juncus* sp.		x	
55	*Lepidosperma laterale*			x
56	*Lepidosperma longitudinale*	Pitty Sword-sedge		x
57	*Leptospermum polygalifolium*	Tantoon		x
58	*Leptospermum* sp.			x
59	*Leucopogon juniperinus*	Prickly Beard-heath		x
60	*Leucopogon lanceolatus*			x
61	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush		x
62	*Lomandra gracilis*			x
63	*Lomandra longifolia*	Spiny-headed Mat-rush	x	x
64	*Lomandra obliqua*			
65	*Lomatia silaifolia*	Crinkle Bush		x
66	*Lophostemon confertus* planted	Brushbox		x
67	*Melaleuca armillaris*	Bracelet Honey-myrtle		x
68	*Melaleuca decora*		x	
69	*Melaleuca linariifolia*	Flax-leaved Paperbark	x	
70	*Melaleuca nodosa*	Prickly-leaved Paperbark	x	x
71	*Melaleuca quinquenervia*	Broad-leaved Paperbark		x
72	*Melaleuca* sp.		x	
73	*Melaleuca styphelioides*	Prickly-leaved Tea-tree	x	
74	*Microlaena stipoides*	Weeping grass	x	x
75	*Myrsine variabilis*			x
76	*Notelaea longifolia*	Large Mock-olive		xx

	Scientific Name	Common Name	Opportunistic	Biometric plots
77	*Oplismenus aemulus*	Australian Basket Grass		x
78	*Oxalis* sp.			
79	*Pandorea pandorana*	Wonga Wonga Vine		x
80	*Parsonsia straminea*	Common Silkpod		x
81	*Persoonia linearis*	Narrow-leaved Geebung		
82	*Phragmites australis*	Common Reed	x	
83	*Phyllanthus hirtellus*	Thyme Spurge		x
84	*Pittosporum revolutum*	Wild Yellow Jasmine		x
85	*Pittosporum undulatum*	Native Daphne	x	x
86	*Poa affinis*			x
87	*Poa labillardierei*	Tussock		x
88	*Pratia purpurascens*	Whiteroot		x
89	*Pteridium esculentum*	Common Bracken		x
90	*Pterostylis* sp.			x
91	*Ptilothrix deusta*			x
92	*Rubus parvifolius*	Native Rasberry		x
93	*Sambucus australasica*	Native Elderberry		x
94	*Sarcopetalum harveyanum*	Pearl Vine		x
95	*Smilax glyciphylla*	Sweet Sarsaparilla		x
96	*Syncarpia glomulifera*	Turpentine	x	x
97	*Typha orientalis*	Typha	x	
98	*Urtica incisa*	Stinging Nettle		x
99	*Viola hederacea*	Ivy-leaved Violet		x
100	*Xanthosia pilosa*	Woolly Xanthosia		x

Table 28: Exotic species list recorded during the field survey

	Scientific Name	Common Name	Opportunistic	Biometric plots
1	*Acetosa sagittata*	Turkey Rhubarb	x	
2	*Araujia sericifera*	Moth Vine	x	x
3	*Asparagus aethiopicus*	Aparagus Fern	x	x
4	*Bidens pilosa*	Cobblers Pegs	x	x
5	*Cestrum parqui*	Green Cestrum	x	
6	*Cinnamomum camphora*	Camphor Laurel	x	x
7	*Conyza* sp.			x
8	*Cotoneaster glaucophyllus*	Cotoneaster	x	
9	*Cyperus rotundus*	Nutgrass		x
10	*Ehrharta erecta*	Panic Veldtgrass		x
11	*Eleusine indica*	Crowsfoot Grass		x
12	*Erythrina crista-galli*	Cockspur Coral Tree	x	
13	*Hypochaeris radicata*	Catsear	x	x
14	*Ipomoea indica*	Morning Glory	x	x
15	*Lagunaria patersonia*	Norfolk Island Hibiscus		x
16	*Lantana camara*	Lantana	x	x
17	*Lepidium didymium*	Lesser Swinecress		x
18	*Ligustrum lucidum*	Large Leaved Privet	x	x
19	*Ligustrum sinense*	Small Leaved Privet	x	x
20	*Lolium perenne*	Perennial Ryegrass		x
21	*Lonicera japonica*	Japanese Honeysuckle		x
22	*Modiola caroliniana*	Red-flowered Mallow		x
23	*Nephrolepis cordifolia*	Fishbone Fern	x	
24	*Ochna serrulata*	Mickey Mouse Plant	x	x
25	*Oxalis* sp.			x
26	*Pennisetum clandestinum*	Kikuyu		x
27	*Plantago lanceolate*	Lamb's Tongues		x
28	*Poa annua*	Winter Grass		x
29	*Populus alba*	White Poplar	x	
30	*Rubus* sp.	Blackberry		
31	*Salix* sp.		x	
32	*Schinus areira*	Pepper Tree	x	
33	*Solanum mauritianum*	Wild Tobacco Bush	x	
34	*Stellaria media*	Common Chickweed		x
35	*Stenotaphrum secundatum*	Buffalo Grass		x
36	*Taraxacum officinale*	Dandelion	x	
37	*Trifolium repens*	White Clover		x
38	*Watsonia* sp.			x

Appendix E Fauna species recorded

Table 29 are the fauna species recorded from opportunistic surveys. **Tables 30-33** are the species recorded during the targeted wader surveys.

Table 29: Fauna species list recorded during the field survey

	Common Name	Scientific Name	Observation Type
1	Australian Magpie	*Cracticus tibicen*	O
2	Australian Raven	*Corvus coronoides*	O
3	Australian White Ibis	*Threskiornis molucca*	O
4	Australian Wood Duck	*Chenonetta jubata*	O
5	Chestnut Teal	*Anas castanea*	O
6	Common Starling*	*Sturnus vulgaris*	O
7	Crested Pigeon	*Ocyphaps lophotes*	O
8	Domestic Goose*	*Anser* sp.	O
9	Dusky Moorhen	*Gallinula tenebrosa*	O
10	Masked Lapwing	*Vanellus miles*	O
11	Noisy Miner	*Manorina melanocephala*	O
12	Pacific Black Duck	*Anas superciliosa*	O
13	Pied Cormorant	*Phalacrocorax varius*	O
14	Pied Currawong	*Strepera graculina*	O
15	Rainbow Lorikeet	*Trichoglossus haematodus*	O
16	Red-rumped Parrot	*Psephotus haematonotus*	O
17	Red Wattlebird	*Anthochaera carunculata*	O
18	Royal Spoonbill	*Platalea regia*	O
19	Silver Gull	*Chroicocephalus novaehollandiae*	O
20	Superb Fairy-wren	*Malurus cyaneus*	O
21	Welcome Swallow	*Hirundo neoxena*	O
22	Willie Wagtail	*Rhipidura leucophrys*	O
23	White-faced Heron	*Egretta novaehollandiae*	O

O denotes observed, W denotes heard, * denotes exotic species.

Table 30: Migratory wader survey 15 April 2015

Recorders: MH and MD					
Site	Eve St Wetland	Date	15/04/2015	Time	0550-0650
Temp	15.2	Precip	None	Wind speed and direction	13 km/hr; NW
Landform	Wetland				
Hydrology	Wetland with surface infow; not tidal; hypersaline?				
Aquatic vegetation	Mangroves	Saltmarsh	*Phragmites*		
Terrestrial Vegetation	*Allocasuarina* sp.	*Banksia integrifolia*			
Disturbance	Noise and light from M5	Stormwater inflow			
Species	Activity (foraging/roosting)	Numbers	Species	Activity	Numbers
Royal Spoonbill	R/F	1	Little Black Cormorant	F	2
Hardhead	F	4	Starling (o)		
Magpie (w)			Little Wattlebird (w)		
Welcome Swallow (o)			Currawong (w)		
Grey Teal	F	32	Superb Fairy Wren (w)		
Willy wagtail (o)			Grey Fantail (o)		
Rainbow Lorikeet (o)			Silvereye (o)		
Magpie Lark (o)					
Sulphur-crested Cockatoo (w)					
Aust. White Ibis	F	1			
Dusky Moorhen	F	2			
White faced Heron	F	1			

Table 31: Migratory wader survey 16 April 2015

Recorders: MH and MD					
Site	Eve St Wetland	Date	16/04/2015	Time	0550-0650
Temp	17	Precip	None	Wind speed and direction	13 km/hr; NNW
Landform	Wetland				
Hydrology	Wetland				
Aquatic vegetation	Mangroves	Saltmarsh	*Phragmites*		
Terrestrial Vegetation	*Allocasuarina* sp.	*Banksia integrifolia*			
Disturbance	Noise and light from M5	Stormwater inflow			

Species	Activity (foraging/roosting/foraging and roosting)	Numbers	Species	Activity	Numbers
Silvereye (o)			Welcome Swallow (o)		
Superb Fairy Wren (w)			Magpie Lark (w)		
Rainbow Lorikeet (w)			Lewin's Honeyeater (w)		
Currawong (w)			Kookaburra (w)		
Royal Spoonbill	F	1	Aust. White Ibis	R/F	2
Willy Wagtail (w)			Red-browed Finch (o)		
Grey Teal	F	15	Grey Fantail (o)		
Little Wattlebird (w)					
Moorhen	F	1			
Hardhead	F	2			
White faced Heron	R	1			
Little Cormorant	F	2			

Table 32: Migratory wader survey 22 April 2015

Recorders: MH and MD					
Site	Eve St	Date	22/04/15	Time	0558-0658
Temp	13.6	Precip	Raining heavily	Wind speed and direction	33 km/hr; SSW
Landform	Wetland				
Hydrology	Wetland				
Aquatic vegetation	Mangroves	Saltmarsh	*Phragmites*		
Terrestrial Vegetation	*Allocasuarina* sp.	*Banksia integrifolia*			
Disturbance	Noise and light from M5	Stormwater inflow	Lightning and thunder		

Species	Activity (foraging/roosting/foraging and roosting)	Numbers	Species	Activity	Numbers
Grey Teal	F	6	Feral Pigeon (o)		
Willy wagtail (w)			Little Wattlebird (o)		
Hardhead	F	3	Dusky Moorhen	F	2
White-faced Heron	R	1	New Holland Honeyeater (o)		
Rainbow Lorikeet (o)					
Currawong (o)					
Superb Fairy Wren (w)					
Chestnut Teal	F	2			
Magpie Lark (w)					
Silvereye (o)					
Royal Spoonbill	Flying overhead	1			
Aust. White Ibis	Flying overhead	28			
Welcome Swallow (o)					

Table 33: Migratory wader survey 23 April 2015

Recorders: MH and MD					
Site	Eve St	Date	23/04/15	Time	0550-0650
Temp	14	Precip	None	Wind speed and direction	Calm
Landform	Wetland				
Hydrology	Wetland				
Aquatic vegetation	Mangroves	Saltmarsh	*Phragmites*		
Terrestrial Vegetation	*Allocasuarina* sp.	*Banksia integrifolia*			
Disturbance	Noise and light from M5	Stormwater inflow			
Species	Activity (foraging/roosting/foraging and roosting)	Numbers	Species	Activity	Numbers
Dusky moorhen	F	2	Hardhead	F	1
Chestnut Teal	F	12	Starling (o)		
Lewin's Honeyeater (w)			Aust. White Ibis	Flying	15
Kookaburra (w)			White Faced Heron	Flying	1
Magpie Lark (w)			Common Myna (o)		
Willy Wagtail (w)			Yellow-faced Honeyeater (o)		
Welcome Swallow (o)			Pied Cormorant	Flying	1
Currawong (w)			Red-browed Finch (o)		
Little Wattlebird (w)			Australian Kestrel? (o)		
Superb Fairy Wren (w)					
Rainbow Lorikeet (w)					
Grey Fantail (w)					
Silvereye (o)					

Appendix F Hollow- bearing tree survey results

ID	Hollow size	Hollow type	Tree sp.	DBH (cm)	Crown cover (per cent)	Evidence of use	Notes	Tree No.	Fauna Group	Hollow No.	Source
1	S	Fissure	Fig	110	60	N	Possible hollow. Large fig. May be more small hollows present in tree.	1	Bat	1	
2	S	Hole on branch / Fissure	Fig	110	75	N	Possible other small hollows. Hollow 6m from ground.	1	Bat	1	
3	S	Fissure	Fig	140	40	N	Split trunk, hollow 1m from ground. Unlikely to used.	1	Bat, small bird	1	
4	Nest Box -	Nest Box	Eucalypt	75	25	Y	Nest Box, just outside impact area. Looked old.	1	Possum	1	
5	S	Branch	Fig	70	85	N	Possible hollow only. Unlikely to be used. 3m above ground.	1	Small bird	1	
6	S	Branch dead	Exotic	60	10	N	Dead branch hollowed out by termites? Hollow low and tree very close to activity. Unlikely to be used.	1	Bat	1	
7	M	Spout	Eucalypt	90	20	Possible	Possible scratches and chew marks. Couldn't sight in hollow – facing upwards.	1	Medium bird or possum	1	
8	S	Spout	Angophora	40	10	Unknown	Possible hollow in spout. Unsighted. Could not get closer access.	1	Bat??	1	
9	M	Trunk / Fissure	Eucalypt	120	60	Unknown	Dual trunk tree, possible use. Hole of hollow unsighted.	1	Possum, bat, small bird	1	

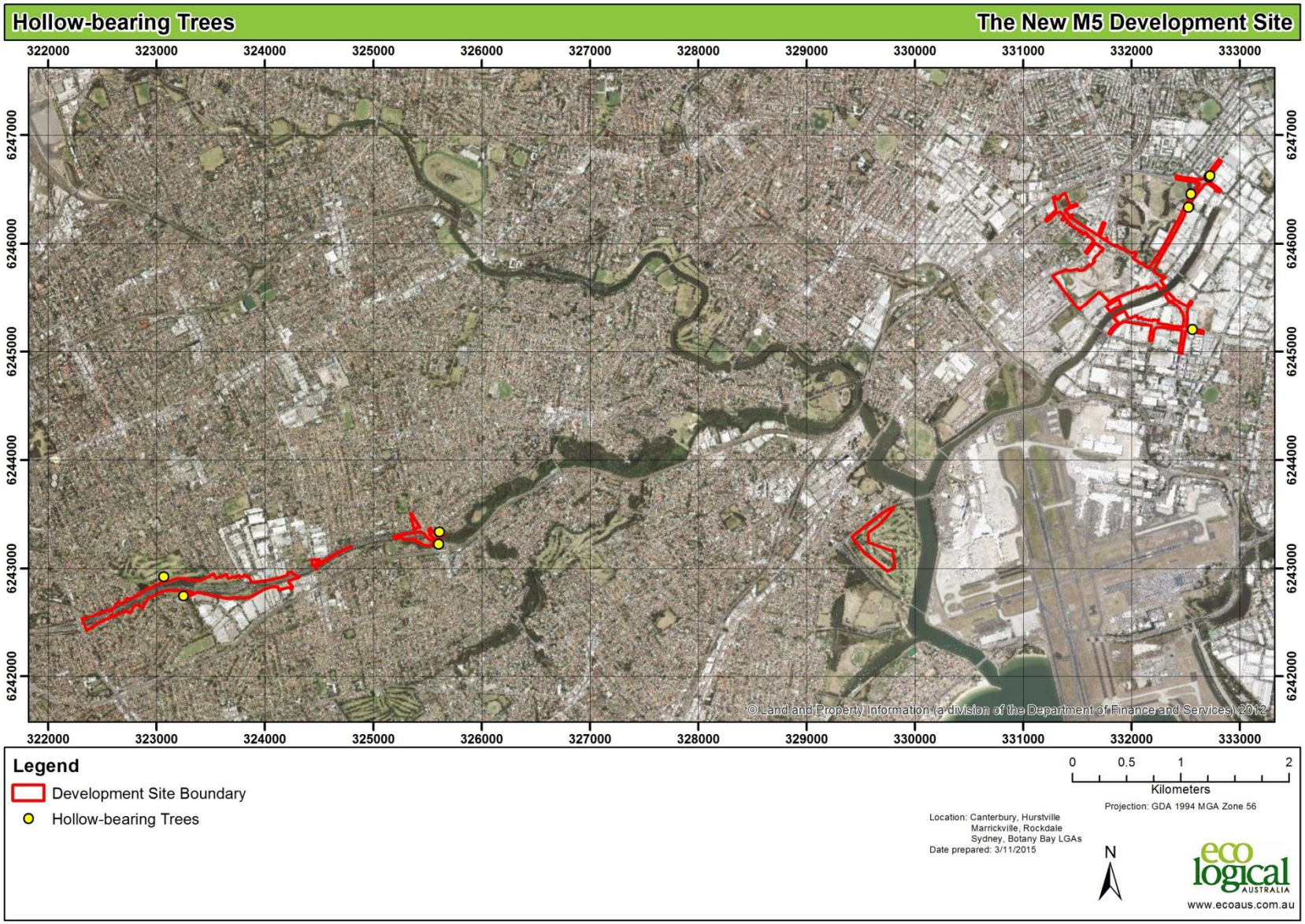

Figure 11: HBT Locations

Appendix G EPBC Act Significant Impact Criteria

The proposed construction footprint of the project supports areas of native vegetation and potential and known habitat for two threatened fauna species. A full list of species and TECs recorded within a ten kilometre radius of the construction footprint is found in **Appendix A**, however not all of these species, TECs or their habitats are likely to be impacted by the project. Potentially impacted species and TEC are listed below. Each species or TEC has been assessed for potential impacts that may result from the project.

Endangered Ecological Communities

- Cooks River / Castlereagh Ironbark Forest of the Sydney Basin Bioregion.

Threatened Fauna

- *Litoria aurea* (Green and Golden Bell Frog)
- *Pteropus poliocephalus* (Grey-headed Flying-fox).

Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion

The Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion (CRCIF) is a dry sclerophyll open-forest to low woodland which occurs predominantly in the Cumberland Subregion between Castlereagh and Holsworthy, as well as around the headwaters of the Cooks River (DotE 2015). It is listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. The majority of the community is found in the north-west section of the Cumberland Subregion in the Castlereagh area between Penrith and Richmond. Other significant patches occur in the Kemps Creek and Holsworthy areas. Smaller remnants occur in the eastern section of the Cumberland Subregion (e.g. upper Cooks River Valley).

The community occurs on clay-rich soils derived from predominantly Tertiary Alluvium and on Wianamatta Shale derived soils found next to Tertiary Alluvium (NSW NPWS, 2002; Tozer, 2003; NSW Scientific Committee, 2011). It occurs below 100 metres above sea level with mean annual rainfall of 800-1000 millimetres (Tozer et al 2010).

CRCIF is usually dominated by *Eucalyptus fibrosa* (broad-leaved ironbark) and *Melaleuca decora* (paperbark). *E. longifolia* (Woollybutt) is also often present. Other over-storey species that may be present include: *E. racemosa* (syn. *E. sclerophylla*, narrow-leaved scribbly gum), *Angophora costata* (smooth-barked apple) and *Angophora bakeri* (narrow-leaved apple) at sandier sites, *E. longifolia* close to creeks, *E. parramattensis* subsp. *parramattensis* in less well drained soils, and *E. moluccana*.

The original extent of CRCIF has been significantly reduced since the introduction of agricultural and urban uses across the Sydney Basin Bioregion following European settlement. The total extent of CRCIF that remains is estimated to be between 609 ha and 2437 ha (Tozer et al 2006, 2010)).

Surveys in 2014 confirmed the presence of CRCIF in the west of the project corridor, adjacent to Canterbury Golf Course and the M5 Motorway totalling to 1.8 hectares. The CRCIF patch of bushland was intentionally avoided by the original M5 project and is now managed for conservation by Roads and Maritime in accordance with the M5 approval conditions. Canopy species are young and sparse and include *Syncarpia glomulifera* (Turpentine) and a range of eucalypts. The mid-canopy layer includes *Casuarina glauca* (Swamp Oak), *Melaleuca nodosa* (Prickly-leaved Paperbark) and *Acacia decurrens* (Black Wattle). Shrubs include *Bursaria spinosa* (Blackthorn) and *Notelaea longifolia* (Mock Olive). Ground covers are predominantly native, with exoticsincreasing in abundance and cover close to the M5. Native species include *Dianella caerulea* (Blue Flax-lily), *Glycine clandestina* (Twining Glycine), *Pratia purpurascens* (White Root) and *Microlaena stipoides* (Weeping grass). Exotic species include *Plantago lanceolata* (Lamb's Tongue), *Bidens pilosa* (Cobbler's Pegs) and *Ehrharta erecta* (Panic Veldtgrass).

The 1.8 hectares of CRCIF comprises two stands separated by a cycleway. The patches are isolated from any other stands of CRCIF and are currently impacted by edge effects.

The proposed action will impact on 1.4 hectares (78 per cent of patch) of the 1.8 hectares CRCIF patch. While this represents a very small proportion, at less than 0.1 per cent, of the total remnant CRCIF vegetation (estimated at 1828 hectares (DotE 2015)) within the Sydney Basin Bioregion, it comprises the majority of CRCIF within the development site.

The 1.4 hectares to be impacted under the worst case scenario is considered to be of low long-term viability due to its high perimeter to area ratio, isolation from larger patches of remnant bushland, considerable edge effects from the adjacent M5 Motorway (lighting impacts, noise, human disturbance), and the current influence of the adjacent golf course run-off (high nutrients and altered hydrology).

The Significant Impact Criteria (DotE 2013) has been reviewed to inform an assessment of the impacts of the proposed action.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

1. Reduce the extent of an ecological community

The proposed action would result in a maximum removal of approximately 1.4 ha of CRCIF or 78 per cent of the 1.8 hectares within the development site. This represents a reduction in the extent of the CRCIF of less than 0.1 per cent of the estimated remaining extent of the community across its range, but a significant area within the development site.

2. Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

The proposed action will not break the patches into two or more patches.

3. Adversely affect habitat critical to the survival of an ecological community

No habitat has been declared as critical habitat for the CRCIF in the Critical Habitat Register. The patch present is less than one per cent of the extant extent of the community. Despite high diversity, the patch has limited long term viability given its high perimeter to area ratio and isolation from other bushland areas. Thus the patch is unlikely to be critical to the survival of the community across its entire extent.

4. Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

The proposed action will destroy the abiotic factors necessary for the survival of the 1.4 hectares of CRCIF within the development site. The abiotic factors necessary for the survival of the patch to be retained are unlikely to be destroyed or adversely modified. Ground water extraction is unlikely to impact on this community and no surface water changes are likely to occur. While the retained patch up upslope of the proposed action area, a sediment and erosion control plan is to be implemented to minimise potential run off from the construction works.

5. Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

The action will remove 78 per cent of the community within the development site and therefore will significantly modify the species composition for this part of the patch. The community is already modified and would have already undergone substantial changes as a result of historic disturbances. As a result of these changes and the community's isolation, most of the key ecological processes such as fire regimes and genetic exchange for some species would have already been altered to the extent that functionally important species have been lost or declined. Therefore the long-term viability of the community has been jeopardised such that without substantial management efforts and resources the patch will continue to decline.

6. Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- assisting invasive species, that are harmful to the listed ecological community, to become established, or

A Construction Environmental Management Plan would be developed and implemented prior to and during construction activities which would minimise the risks associated with the introduction of any invasive weeds or pathogens in the remaining 0.4 hectares of CRCIF. However the long-term viability of the patch that remains is questionable (see below). Any actions in the Construction Environmental Management Plan would need to demonstrate how the measures are consistent with the threat abatement plan developed to manage threats casued by infection of *Phytophthora cinnamomi*. Measures would include conducting a risk assessment to determine if the pathogen is present and to then determine the need to clean machinery before entering and leaving the area.

- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The proposed action will not introduce chemicals or pollutants which are likely to kill or inhibit the growth of species in this community. As part of the Construction Environmental Management Plan, there would be procedures regarding the use and application of herbicides in and around environmentally sensitive areas. Implementation of these measures would limit impacts of any herbicides on this community.

7. Interfere with the recovery of an ecological community.

The proposal will result in a permanent loss of 1.4 hectares of the extent of CRCIF within the development site. This will inhibit the recovery of the community. However the CRCIF within the development site is not considered to be important to the recovery of the CRCIF across its entire extent given that it is highly modified in structure and composition, it has a high perimeter to area ratio and has no prospect of expanding into adjacent areas. Without substantial effort and continuing management, this patch is unlikely to be viable in the longer term.

Conclusion

Considering all of the criteria, the proposed action is considered to have the potential to have a significant impact on the CRCIF and a referral was submitted.

Unavoidable biodiversity impacts to CRCIF from the proposed action are being addressed through a range of mitigation and management actions to be carried out before development, alongside development, and into the future. These are outlined in more detail in Chapter 6 and include:

- Environmental management plans including appropriate salvage of plant materials.
- Delineation fencing.
- Sediment and erosion controls.

An offset package has been developed for the project, in accordance with the FBA. This will include measures to compensate for the loss of CRCIF from construction of the project. This will require that all identified significant residual impacts on CRCIF are offset in accordance with the principles of the NSW Offset Policy for Major Projects.

THREATENED FAUNA

Litoria aurea (Green and Golden Bell Frog)

In NSW, the Green and Golden Bell Frog has been found in a wide range of water bodies. It inhabits many disturbed sites, including abandoned mines and quarries. Breeding habitat in NSW includes water bodies that are still, shallow, ephemeral, unshaded, with aquatic plants and free of *Gambusia holbrooki* (Plague Minnow) and other predatory fish, with terrestrial habitats that consists of grassy areas and vegetation no higher than woodlands, and a range of diurnal shelter sites. Breeding occurs in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds, and where predatory fish are absent (DEWHA 2010).

Goldingay and Lewis (1999) suggest that the Green and Golden Bell Frog is highly mobile, and may move among breeding sites, however, dispersal patterns can vary between populations. Various studies have revealed that the species is capable of moving long distances in a single day/night of up to 1–1.5 kilometres, and mark/recapture studies found individuals moved up to three kilometres. Observations suggest movements of up to five kilometres may be common, and the frog may possibly disperse as far as 10 kilometres. Isolated occurrences of Green and Golden Bell Frog have been reported several hundred metres from major drainage lines or other waterbodies (DEWHA 2010).

Green and Golden Bell Frogs require a range of habitats for different aspects of their life cycle including foraging, breeding, over-wintering and dispersal. They will also use different habitats or habitat components on a temporal or seasonal basis (DEWHA 2010).

There is one Green and Golden Bell Frog population within the development site. The Green and Golden Bell Frog population inhabiting the site has been identified as the Arncliffe Key Population within the Green and Golden Bell Frog Recovery Plan (DEC 2005).

The Arncliffe population in the vicinity of the Marsh Street wetlands was previously the subject of major road works and infrastructure development associated with the M5 East Motorway construction in 1998. Green and Golden Bell Frog habitat was created in the form of two breeding ponds in the north-western corner of Kogarah Golf Course on Roads and Maritime land and a frog underpass connecting the new breeding ponds with Marsh Street wetlands. In addition, a long-term monitoring and management program was established and is still operating.

Annual monitoring by Dr Arthur White identified that the purpose built frog ponds, referred to as the RTA ponds, are being successfully used for breeding. Habitat enhancement works in the RTA ponds have combined regular interventions to manipulate the water levels to manage vegetation and Green and Golden Bell Frog predators (e.g. Plague Minnow), and management of chytrid fungus through salt water flushing.

During the annual monitoring, Dr Arthur White identified that the local population centres around the RTA ponds. Breeding has not been identified outside these areas since 2000. Therefore, the RTA ponds are considered to be the key source for adult frogs for the local population, which disperse across the Kogarah Golf Course. It is unlikely that the other ponds within the golf course provide suitable significant breeding habitat as they contain Plague Minnow. However, rare breeding events in the golf course ponds have been recorded previously (Dr Arthur White pers. comm 2015).

Adult frogs have been recorded in the golf course areas during each annual survey period. Activity is concentrated around the fifth and sixth fairways and also the Crescent Lake further to the north-east of

these fairways. These areas are considered important as foraging habitat and movement corridors for the local population.

The frog population within the RTA ponds and the golf course has been monitored. Results from the monitoring estimates the local population has increased since 2003, with the largest estimate in 2012, with 110 adults. In the most recent monitoring period, 2014/12015, the population was estimated to be around 30 – 50 adults.

The current population is unlikely to persist without constant management and is considered to have poor long-term viability (Dr Arthur White pers. comm 2015). The population is now small (less than 50 adult frogs; Dr Arthur White pers. comm 2015) and is limited by the presence of Plague Minnow and chytrid fungus in ponds other than the RTA ponds. Since 2003, breeding has occurred in the RTA ponds in every year except 2014.

The Kogarah Golf Course is approximately 40 hectares in size and contains a wide range of habitats, suitable for this species. Habitat types within the Kogarah Golf Course locality are described as follows (extracted from Management Plan Green and Golden Bell Frog Lower Cooks River Key Populations, DECC 2008a):

- *Breeding habitat*: primarily consist of the permanent and semi-permanent purpose built artificial ponds (RTA ponds) in the north-western corner of the golf course. These ponds were built as a requirement of a previous RTA development approval. Two other ponds within the golf course have provided breeding habitat, although breeding events are rare, presumably due to predation by the Plague Minnow. The key source of adults and juveniles are the RTA ponds (which are actively managed for Plague Minnow and chytrid fungus by Roads and Maritime).
- *Foraging habitat*: Includes grassed areas (native or exotic), tussock vegetation and emergent sedges and reeds bordering water features and ponds. The drainage channel and reed beds that border the southern extremity of the golf course may also provide foraging habitat.
- *Sheltering habitat*: includes similar vegetation to that used as foraging areas that contain rock piles, fallen timber, tussock grasses and other artificial sheltering sites. Sheltering habitat is present surrounding the artificial RTA ponds.
- *Dispersal habitat*: typically includes wet areas such as creek lines, drains, stormwater canals, connecting vegetation, and other easements and depressions. However, in the golf course, fairways currently provide movement habitat between breeding ponds and foraging habitat. An artificial frog passage was built underneath the M5 East Motorway to facilitate movement between the golf course and habitat to the west and south (Marsh Street Wetlands and Old Spring Creek Wetland site). However, this passage is not regularly used (DECC 2008a). Frogs have been recorded using the cycleway, which passes under the M5 East Motorway, to move between the RTA ponds/golf course and areas south-west of the M5 East Motorway (Dr Arthur White, pers. comm. 2015).
- *Over-wintering habitat*: no overwintering habitat has been observed in the Arncliffe surface works area (White and Pyke, 2015 in press).

The Significant Impact Guidelines for vulnerable species Green and Golden Bell Frog (DoE 2013) have been reviewed to inform an assessment of the impacts of the proposed action. The assessment found:

1. Lead to a long-term decrease in the size of an important population of the species

The population within the Kogarah Golf course is a key population. The proposed action would remove or degrade a maximum of 7.82 hectares of known Green and Golden Bell Frog foraging, sheltering and

dispersal habitat. The two RTA ponds, identified by Dr White as the population centres and breeding habitat, are to be retained and buffered by an exclusion zone of about 32 metres.

Breeding has been recorded in two golf course ponds to be impacted by the proposed action (Dr Arthur White, pers. comm. 2015), although breeding in these ponds is rare likely as a result of the presence of Plague Minnow.

The proposed works are unlikely to directly impact on breeding habitat located within the RTA ponds. However, the proposed works will be in close proximity to these ponds and would impact on 7.82 hectares of known foraging habitat.

The proposed works are likely to result in a decrease in the viability of the Green and Golden Bell Frog local population due to a large portion of foraging, dispersal and sheltering habitat being removed. Although previous records have identified individual frogs located at the Marsh Street and Eve Street wetlands, there has not been any record of frogs breeding in these habitats, suggesting that these habitats are unsuitable. Therefore a Plan of Management to manage the temporary and permanent disturbances to the population has been proposed. With the implementation of the Plan of Management, the longer-term viability of the population should not decrease.

2. Reduce the area of occupancy of an important population

The current Green and Golden Bell Frog population is centred around the RTA ponds which are used as breeding habitat. The proposed action would result in the removal of 7.82 hectares of dispersal, foraging, and sheltering habitat, thereby reducing the area of occupancy of an important population. The proposed action will not reduce the area of occupancy of the breeding habitat at the RTA ponds.

The Plan of Management proposes to create additional habitat adjacent to the Arncliffe surface works area to be used for the duration of construction. Management actions would include increasing tussocky grasses and swales to increase area and quality of foraging and sheltering habitat. Ponds will be established to increase the chances of frogs being able to disperse to the remainder of the golf course area, which provides foraging, sheltering and dispersal habitat. Supplementary feeding is also planned to further reduce risks to this population.

3. Fragment an existing important population into two or more populations

Due to the location of the Arncliffe Green and Golden Bell Frog population, which is situated in an urban setting, the population appears to be isolated from other populations with the nearest population located approximately 9.5 kilometres northwest at Greenacre. It is unlikely that the proposed works will further fragment the current population as long as any individuals located within the Arncliffe surface works area are re-located according to the Plan of Management. Therefore the proposal is unlikely to fragment to the current population into two or more populations.

4. Adversely affect habitat critical to the survival of a species

No critical habitat has been declared for this species. However, important habitat critical to this species survival would include breeding, foraging, dispersal and over-wintering habitat.

The proposal will result in the removal of foraging and dispersal habitat that exists within the golf course lands, however breeding habitat that exists within the RTA ponds will be retained.

Through proposed mitigation measures creation of alternative habitat these measures could ameliorate the impacts of the proposal. These measures are outlined in more detail in the Plan of Management. The Plan of Management for the Green and Golden Bell Frog population at Arncliffe is to:

- Minimise or eliminate all avoidable construction impacts by removing and excluding frogs from the construction zone and implementing strict ongoing construction protocols and exclusions.
- Compensate for unavoidable construction impacts by augmenting existing foraging habitat including supplementary feeding.
- Insure against stochastic impacts on RTA ponds by establishing a captive breeding colony and managing non construction related threats known to adversely impact the RTA ponds.
- At least double the availability of suitable habitat in the vicinity by creating new habitat at Marsh Street wetlands and re-instating habitat within Kogarah Golf Course post construction.
- Together these objectives are designed to ensure the long term persistence of the species at Arncliffe which is the ultimate aim of this management plan.

5. Disrupt the breeding cycle of an important population

The RTA ponds are considered to be the key source for adult frogs for the local population, which disperse across the Kogarah Golf Course. It is unlikely that the other ponds within the golf course provide suitable breeding habitat as they contain Plague Minnow. However, occasional breeding events in the golf course ponds have been recorded (Dr Arthur White pers. comm 2015).

The proposed action will not directly impact the RTA ponds. There is a chance that indirect impacts may affect these ponds. Indirect impacts such as increases in noise, light, dust and vibration will be managed by:

- Installing temporary sound proof fencing adjacent to the RTA ponds
- Constructing the sound proof fence with a transparent material to minimise shadowing of the ponds
- Installing directional lighting for use during the 24 hour construction works to reduce light spill into the ponds at night
- Using town water supply to decrease dust falling into the RTA ponds
- Using a non-acoustic shed for dumping and loading of spoil to assist in noise attenuation.

The action proposes to construct permanent facilities adjacent to the RTA ponds. A solar study demonstrated that there would be overshadowing of the RTA ponds at 9.00 am during the winter solstice, but that by midday, this shading would affect the ponds. The study also showed that there would be no shading of the RTA ponds during the summer solstice. This means that basking habitat would be available during the critical period of breeding for this population, which is during summer. Therefore the proposal is unlikely to disrupt the breeding cycle of the Green and Golden Bell Frog located at Arncliffe.

6. Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed action will decrease the availability of foraging, sheltering and dispersal habitat. The area of habitat to be modified is 7.82 hectares, which is about 20 per cent of the available habitat. Mitigation measures including ensuring individual frogs located on the golf course are relocated prior to construction, frog proof fences are erected to separate the construction zone from the frogs and alternative habitat is to be created would reduce the risk of the population of Green and Golden Bell Frog declining.

7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species that would be harmful to the Green and Golden Bell Frog include cats, foxes and the Plague Minnow. The project is unlikely to exacerbate the risk of these species becoming established in habitats where they are not already present. The Plague Minnow is present in all of the ephemeral ponds and water hazards within the Kogarah Golf Course (White A. pers comm. 2015). The Plague Minnow is not present within the RTA ponds. This is because these ponds were purpose built and designed to allow management of water levels to remove Plague Minnow. The management of the RTA ponds will continue during the construction and operation of the proposed action.

8. Introduce disease that may cause the species to decline, or

The frog fungal disease, Chytrid fungus, is already likely to be present on the development site (White A, pers comm 2015). However the fungus is managed within the RTA ponds via salt water flushing. The action is unlikely to introduce a disease that may cause the current Green and Golden Bell Frog population to decline, however the project will need to implement mitigation measures as an extra precaution to wash down (and, if necessary, bleach) equipment used in other aquatic environments to reduce the risk of introduction of Chytrid fungus to the RTA ponds and the enhanced frog area. The RTA ponds will continue to be managed during the construction and operation of the proposed action.

9. Interfere substantially with the recovery of the species.

A draft recovery plan has been prepared for the Green and Golden Bell Frog (DEC 2005). The specific objectives of this plan relate to securing and managing existing populations, ex-situ conservation and further research. The proposed works conflict with objectives set out in the recovery plan. In particular two specific objectives:

- increase the security of key GGBF populations by way of preventing the further loss of GGBF habitat at key populations across the species' range and where possible secure opportunities for increasing protection of habitat areas
- ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species.

A Plan of Management for the Green and Golden Bell Frog Key Population of the Lower Cooks River - NSW was prepared by the Department of Environment and Climate Change in 2008 (DECC 2008a) and provides information for the management and monitoring of the species for its long-term viability at Arncliffe, Lower Cooks River. It also provides a detailed threat assessment, outlines past and current management issues, outlines future management actions relating to the enhancement of existing habitat and connectivity within and between sub-populations, and provides a framework for the plans implementation.

Therefore, the proposal interferes with the recovery of the Arncliffe Green and Golden Bell Frog key population. A series of mitigation measures have been proposed to reduce the risks to the population by managing:

- Noise
- Light
- Dust
- Vibration
- Reduction in foraging and sheltering habitat
- Access to the RTA ponds
- Managing access to the enhanced frog habitat area.

Conclusion

The project would result in the removal of potential foraging, dispersal and sheltering habitat for the Green and Golden Bell Frog. Consequently, the impact to the Arncliffe Green and Golden Bell Frog population and habitat from the proposed action is considered to present a potential significant impact. A referral was submitted on this basis.

The majority of the impacts are to be temporary (up to four years), with the proposed temporary works impact area to be rehabilitated following completion of the action.

To ameliorate the impact to the Green and Golden Bell Frog population a number of appropriate mitigation and management measures are proposed as part of the action.

Roads and Maritime has developed a Green and Golden Bell Frog Plan of Management and mitigation measures with the objective of creating new and enhanced Green and Golden Bell Frog habitat for the term of the construction activities.

Completion of the Green and Golden Bell Frog management works during the construction phase will require that monitoring s prepared and implemented. The details of this plan would be agreed with OEH and partners, and would be developed with input from Green and Golden Bell Frog experts.

The management and mitigation measures being prepared by Roads and Maritime include:

- Creation of a physical barrier and about a 32 metre buffer between the construction works and existing RTA ponds and habitat for Green and Golden Bell Frog protection.
- Development of foraging routes and corridor for Green and Golden Bell Frog connecting the existing RTA ponds and the remainder of the golf course, which is currently used as foraging, dispersal and sheltering habitat;
- Captive breeding program to ensure a sustainable population is maintained during the works and to meet potential approval obligations for maintaining the Green and Golden Bell Frog population.
- Development of enhanced frog protection area adjacent to the proposed action and within the Marsh Street wetlands.

Grey-headed Flying Fox

Pteropus poliocephalus (Grey-headed Flying-fox) are listed as vulnerable under the EPBC Act. Grey-headed Flying-foxes are found within 200 kilometres of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. They occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 kilometres of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy (DECC 2005).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. Site fidelity to camps is high with some camps being used for over a century. They can travel up to 50 kilometres to forage in a single night (DECC 2005).

This species feeds on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. They also forage in cultivated gardens and fruit crops and can inflict severe crop damage (DECC 2005).

There is a camp at Turrella, some 500 metres north of the project area.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that the project would:

1. Lead to a long-term decrease in the size of an important population of the species

The closest known camp to the project area is located 500 metres to the north of the project area. Individuals will move between maternity and non-maternity camps around Sydney to utilise foraging resources.

Under the proposed action, ten hectares of potential foraging habitat for the Grey-headed Flying Fox is to be removed. The area of potential foraging habitat to be affected is relatively small compared to the area available to this population. The proposed action will not directly impact any part of a known camp.

Given that foraging habitat exists in the surrounding landscape, and that this species is wide-ranging (travelling up to 50 kilometres in one night), the proposed action is unlikely to lead to a long-term decrease in an important population of this species its size.

2. Reduce the area of occupancy of an important population

The project would result in the loss of a relatively small area of potential foraging habitat for the Grey-headed Flying-fox, in the context of the extent of foraging habitat that is available to the local population of the species. These impacts are unlikely to reduce the area of occupancy of an important population of the species. Plantings of species likely to provide foraging habitat for Grey-headed Flying Fox should be undertaken to compensate for the minor loss of foraging habitat.

3. Fragment an existing important population into two or more populations

The project woud result in the removal of a small area of potential foraging habitat for the Grey-headed Flying-fox (ten hectares) in the context of that which is available to the local population of the species. The proposal will not adversely impact on any Grey-headed Flying-fox or result in barriers to the movement of this highly mobile species.

Under these circumstances, the proposed action will not fragment an existing important population of the species into two or more populations.

4. Adversely affect habitat critical to the survival of a species

No breeding habitat (camps) would be impacted by the proposed action. There will be some loss of foraging habitat (about ten hectares) with the camp in closest proximity to the study area located to the north at Turrella, around 0.5 kilometres away.

Under the DECC (2009c) Draft National Recovery Plan, foraging habitat within a 50 kilometre radius of a roost site with greater than 30,000 individuals is foraging habitat critical to survival. The Turrella camp does not meet this definition. However the camp at Gordon, approximately 20 kilometres to the north does. The Gordon camp site can vary in the number of individuals present from zero to 80,000 (Ku-ring-gai Council 2013) and the data for this camp suggests that the camp will vary during the breeding season (summer) between 20,000 and 40,000.

Therefore there is foraging habitat present which meets the definition of habitat critical to the survival of the species. However, the amount of habitat loss is not considered to be significant in terms of the regional context. From analysis of the native vegetation mapping GIS dataset for the Sydney Metropolitan Area (Office of Environment and Heritage 2013), more than 77,000 hectares of native vegetation was identified as occurring within 50 kilometres of the Gordon camp site. This dataset is limited in its extent to the Sydney Metropolitan Catchment Management Authority area, and thus only includes around 50 per cent of the native vegetation within 50 kilometres of the camp site. This analysis also only included native foraging habitat and does not include non-native street trees or urban vegetation that may be used for foraging by this species.

Around ten hectares of potential foraging habitat would be removed or modified as part of the action. This is estimated to be around 0.012 per cent of the available foraging habitat for the Gordon camp. While habitat critical to the survival of the species would be removed, the impacts are not expected to be significant in the context of the area of habitat available.

5. Disrupt the breeding cycle of an important population

As no camps will be directly impacted or otherwise disturbed, it is highly unlikely the proposed action would disrupt the breeding cycle of an important population.

6. Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

As no camps would be removed or disturbed, and the impacts on the extent of foraging habitat available to the species will be minor, the proposed action is unlikely to modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7. Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The project would not result in the establishment of invasive species, such as weeds, that would be harmful to Grey-headed Flying Fox. It is unlikely that the proposed works will result in an increased number of weeds due to the current disturbed nature of the area in which the species persists. There are measures to mitigate against increases in weeds within the development site. These measures will be consistent with the Roads and Maritime guidelines for protection of biodiversity.

8. Introduce disease that may cause the species to decline, or

Grey-headed Flying-foxes are reservoirs for the Australian bat lyssavirus (ABL) and can cause clinical disease and mortality in GHFF (DECCW 2009). The proposed works are unlikely to present a significant ecological stress on any camps or on individuals that may utilise the development site and therefore the proposed action is unlikely to introduce or exacerbate this virus or any other disease that may cause this species to decline.

9. Interfere substantially with the recovery of the species.

A Draft National Recovery Plan for the Grey-headed Flying-fox was developed in 2009. As no maternity camps would be removed, and the proposed action will only result in the removal of a small area of potential foraging habitat, it is unlikely the proposed action will interfere with the recovery of this species.

Conclusion

The project would not affect known breeding habitat and will only impact on a relatively small area of potential foraging habitat for this highly mobile species. No important populations would be isolated or fragmented and the life cycle of this species is not likely to be adversely affected. Therefore, the proposal is not likely to have a significant impact on this species.

Appendix H FBA Methodology and where addressed in document

Table 34: Location of FBA methodology requirements for a 'Biodiversity Assessment Report' for stages 1 and 2 and where these are addressed in this report

Report section	Information	Maps & data	FBA reference	Section in this Report
Introduction	Introduction to the biodiversity assessment including: • identification of development site footprint, including: ○ operational footprint ○ construction footprint indicating clearing associated with temporary construction facilities and infrastructure • general description of development site • sources of information used in the assessment, including reports and spatial data.	• Site Map (as described in Section 3.2) • Location Map (as described in Section 3.2) • Digital shape files for all maps and spatial data	Chapter 3 and Section 3.2	Chapter 1 – Introduction and Chapter 2 Methodology

Report section	Information	Maps & data	FBA reference	Section in this Report
Landscape features	Identification of landscape features at the development site, including: • IBRA bioregions and subregions, NSW landscape region and area (ha) • native vegetation extent in the outer assessment circle or buffer area • cleared areas • evidence to support differences between mapped vegetation extent and aerial imagery • rivers and streams classified according to stream order • wetlands within, adjacent to and downstream of development site • landscape value score components, including: ○ identification of method applied (i.e. linear or site-based) ○ per cent native vegetation cover in the landscape ○ connectivity value ○ patch size ○ area to perimeter ration • landscape value score.	• IBRA bioregions and subregions (as described in Paragraphs 4.1.1.3–4) • NSW landscape regions (as described in Paragraphs 4.1.1.5–6) • Rivers and streams (as described in Paragraphs 4.1.1.8–10 • Wetlands (as described in Paragraphs 4.1.1.11–13) • Other landscape features (as required by SEARs) • Native vegetation extent (as described in Paragraphs 4.1.1.12–15) • State, regional and local biodiversity links (as described in Paragraphs 4.1.1.16–17) • Regional vegetation used to calculate patch size	Section 4.1, Appendix 4 and Appendix 5	Chapter 3 – Landscape features

Report section	Information	Maps & data	FBA reference	Section in this Report
Native vegetation	Identify native vegetation extent within the development site, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery. Describe PCTs within the development site, including: • vegetation class • vegetation type • area (ha) for each vegetation type • species relied upon for identification of vegetation type and relative abundance • justification of evidence used to identify a PCT (as outlined in Paragraph 5.2.1.8) • EEC status (as outlined in Subsection 5.2.1) • estimate of per cent cleared value of PCT. Describe vegetation zones within the development site, including: • condition class and subcategory (where relevant) • area (ha) for each vegetation zone • survey effort as described in Paragraphs 5.2.1.5–7 (number of plots/transects). Where use of local data is proposed: • identify relevant vegetation type • identify source of information for local benchmark data • justify use of local data in preference to database values.	• Map of native vegetation extent within the development site (as described in Section 5.1) • Map of PCTs within the development site • Map of condition class and subcategory (where relevant) • Map of plot and transect locations relative to PCTs and condition class • Map of EECs • Plot and transect field data (MS Excel format) • Plot and transect field data sheets • Table of current site value scores for each vegetation zone within the development site • Map of vegetation zones with a current site value score of <17.	Chapter 5	Chapter 2 – Methodology for details on methods, Appendix B, C and D for details on species data and plot sheets. Chapter 4 – Native vegetation

Report section	Information	Maps & data	FBA reference	Section in this Report
Threatened species	Identify ecosystem credit species associated with PCTs on the development site as outlined in Section 6.3, including: • list of species derived • justification for exclusion of any ecosystem credit species predicted above. Identify species credit species on the development site as outlined in Sections 6.5 and 6.6, including: • list of candidate species • justification for inclusions and exclusions based on habitat features • indication of presence based on targeted survey or expert report • details of targeted survey technique, effort, timing and weather • species polygons • species that cannot withstand a further loss. Where use of local data is proposed: • identify relevant species or population • identify aspect of species/population data • identify source of information for local data • justify use of local data in preference to database values. Where expert reports are used in place of targeted survey: • identify the relevant species or population • justify the use of an expert report • indicate and justify the likelihood of presence of the species or population and information considered in making this assessment • estimate the number of individuals or area of habitat (whichever unit of measurement applies to the species/individual) for the development site, including a description of how the estimate was made • identify the expert and provide evidence of their expert credentials.	• Table of vegetation zones and landscape Tg values, particularly indicating where these have changed due to species exclusion • Targeted survey locations • Table detailing the list of species credit species and presence status on site as determined by targeted survey, indicating also where presence was assumed and/or where presence was determined by expert report • Species credit species polygons (as described in Paragraph 6.5.1.19) • Table detailing species and habitat feature/component associated with species and its abundance on site (as described in Paragraph 6.5.1.19) • Species polygons for species that cannot withstand a loss	Chapter 6	Chapter 2 – methodology for survey details and Appendix E and F for migratory bird survey results and HBT survey results; Chapter 5 – Threatened Species Appendix A likelihood of occurrence for threatened species.

Report section	Information	Maps & data	FBA reference	Section in this Report
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impact on biodiversity values in accordance with Section 8.3. Identification of final project footprint during construction and operation in accordance with Subsection 8.3.3. Assessment of direct and indirect impacts unable to be avoided at the development site in accordance with Sections 8.3 and 8.4. The assessment would include but not be limited to: type, frequency, intensity, duration and consequence of impact. Statement of onsite measures proposed to avoid and minimise direct and indirect impacts of the Major Project.	• Table of measures to be implemented before, during and after construction to avoid and minimise the impacts of the project, including action, outcome, timing and responsibility • Map of final project footprint, including construction and operation • Maps demonstrating indirect impact zones where applicable	Chapter 8	Chapter 6 – Avoidance, mitigation, and impacts

Report section	Information	Maps & data	FBA reference	Section in this Report
Impact summary	Identification of areas not requiring assessment in accordance with Section 9.5. Identification of areas not requiring offset in accordance with Section 9.4. Identification of PCTs and species polygons requiring offset in accordance with Section 9.3. Identification of impacts that require further consideration in accordance with Section 9.2, including: • the entity and/or impact for which further consideration is necessary • supporting information relevant to the impact, as outlined in Subsection 9.2.2. Ecosystem credits and species credits that measure the impact of the Major Project on biodiversity values at the development site, including: • future site value score for each vegetation zone at the development site • change in landscape value score • number of required ecosystem credits for the impact of development on each vegetation zone at the development site • number of required species credits for the impact of development on each threatened species that occurs on the development site.	• Map of areas not requiring assessment • Map of PCTs and species polygons not requiring offset • Map of PCTs and species polygons requiring offset • Map of the occurrence of the entity or impact that requires further consideration • Table of PCTs requiring offset and the number of ecosystem credits required • Table of species and populations requiring offset and the number of species credits required • Full biodiversity Credit Calculator output • Submitted proposal in the Credit Calculator	Chapter 9 Subsections 10.4.3 and 10.4.4	Chapter 7 – Impact summary
Biodiversity credit report	Credit profiles for ecosystem credits and species credits at the development site.	• Table of credit type and matching credit profile • Biodiversity credit report from the Credit Calculator	Subsection 10.4.5	Chapter 8 – Biodiversity credit report

Appendix I Compliance with Commonwealth requirements

Table 35: Compliance with Commonwealth requirement

Commonwealth requirement	Complying statement and references to relevant sections of the BAR document
Attachment 1 – Commonwealth SEARS	
Whether the proposed action will have a significant impact on the following matters and describe the basis for the conclusion • Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion, • Green and Golden Bell Frog (*Litoria aurea*), • Turpentine Ironbark Forest in the Sydney Basin Bioregion, • Bynoe's Wattle (*Acacia bynoeana*), • Downy Wattle (*Acacia pubescens*), • Deane's Paperbark (*Melaleuca deanei*), • Hairy Geebung (*Persoonia hirsuta*), • Spiked Rice-flower (*Pimelea spicata*), • Magenta Lilly Pilly (*Syzygium paniculatum*) • Black-eyed Susan (*Tetratheca juncea*).	Significance tests have been prepared for all species and communities that may be impacted by the proposal – See Appendix G. In summary, the proposed action will have a significant impact on the following MNES: • Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion • Green and Golden Bell Frog (*Litoria aurea*). Significance tests have not been prepared for species that have no probability of occurring in the development site: • Bynoe's Wattle (*Acacia bynoeana*), • Downy Wattle (*Acacia pubescens*), • Deane's Paperbark (*Melaleuca deanei*), • Hairy Geebung (*Persoonia hirsuta*), • Spiked Rice-flower (*Pimelea spicata*), • Magenta Lilly Pilly (*Syzygium paniculatum*) • Black-eyed Susan (*Tetratheca juncea*). Table 26 and Appendix A demonstrate how these decisions were made. A significance test was not applied for Turpentine - Ironbark Forest in the Sydney Basin Bioregion because the remnant patches do not meet the condition thresholds under the EPBC Act. For a full description of this community, please see Section 4.1.3.

Guidelines for preparing assessment documentation relevant to the EPBC Act – West Connex New M5 Project (EPBC 2015/7520)	
General requirements – background and description of the Action	Chapters 5 and 6 of the EIS
Key issues – Biodiversity - Matters of National Environmental Significance	
The assessment document must describe the environment with regard to listed threatened species and communities including suitable breeding habitat, suitable foraging habitat, important populations, habitat critical to the survival). Consideration of and reference to any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice, recovery plans and threat abatement plans is essential	For Green and Golden Bell Frog this information can be found at section 5.2.1 and in Appendix G. For CRCIF this information can be found at Section 4.1.1 and in Appendix G.
Details of the scope, timing/effort (survey season/s) and methodology for studies or surveys used to provide information on the EPBC Act listed species and species habitat or listed ecological communities at the site (and in areas that may be impacted by the project. Include details of: best practice survey guidelines ; and How they are consistent with (or justify a divergence from) published Australian Government guidelines and policy statements	Details of the methods applied, the effort, timing and personnel are described in Chapter 2 Assessment Methodology. The following survey guidelines were adopted to develop the survey: • *NSW Draft Threatened Species Survey Guidelines* (NSW DEC 2004) – for sampling threatened plants and bats • *The NSW Framework for Biodiversity Assessment* – for sampling of vegetation • *Draft Background Paper to EPBC Act Policy Statement 3.21 – Significant Impact Guidelines for 36 Migratory Shorebird Species* (DEWHA 2009) – for survey of marginal migratory waders and shorebirds • *Survey guidelines for Australia's threatened bats* (DEWHA 2010) – for sampling the potential habitat for bats.

	For the Green and Golden Bell Frog, survey data captured over a period of ten years was used. This survey data was collected by Dr Arthur White and sampled the habitat of the Arncliffe Key Population over multiple nights, months and years. This sampling meets the minimum survey requirements outlined in the *Survey guidelines for Australia's threatened frogs* (DEWHA 2010). That is survey was conducted to maximise detection by being carried out in peak activity periods, for a minimum of four nights, during suitable weather conditions, by an experienced herpetologist and using a range of techniques. The White monitoring is carried out over multiple nights in mutltiple months usually between August and May. The survey used a combination of diurnal searches, tadpole survey and nocturnal spotlighting and call playback. Surveys were conducted over several nights per month, which far exceeds the minimum of four nights in total. Dr White is regarded as one of the most experienced herpetologists in NSW and is the most acquainted with this key population.
Impacts	
All impacts must be assessed on each listed species and communities	Refer to Table 16
A detailed analysis of the nature and extent of the likely direct, indirect and consequential impacts relevant to listed species and communities, including likely short-term and long-term impacts	Refer to Table 16
Consideration of, and reference to any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice, recovery plans and threat abatement plans is essential	Refer detail on conservation advices in Chapter 4. Detail on measures consistent with threat abatement plans in Chapter 6 and Appendix G. Also refer to detail responses in Appendix G.
A statement whether an of the relevant impacts are likely to be unknown, unpredictable or irreversible	Refer to Table 16

Any technical data and other information used or needed to make a detailed assessment of the relevant impacts	See data in various Appendices and also monitoring reports which were appended to the Referral documentation.
An explanation of how the views of Indigenous stakeholders, directly affected by the action, have been sought and considered in the assessment if the action will have or is likely to have a significant impact on threatened species and communities that relates to their Indigenous cultural heritage. Including where relevant, how guidelines published by the Commonwealth in relation to consulting with Indigenous peoples for proposed actions that are under assessment have been considered and applied	See Aboriginal Heritage section of EIS
Avoidance and mitigation measures	
Take into account relevant agreements and plans including - Recovery plans - Threat abatement plans - Wildlife conservation plan	We have considered the following plans and policies: • Significant impact guidelines for the green and golden bell frog (*Litoria aurea*) (DEWHA 2010) – see Appendix G • Significant impact guidelines – matters of national environmental significance (DoE 2013) – see Appendix G • Approved conservation advice for Cooks River / Castlereagh Ironbark Forest of the Sydney Basin Bioregion (TSSC 2015) – see Appendix G and Section 4.1.1. • Approved conservation advice for *Litoria aurea* (green and golden bell frog) (TSSC 2014) – see section 5.2.1 and Appendix G • Approved conservation advice for Turpentine – Ironbark Forest of the Sydney Basin Bioregion (TSSC 2014) and Commonwealth Listing advice on Turpentine – Ironbark Forest of the Sydney Basin Bioregion (TSSC 2005) – see section 4.1.3.

	There is no approved recovery plan for the Cooks River / Castlereagh Ironbark Forest or for the Green and Golden Bell Frog. However, the draft NSW recovery plan for the Green and Golden Bell Frog was considered in the impact assessment for this species (see Appendix G and the Green and Golden Bell Frog Plan of Management). The following Threat Abatement Plans were considered when preparing mitigation measures: • *Threat abatement plan for predation by the European red fox*. Department of the Environment, Water, Heritage and the Arts, Canberra. (DEWHA 2008) for potential impacts to Green and Golden Bell Frog. • *Threat abatement plan for predation by feral cats* (Commonwealth of Australia 2015) for potential impacts to Green and Golden Bell Frog. • *Threat abatement plan - Infection of amphibians with chytrid fungus resulting in chytridiomycosis* Department of Environment and Heritage, Canberra (DEH 2008) for potential impacts to Green and Golden Bell Frog. • *Threat abatement plan for disease in natural ecosystems caused by* Phytophthora cinnamomi, (Commonwealth of Australia, 2014) for potential impacts to native vegetation including the CEEC Cooks River / Castlereagh Ironbark Forest. Detail on measures consistent with threat abatement plans in section 6 and Appendix G.
A description of the proposed avoidance and mitigation measures	See Table 22
An assessment of the expected or predicted effectiveness of the mitigation measure, including the scale and intensity of impacts of the proposed action and the on-ground benefits to be gained through each of these measures	See Table 22

A description of the outcomes that the avoidance and mitigation measure will achieve	For the Green and Golden Bell Frog the outcomes expected are that a population continues in the wild at Arncliffe. This population is vulnerable to stochastic events impacting on the breeding habitat. The mitigation measures were designed to minimise the risks of stochastic events due to the proposed action. Expanding breeding and foraging habitat adjacent to the proposed action would reduce the risk to the population at Arncliffe. The measures are expected to be effective subject to the implementation of an appropriate framework. The measures to protect or enhance this MNES are consistent with the proposed systems based conditions (e.g. pre-clearance surveys for Green and Golden Bell Frogs, establishment of fencing to avoid areas of Green and Golden Bell Frog habitat). For the Cooks River / Castlereagh Ironbark Forest, there is approximately only 1011 hectares remaining in the wild (eight per cent of its former extent). Its reservation status is low, with about 290 hectares protected in reserves. The measures proposed for this critically endangered ecological community are for an increase in formal protection status through offsetting the significant residual unavoidable impacts. This would be achieved by improving security of tenure for otherwise unprotected patches and provision of active management of these patches. This would be by way of establishing BioBanking agreements over land containing this ecological community.
A detailed outline of a plan for the continuing management, mitigation and monitoring of the impacts of the action including a description of the outcomes that will be achieved and any provisions for independent environmental auditing	A plan of management for the Green and Golden Bell Frog has been developed to provide clear guidance on the specific management, mitigation and monitoring actions. The plan describes in detail the expected targets, procedures and objectives for all phases of the proposed action. The Biodiversity Offset Strategy details the offsets required for the residual unavoidable impacts. All residual unavoidable impacts for MNES are to be offset in accordance with this strategy document. The provision of offsets would be compliant with the Australian Government's requirements for like for like, managed and funded offsets, with auditing to be completed by the NSW Office of Environment and Heritage.
Consideration of and reference to any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice, recovery plans and threat abatement plans	Refer detail on conservation advices in Chapter 4. Detail on measures consistent with threat abatement plans in Chapter 6 and Appendix G. Also refer to detail responses in Appendix G. See above for how recovery plans were considered.

Residual impacts/offsets	
All residual impacts must be offset	All residual significant impacts have been offset in accordance with the FBA. See sections 6.2, 6.3, 7.2, 7.3, 7.6 and 8 of the BAR as well as the BOS. All indirect impacts have been either avoided or mitigated and no significant residual impact is anticipated as a consequence of these impacts. Therefore there is no basis to require offsets outside the framework provided by the FBA. See Section 6.6 of BAR.
Must detail the likely residual unavoidable impacts that are likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account	The residual unavoidable impacts are: • Clearance of 1.4 hectares of Cooks River / Castlereagh Ironbark Forest • Modification of 7.82 hectares of Green and Golden Bell Frog foraging, dispersal and sheltering habitat. See also sections 6.3, 6.4, and 7 for further details.
Must include reasons why the avoidance or mitigation of impacts cannot be reasonably achieved	See Chapter 4 (Project development and alternatives) in EIS and Section 6.1 in BAR.
Must include details of how the FBA has been applied in accordance with the objects of the EPBC Act	The objectives of the EPBC Act are to: • provide for the protection of the environment, especially matters of national environmental significance • conserve Australian biodiversity • provide a streamlined national environmental assessment and approvals process • enhance the protection and management of important natural and cultural places • control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife • promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources • recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity

	• promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge. The FBA has been adopted by the Commonwealth as the assessment tool for major projects in NSW. An accredited assessor has applied the FBA for this proposed action. The FBA streamlines the assessment of this proposed action by serving both the Commonwealth and State interests. Application of the FBA requires that the project must demonstrate how impacts to biodiversity, including MNES, can be avoided, minimised or mitigated first. The conservation hierarchy of avoid, minimise and mitigate have been applied in accordance with the FBA. An initial investigation of biodiversity values for a conceptual and much larget project corridor was carried out in 2014. This investigation, which formed part of the FBA, allowed some MNES to be avoided as outlined in Section 6.1 of this report. The FBA has considered all MNES that are likely to occur in the development site and has provided an assessment of the significant residual unavoidable impacts. The FBA requires that if such impacts are present as a result of the proposed action that these impacts are to be offset in accordance with the BOS. While the proposed action would have residual unavoidable impacts, an area of Cooks River / Castlereagh Ironbark Forest would be managed in perpetuity. The future of the Arncliffe population of Green and Golden Bell Frog would be secured. All unavoidable residual impacts would be applied in a like for like manner for all MNES impacted by the proposed action. The proposed action does not involve international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife, therefore this object is not relevant to this proposed action. Discussion and involvement with the Aboriginal community is outside the scope of this biodiversity technical report but is covered elsewhere in the EIS.
Must include details of the offset package to compensate for the significant residual impacts on MNES	The Biodiversity Offset Strategy details the offsets required to compensate for the significant residual impacts.

Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the EPBC Act offsets policy	There are no significant residual impacts not addressed by FBA and outlined in the BOS.
Environmental record of persons proposing to take the action	The environmental record of persons proposing to take the action is outlined in the referral documentation.
Information sources provided in the assessment documentation: (a) the source of the information; (b) how recent the information is; (c) how the reliability of the information was tested; (d) what uncertainties (if any) are in the information; and (e) what guidelines, plans and/or policies were considered.	Primary information collected for this assessment was the plots and transect data collected in November 2014 and May 2015. This data was collected in accordance with the FBA and is considered reliable. This is because the latest information such as vegetation mapping, aerial imagery and dataset searches were used. Two accredited biobanking and major project assessors and an experienced ecologist carried out the field work. Between them they have 43 years' of experience in ecological sampling, impact assessment and survey. Data for the Green and Golden Bell Frog was collected by Dr Arthur White. It was collected between 2000 and 2015. The data is considered to be reliable and see above and in section 5.2.1 for details of survey in addition see the monitoring reports appended to the referral. Data for migratory birds was collected in April 2015. The data is considered reliable because two observers per survey period were present and conferred where identification was unclear. The two observers carried out independent counts and then conferred about the abundance of birds (otherwise known as the Delphi procedure). Information on other MNES was found in the following: • NSW Office of Environment and Heritage Bionet Wildlife Atlas of NSW. Information in this dataset may be spatially unreliable and some species may have been misidentified. For the purposes of this assessment, only recent (last 20 years) records were used. • NSW Office of Environment and Heritage Threatened Species Profile Database. This is a set of data describing individual threatened species and their requirements. It is considered reliable as it forms the basis of assessment in the FBA. • The NSW Vegetation Information System dataset was used to determine the TEC and PCT for the project area. Use of this data is mandatory. While ELA has not assessed the data for reliability and accuracy, this data set is considered reliable.

	• Commonwealth Protected Matters Search Tool dataset for the project area. This data set provides a list of MNES in a 10 kilometre radius from the project area. There is no ability to determine the spatial or temporal reliability of this data set. • The Commonwealth Interactive Flying Fox Viewer available online was used to determine the numbers of Grey-headed Flying Foxes at Turrella. The online data is considered to be reliable as data is collected using a specific methodology and experienced local observers capture the data. Individual count data sets are not made available and no information is provided on the standard error of the counts or confidence intervals of the counts. Policies, plans and guidelines considered in this assessment have been listed above.
Additional matters relevant for the Bilateral assessment	
Consistency with the Conventions (cl.7.3(d) and (e) of the Bilateral	The proposed action is consistent with the following international obligations: • the Convention on Biological Diversity • the Convention on Conservation of Nature in the South Pacific • the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The *Convention on Biological Diversity* aims to conserve biological diversity, promote the sustainable use of its components and provide for the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. It is the key document for sustainable development. The components relevant to this project are the sustainable use of biodiversity. By following the conservation hierarchy of avoid, minimise and mitigate the project is consistent with sustainable development principles. Therefore the project approval would not be inconsistent with this Convention. The *Convention on Conservation of Nature in the South Pacific* was suspended in 2006.

	The *Convention on International Trade in Endangered Species of Wild Fauna and Flora* is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. This project does not involve trade in wildlife and is unrelated to trade. The proposed action is not inconsistent with Australia's obligations under the Convention on the Conservation of Migratory Species of Wild Animals, the China-Australia Migratory Bird Agreement, the Japan-Australia Migratory Bird Agreement, or the Republic of Korea-Australia Migratory Bird Agreement. There are no impacts expected to Ramsar or migratory species subject to these conventions or their habitats.
Cost of the mitigation measures	Approximate costs of the mitigation measures for impacts to Green and Golden Bell Frog and Cooks River / Castlereagh Ironbark Forest have been calculated as $3,113,000.

Appendix J Detailed project description

Appendix J Project description

Prepared by AECOM Australia Pty Ltd

Key components of the project would include:

- Twin motorway tunnels between the existing M5 East Motorway (between King Georges Road and Bexley Road) and St Peters. The western portals along the M5 East Motorway would be located east of King Georges Road, and the eastern portals at St Peters would be located in the vicinity of the Princes Highway and Canal Road. Each tunnel would be about nine kilometres in length and would be configured as follows:
    - Between the western portals and Arncliffe, the tunnels would be built to be three lanes but marked for two lanes as part of the project. Any change from two lanes to three lanes would be subject to future environmental assessment and approval
    - Between the Arncliffe and St Peters, the tunnels would be built to be five lanes but marked for two lanes as part of the project. Any change from two lanes to any of three, four or five lanes would be subject to future environmental assessment and approval
- The western portals along the M5 East Motorway would be located east of King Georges Road, and the eastern portals at St Peters would be located in the vicinity of the Princes Highway and Canal Road
- Tunnel stubs to allow for a potential future connection to the future M4-M5 Link and a potential future connection to southern Sydney
- Surface road widening works along the M5 East Motorway between east of King Georges Road and the new tunnel portals
- A new road interchange at St Peters, which would initially provide road connections from the main alignment tunnels to Campbell Road and Euston Road, St Peters
- Two new road bridges across Alexandra Canal which would connect St Peters interchange with Gardeners Road and Bourke Road, Mascot
- Closure and remediation of the Alexandria Landfill site, to enable the construction and operation of the new St Peters interchange
- Works to enhance and upgrade local roads near the St Peters interchange
- Ancillary infrastructure and operational facilities for electronic tolling, signage (including electronic signage), ventilation structures and systems, fire and life safety systems, and emergency evacuation and smoke extraction infrastructure
- A motorway control centre that would include operation and maintenance facilities
- New service utilities and modifications to existing service utilities
- Temporary construction facilities and temporary works to facilitate the construction of the project
- Infrastructure to introduce tolling on the existing M5 East Motorway
- Surface road upgrade works within the corridor of the M5 East Motorway.

Construction activities associated with the project would generally include:

- Commencement of enabling and temporary works, including construction power, water supply, ancillary site establishment, demolition works, property and utility adjustments and public transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway control centre and ancillary operations buildings
- Upgrades to surface roads and construction of bridges
- Implementation of environmental management and pollution control facilities for the project.

Subject to the project obtaining environmental planning approval, construction of the project is anticipated to commence around mid-2016 and is expected to take around three years to complete.

The M5 Motorway corridor (the M5 East Motorway and the M5 South West Motorway) is the main passenger, commercial and freight corridor between Port Botany, Sydney Airport and south-west Sydney. Traffic demands on the M5 East Motorway currently exceed the design capacity of the roadway, and as a result, present a significant bottleneck to the M5 Motorway corridor with motorists experiencing heavy congestion and unreliable journey times. The project is needed to provide additional capacity along the M5 Motorway corridor, and would allow for a more robust and reliable transport network.

A detailed project description is provided in Chapter 5 and Chapter 6 of the environmental impact statement (EIS) for the project. A brief overview is provided below.

1.0 Operation

An overview of the project is provided in Figure J1.

Western surface works and Kingsgrove Road surface works

The western surface works would connect the New M5 and the existing M5 East Motorway to the M5 South West Motorway through works within and around the King Georges Road interchange.

The western surface works would include:

- Construction of four new lanes (two eastbound and two westbound) to connect the M5 South West Motorway and the King Georges Road interchange with the New M5 main alignment tunnels
- Realignment of the M5 East Motorway surface roads between the King Georges Road interchange and the M5 East Motorway tunnel portals. The M5 East Motorway surface roads would be resurfaced, delineated from the New M5 and provided with new signage
- Construction of two new bypass lanes comprising eastbound and westbound ramps to bypass the New M5 and provide a connection between the King Georges Road interchange and the M5 East Motorway
- Construction of a permanent noise barrier along the northern project boundary. The noise barrier would extend from around the King Georges Road interchange to the M5 East Motorway eastbound tunnel portal
- Construction of a permanent noise barrier along the southern project boundary. The noise barrier would extend from around the King Georges Road interchange to the M5 East Motorway westbound tunnel portal
- Extension of the Kindilan underpass within Beverly Grove Park to accommodate the project
- Realignment of and improvements to the shared pedestrian and cyclist path that runs through Beverly Grove Park, parallel to, and north of, the M5 East Motorway
- Reinstatement of the shared pedestrian and cyclist path that runs parallel to and south of the M5 East Motorway
- Cuttings and embankments for surface road works
- Installation of tolling infrastructure for the New M5 and M5 East Motorways
- Landscaping and rehabilitation works
- Extension of two existing box culverts at Kooemba Road
- New operational drainage infrastructure to connect existing stormwater infrastructure to a concrete channel at Kirrang Street.

The western surface works area would also contain the Kingsgrove motorway operations complex (MOC1), which would include ancillary operational infrastructure including the Kingsgrove ventilation facility, deluge tanks, the main alignment tunnels emergency response system, a maintenance facility and a workshop, offices, storage and car parking.

Main alignment tunnels

The main alignment tunnels would be about nine kilometres long, with the western tunnel portals located at Kingsgrove and the eastern ramp portals located at the St Peters interchange. The eastern end of the main alignment tunnels would terminate underground at St Peters in the form of stub tunnels, providing a potential future connection to the future M4-M5 link.

The project has been designed to connect to the existing road network at two locations:

- The King Georges Road interchange, the M5 East Motorway and M5 South West Motorway via the western portals
- The St Peters interchange and local surface road network via the eastern portals.

Tunnel stubs would also be included to potentially provide a connection to

- The future Southern extension via stub tunnels at the Southern extension caverns near the Kogarah Golf Course
- The future M4-M5 Link via stub tunnels at the St Peters caverns near the St Peters interchange.

The width of excavation would be widened at these locations to allow the tunnel stubs to diverge from the main alignment tunnels. This would result in the development of a void or cavern between the two tunnels.

The main alignment tunnels include two vehicular cross passages at Bexley and Arncliffe to allow for emergency traffic switching, as well as pedestrian cross passages spaced at a maximum of 120 metres and emergency pedestrian egress between tunnels in the event of an emergency.

The main alignment tunnels would also include a breakdown bay around the Cooks River between the Southern extension caverns and St Peters caverns. The breakdown bay would be large enough to allow a B-triple vehicle to pull over into the bay and safely park outside of the nominal tunnel shoulder width. The main alignment tunnels would be widened at this location to accommodate the breakdown bay outside of the shoulders.

The speed limit within the main alignment tunnels would be 80 kilometres per hour.

Tunnel portals

The New M5 western tunnel portals would be located at Kingsgrove and would connect to the western surface works.

The western tunnel portals would be staggered, with the eastbound portal meeting the surface around 90 metres further west than the westbound tunnel portal. The eastern tunnel portals would connect to the surface at the St Peters interchange, about 70 metres east of Canal Road.

Dive and cut and cover structures would be constructed at the western and eastern tunnel portals to create entry and exit ramps to join surface roads with the main alignment tunnels. On and off-ramps would vary in size and shape in response to local conditions and would require a number of cuttings and embankments. The eastern and western on and off-ramps have been designed to provide for a 5.3 metre vertical clearance. The main alignment tunnels at the western and eastern tunnel portals would be line marked for two lanes with the provision to be widened in the future to three and up to five lanes (respectively), subject to additional assessment and approval.

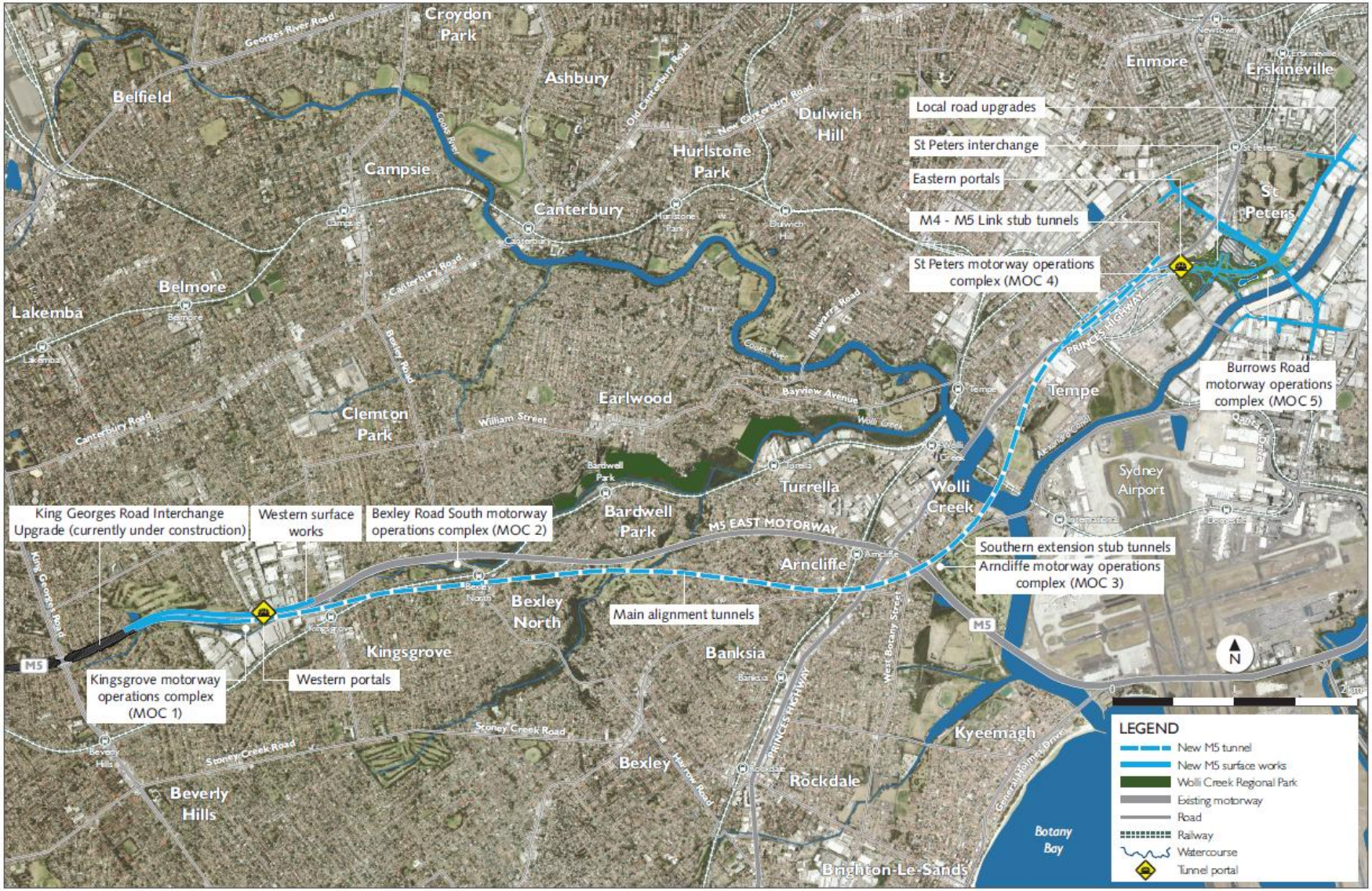

Figure J1 The project

St Peters interchange

The St Peters interchange would be constructed as part of the project. Construction of the St Peters interchange would include:

- The closure of the former Alexandria Landfill site
- Construction of roads and embankments within the St Peters interchange site
- Construction of operational ancillary infrastructure associated with the New M5
- Connection of the New M5 with the local road network at the intersection of Euston Road with Campbell Road, and with Gardeners Road via a new bridge over the Alexandra Canal
- Landscaping and revegetation works within the interchange site.

Construction of the St Peters interchange would allow for two additional future stages to provide connections between the St Peters interchange and the:

- Future M4-M5 Link and the
- Future Sydney Gateway.

The additional future stages of works would provide the ultimate connectivity through the interchange between the New M5, the future M4-M5 Link, the future Sydney Gateway and the local road network. These stages would be subject to future environmental assessment and approval.

The construction of all roads within the St Peters interchange site would be delivered as part of this project. The road construction works within the Alexandria Landfill site, would include landforming and construction of embankments as part of the Alexandria Landfill closure plan. All roads that form part of St Peters interchange would be constructed as part of the initial stage with the aim of minimising potential disruptions to the operation of the New M5 and local road connections during construction of the additional future stages of the WestConnex program of works.

Sections of road that provide the following road connections would be constructed within the boundary of the St Peters interchange site but would not connect to any operating roads as part of the initial stages of interchange construction:

- The New M5 and the future Sydney Gateway
- The future M4-M5 Link and the future Sydney Gateway
- The future M4-M5 Link and Gardeners Road
- The future M4-M5 Link and Euston Road at the intersection of Campbell Road.

As these roads approach the boundary of the interchange site, embankments would be constructed and stabilised. It is anticipated that if the future M4-M5 Link and the future Sydney Gateway projects proceed, they would tie-in to these embankments to complete the interchange and provide operational connections.

Landscaping and revegetation works within the St Peters interchange site would be undertaken across the site in accordance with an urban design concept plan. A section of the interchange site immediately south-west of Campbell Road and south of Albert Street, would be kept as an area of hardstand, with the anticipation of it being used to support construction of the future M4-M5 Link. As part of the project, this area would be physically separated from the remainder of the interchange to restrict access.

The intersection of Campbell Road and Euston Road would be upgraded to safely and efficiently manage traffic entering and leaving the St Peters interchange.

Local road upgrades

Local roads around the St Peters interchange and the intersection of Campbell Road and Euston Road would be upgraded to ensure safe and efficient connections with the New M5, and to cater for additional traffic demands. Local road upgrades would include:

- Upgrade and widening of Euston Road, from the upgraded Campbell Road / Euston Road intersection to the intersection with Maddox Street to the north of Sydney Park
- Upgrade, widening and extension of Bedwin Road / Campbell Street / Campbell Road from the railway bridge near Camdenville Park to a new intersection with Bourke Road, Mascot
- Upgrade and widening of Bourke Road / Bourke Street, Mascot between Church Street and the Campbell Road extension
- Widening of Gardeners Road
- Other minor local road changes (such as tie-in works)
- New and upgraded bridges and structures
- Access arrangements for heavy vehicles
- Provision of pedestrian and cycle infrastructure
- Changes to bus infrastructure.

Local road upgrades would include modifications to existing intersections, construction of new intersections, localised tie-in works on connecting streets, cutting and embankment works and works to impacted utilities and drainage.

Motorway operations complexes

The project would require permanent operational ancillary infrastructure including:

- Operational management control systems and incident and emergency response infrastructure
- Tunnel ventilation systems and facilities
- Drainage and water treatment facilities
- Noise attenuation measures
- Utilities
- Roadside furniture and lighting.

Most operational ancillary infrastructure would be established in five main motorway operations complexes:

- The Kingsgrove motorway operations complex (MOC1) – located to the south of the western project portals and the existing M5 East Motorway, on land previously occupied by the Kingsgrove South construction compound (C3)
- The Bexley Road South motorway operations complex (MOC2) – located to the south of the M5 East Motorway western portals, adjacent to Bexley Road, on land previously occupied by the Bexley Road South construction compound (C5)
- The Arncliffe motorway operations complex (MOC3) – located near the south western corner of the Kogarah Golf Course site, on land previously occupied by the Arncliffe construction compound (C7)
- The St Peters motorway operations complex (MOC4) – located near the western corner of the St Peters interchange, adjacent to the Prince Highway / Canal Road intersection, on land previously occupied by the Canal Road construction compound (C8)
- The Burrows Road motorway operations complex (MOC5) – located at the corner of Burrows Road and Campbell Road, St Peters on land previously occupied by the Burrows Road construction compound (C11).

Noise attenuation measures, utilities, roadside furniture and lighting would be provided as required along the project corridor.

Operational ancillary infrastructure that would be located within each motorway operations complex is summarised in **Table J1**.

Table J1 Summary of motorway operations complexes and operational ancillary infrastructure

Operational ancillary facilities	Motorway operations complex				
	Kingsgrove (MOC1)	Bexley Road South(MOC2)	Arncliffe (MOC3)	St Peters (MOC4)	Burrows Road (MOC5)
Ventilation facility	✓		✓	✓	
Emergency smoke extraction facility		✓	✓		
Deluge water tanks	✓				
Car parking	✓	✓	✓	✓	✓
Substation / power supply	✓	✓	✓	✓	
Emergency response system	✓				
Maintenance facility	✓				
Workshop / offices	✓				
Storage	✓				
Water treatment plant / infrastructure			✓		
Motorway control centre					✓

2.0 Construction activities

Key activities to be undertaken as part of the construction of the project would include:

- Site establishment and establishment of construction compounds
- Construction traffic works
- The use of temporary construction compounds to facilitate construction
- Tunnelling activities, including tunnel excavation, civil finishing works and fit-out
- Other bulk earthworks for construction of cut and cover structures, surface road works and the closure of the Alexandria Landfill
- Closure of the Alexandria Landfill, including bulk earthworks, landfill capping, leachate and groundwater management systems and a gas collection and management system
- Construction of permanent operational infrastructure, including a maintenance facility, ventilation and emergency smoke extraction/ air injection facilities, substations, operational water treatment plan and a New M5 motorway control centre
- Construction of new and upgrades/ modifications to existing bridges
- Construction of new, and modifications to existing drainage and water management infrastructure
- Road pavement works (surface and tunnel)
- Finishing works.

Construction activities required for the project can be grouped into the following distinct areas:

- Underground tunnelling and tunnel construction activities
- The western surface works, including:
  - Construction of the M5 East Motorway integration works
  - Construction activities associated with the Kingsgrove North construction compound (C1), the Kingsgrove South construction compound (C2) and the Commercial Road construction compound (C3)
  - Construction of the Kingsgrove motorway operations complex (MOC1).
- Kingsgrove Road surface works, including the installation of tolling infrastructure on the M5 East Motorway
- Bexley Road surface works, including:
  - Construction activities associated with the Bexley Road North construction compound (C4), the Bexley Road South construction compound (C5) and the Bexley Road East construction compound (C6)
  - Construction of the Bexley Road South motorway operations complex (MOC2).
- Arncliffe surface works, including:
  - Construction activities associated with the Arncliffe construction compound (C7)
  - Construction of the Arncliffe motorway operations complex (MOC3).
- St Peters interchange and local road upgrade surface works, including:
  - Construction of the St Peters interchange
  - Construction activities associated with the Canal Road construction compound (C8), the Campbell Road construction compound (C9), the Landfill Closure construction compound (C10), the Burrows Road construction compound (C11), the Campbell Road bridge construction compound (C12), the Gardeners Road bridge construction compound (C13) and the Sydney Park construction compound (C14)
  - Construction of the St Peters motorway operations complex (MOC4) and the Burrows Road motorway operations complex (MOC5)
  - Construction of local road upgrade works.

Fourteen construction compounds would be required to facilitate construction of the project

The depth of the main alignment tunnels would vary depending on geological constraints. The maximum depth of the tunnels would be around 80 metres below the ground surface, with shallower sections on the approach to the western and eastern tunnel portals.

Tunnel excavations would be carried out with roadheaders. A roadheader is a machine which comprises a boom-mounted rotating cutter head on track-mounted frames and a loader device (usually on a conveyor).

Rock breaking and controlled blasting would be used in some areas of the tunnel excavation to improve the efficiency of excavation activities and shorten the overall excavation program. Areas that are likely to require controlled blasting would be confirmed during detailed design and refined where necessary in response to geological conditions experienced during construction

Surface works would be required to support tunnelling activities, and to construct the interchanges, tunnel portals, the M5 East Motorway, local road upgrades and motorway operations complexes. Construction compounds would also be required to support construction activities. These are described further in this section.

An overview of the construction activities associated with the project is provided in **Table J2**. An overview of construction compounds is provided in **Table J3** and shown in **Figure J2**. A construction program is provided in **Table J4**. Detailed descriptions of each construction activity can be found in Chapter 6 of the EIS for the project.

Table J2 Overview of construction works

Component	Typical activities
Construction set-up and preparatory works	
Site establishment and establishment of construction compounds	• Demolition of existing buildings • Establishment of construction compound fencing and hoardings • Vegetation clearance • Installation of sediment and erosion control measures • Installation of site offices and crib rooms • Construction of hardstands • Construction of access roads, site entry and exit points and security • Set up of spoil sheds and support equipment as required • Set up of construction monitoring equipment • Construction traffic works, including • Relocation of utilities.
Alexandria Landfill closure	
Landfill closure works	• Construction of access roads, site entry and exit points and enabling works • Foundation preparatory works • Bulk earthworks (St Peters interchange cut to fill) • Bulk earthworks (imported fill and engineered fill) • Cut foundation treatment • Capping installation • Establishment of leachate collection, treatment pumping station • Construction and establishment of groundwater seepage cut-off wall • Landscaping.
Tunnel construction and fit out	
Tunnel construction	• Construction of shafts and / or declines • Installation and operation of roadheaders • Spoil stockpiling and removal • Controlled blasting of the bench and cross passages • Controlled blasting and / or rockbreaking of the main alignment tunnels and cross passages • Installation of shotcrete lining • Installation of waterproof membrane, where required • Installation of final lining and architectural treatments • Construction of the concrete floor • Installation of drainage and utility infrastructure • Final finishes and line marking.
Portal construction	• Construction of the cut and cover structures • Bulk excavation with the cut and cover and the dive structure • Spoil stockpiling and removal • Installation of the drainage and utility infrastructure • Installation of road base, lighting, new jersey barriers • Final asphalting layer installed • Sign installation and construction of the toll gantries • Linemarking, traffic switches to tie in with existing road network landscaping and noise walls.
Mechanical and electrical systems	• Installation of fire and life safety systems, tunnel ventilation facilities, operational tunnel lighting, signage, power reticulation through the tunnel, communication systems, and control and operational management control systems and infrastructure • Commissioning of mechanical and electrical systems, including emergency procedures.

Component	Typical activities
Surface works – roads	
Local road upgrades	• Removal of existing road pavements, as required • Installation of the drainage and utility infrastructure • Installation of road base, lighting, kerb and guttering, verges, medians, and new jersey barriers • Earthworks and excavation • Spoil stockpiling and removal • Installation of final asphalting layer • Sign installation and street lighting • Line-marking, traffic switches to tie in with existing road network landscaping.
St Peters interchange construction	• Bulk excavation and material disposal • Foundation works to pavements including piling • Structural and flexible pavement construction to St Peters interchange • Construction of the St Peters interchange bridges • Construction of the Campbell Road pedestrian and cycle bridge • Construction of bridges over Alexandra Canal • Construction of retaining walls and landscaping.
Surface works – operational infrastructure	
Tolling facilities construction	• Construction of toll gantries • Construction of technical shelters • Installation of communications and power • Commissioning of toll operations.
Operational facilities construction	• Construction of ventilation system facilities, including emergency smoke extraction facilities • Construction of the motorway control centre and backup facility • Construction of permanent access roads to operational facilities • Construction of drainage and water treatment facilities, including water treatment plant • Construction of motorway operations complexes • Establishment of noise barriers • Installation of roadside furniture and lighting.
Commissioning and demobilisation	
Testing and commissioning	• Testing of plant and equipment • Commissioning of the project.
Finishing work and demobilisation	• Removal of construction facilities • Landscaping • Rehabilitation of affected areas • Post-construction condition surveys • Removal of construction environmental controls • Removal of construction ancillary facility related traffic signage.

Table J3 Summary of temporary construction compounds

Construction compound	Compound purpose		Compound activities							
	Civil and surface works	Tunnelling support	Site offices	Staff amenities	Parking	Laydown area	Spoil management	Workshop and maintenance	Tunnelling launch and support	Construction water treatment plant
Kingsgrove North (C1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kingsgrove South (C2)	✓		✓	✓	✓	✓	✓	✓		
Commercial Road (C3)		✓	✓	✓	✓	✓	✓	✓	✓	✓
Bexley Road North (C4)		✓		✓		✓	✓	✓	✓	
Bexley Road South (C5)		✓		✓	✓	✓	✓	✓	✓	✓
Bexley Road East (C6)		✓	✓	✓	✓	✓				
Arncliffe (C7)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canal Road (C8)		✓	✓	✓	✓	✓	✓	✓	✓	✓
Campbell Road (C9)	✓		✓	✓	✓	✓	✓			
Landfill Closure (C10)	✓		✓	✓	✓	✓	✓			
Burrows Road (C11)	✓		✓		✓	✓	✓			
Campbell Road bridge (C12)	✓			✓	✓	✓				
Gardeners Road bridge (C13)	✓		✓	✓	✓	✓	✓			
Sydney Park (C14)	✓			✓		✓				

Table J4 Indicative construction program

Construction activity	Indicative construction timeframe															
	2016				2017				2018				2019			
Site establishment and establishment of construction compounds																
Landfill closure works																
Construction of western surface works																
Tunnel construction																
Construction of St Peters interchange																
Portal construction																
Construction of local road upgrades																
Construction of permanent operational facilities*																
Mechanical and electrical fit-out																
Establishment of tolling facilities																

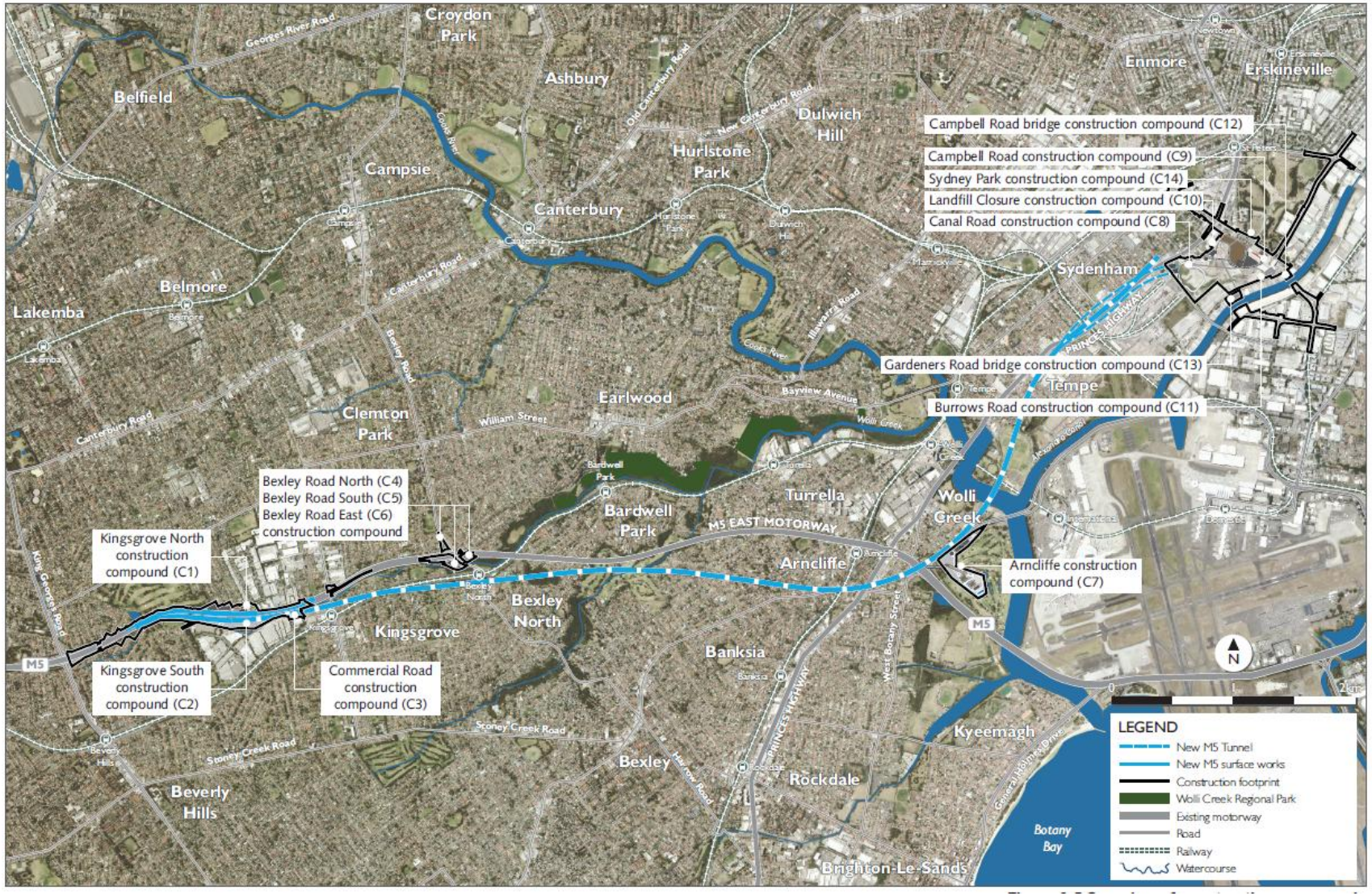

Figure J2 Construction compounds

Construction hours

Construction activities required for the project would be managed in six broad categories:

- Tunnelling and tunnelling support activities, including spoil handling and haulage, deliveries and underground construction and fit-out works. These activities would be carried out up to 24 hours per day and seven days per week
- Out of hours construction activities that cannot be conducted during standard construction hours for safety or operational reasons. These activities would include some M5 East Motorway integration works and local road upgrade works
- Most other construction activities, which would be carried out within standard construction hours
- Blasting and rock breaking, which would be conducted with reduced construction hours and subject to provision of respite periods
- Minor or ancillary activities that would not generate a noise impact above acceptable levels, or are otherwise authorised by an Environment Protection Licence under the *Protection of the Environment Operations Act 1997*
- Activities that are required to be conducted under direction from a relevant authority (such as Police) or are required to prevent an imminent loss of life or environmental damage.

In accordance with the Interim Construction Noise Guidelines (DECC, 2009), the majority of surface construction would be carried out between the following standard construction hours:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm Saturdays

There would generally be no aboveground construction works on Sundays or public holidays, with the exception of those activities required to be undertaken outside of standard construction hours.

A summary of construction hours for these categories of construction activities is provided in **Table J5**, with further details provided in the following sections.

Table J5 Construction hours

Activity	Construction hours	Comments or exception
Tunnelling, tunnelling support and underground construction activities		
Tunnelling excavation	24 hours per day, seven days a week.	• The main alignment tunnels, tunnel stubs, ventilation extraction tunnels and all underground excavations would be carried out continuously. • Activities that support tunnelling works would occur 24 hours per day, seven days a week
Spoil handling and haulage	Up to 24 hours per day, seven days per week.	• Spoil haulage would be limited and managed during peak hours and special events • Vehicle movements would be limited and managed during evening and night-time in residential areas or close to identified sensitive receivers • Vehicle movements outside of standard construction hours would occur at the following construction compounds: – Kingsgrove North construction compound (C1) and, via left-in, left-out access from the M5 East Motorway or via Garema Circuit, Wirega Avenue, Moorefields Road, Kingsgrove Road and King Georges Road[1], Kingsgrove South construction compound (C2) – Commercial Road construction compound (C3), via access from Commercial Road, Kingsgrove Road and the M5 East Motorway – Bexley Road North construction compound (C4), via Bexley Road, Canterbury Road and King Georges Road and the M5 East Motorway – Bexley Road South construction compound (C5), via Bexley Road, Kingsgrove Road, Stoney Creek Road, Forest Road and the M5 East Motorway – Bexley Road East construction compound (C6), via Wolli Avenue, Frost Street, Douglas Street, Stoney Creek Road, Bexley Road, Forest Road and the M5 East Motorway[2] – Arncliffe construction compound (C7), via Marsh Street Princes Highway, Wickham Street, West Botany Street and the M5 East Motorway – Canal Road construction compound (C8), via Canal Road and the Princes Highway. • Spoil would be moved during the day, outside of peak periods where practical, feasible and reasonable management strategies would be investigated to minimise the volumes of heavy vehicle movements at night
Underground construction and tunnel fit-out	Up to 24 hours per day, seven days per week.	• Deliveries for underground construction would be subject to the same management measures as spoil haulage.

Activity	Construction hours	Comments or exception
Out of hours activities for safety and operational reasons		
Out of hours activities for safety and operational reasons	At any time, subject to individual requirements.	• Construction activities would only be conducted outside standard construction hours for safety or operational reasons, including design and quality considerations and to avoid traffic interruptions • Specific management measures would be developed for each relevant activity or group of activities to manage potential impacts on sensitive receivers • The construction activities will include – Surface works at the Kingsgrove, Arncliffe & St Peters Interchange sites – Local road upgrade works – Bridge construction – Delivery of precast units & other materials – Services searches – Road maintenance works – Traffic control and switches – Line-marking – Service relocations & adjustments.
Surface construction activities (not specified elsewhere)		
Most surface construction activities	Daytime construction hours: • 7 am to 6 pm on weekdays • 8 am to 1 pm on Saturdays • No works on Sundays or public holidays.	• Surface works supporting underground construction • Construction traffic movements for tunnel support • Excavation and spoil removal from construction shafts and declines at the surface • Western surface works • Local road upgrades • Bridge construction • Surface works at the Kingsgrove, Arncliffe and the St Peters interchange.
Blasting and rock breaking		
Blasting	Between 9:00am and 5:00pm, Mondays to Fridays and 9:00 am to 1:00pm on Saturdays	• Blasting would occur up to six days per week (Monday to Saturday). Blasts would be limited to one single detonation in any one day per receiver group, unless otherwise agreed by the Environment Protection Agency through consultation on the Construction Noise and Vibration Management Plan.
Rock breaking (with potential for impulsive or tonal noise impact at a sensitive receiver)	Between 8:00am and 6:00pm Monday to Friday and 8:00am to 1:00pm Saturdays, with respite periods.	• Respite periods would be scheduled to minimise the frequency and duration of extended rock breaking activities with potential for impulsive or tonal noise emissions.
Minor or ancillary activities		
Minor activities	At any time	• Minor activities would include activities that do not lead to an exceedance of the applicable noise management level at an affected receiver.

Activity	Construction hours	Comments or exception
Activities authorised by an environment protection licence	As specified in the environment protection licence.	• Construction activities would be managed as required by the Environment Protection Licence.
Emergency or directed activities		
Emergency or directed activities	At any time	• Activities would be carried out as directed by a relevant authority • Activities would be carried out if required to prevent an imminent loss of life or environmental damage.

1: Heavy vehicle movements from C1 outside of standard construction hours would only occur via access and egress directly to and from the M5 East Motorway. There would be times when direct access to the M5 East Motorway would be blocked due to construction works within the site and access would then be required via Garema Circuit
2: Only light vehicles would travel via Wolli Avenue, Frost Street, Douglas Street, Stoney Creek Road, Bexley Road and Forest Road

A summary of the proposed construction work hours at each construction compound is provided in **Table J6**.

Table J6 Construction hours at construction compounds

Construction compound	Type of construction activity	Construction work hours
Kingsgrove North (C1)	Tunnelling	24 hours a day, seven days a week
	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Kingsgrove south (C2)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Commercial Road (C3)	Tunnelling	24 hours a day, seven days a week
Bexley Road North (C4)	Tunnelling	24 hours a day, seven days a week
Bexley Road South (C5)	Tunnelling	24 hours a day, seven days a week
Bexley Road East (C6)	Tunnelling	24 hours a day, seven days a week
Arncliffe (C7)	Tunnelling	24 hours a day, seven days a week
Canal Road (C8)	Tunnelling	24 hours a day, seven days a week
	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Campbell Road (C9)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Landfill Closure (C10)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Burrows Road (C11)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Campbell Road bridge (C12)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Gardeners Road bridge (C13)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays
Sydney Park (C14)	Civil construction*	7:00am to 6:00pm Monday to Friday 8:00am to 1:00pm Saturdays

*Some works outside of standard construction hours may be required

Works outside of standard construction hours

While the majority of the surface construction work would be constructed during standard construction hours, some construction activities would need to be undertaken at night for reasons including:

- Public and construction worker safety,
- Design and quality considerations,
- To minimise the length of construction and the duration of any associated amenity impacts on the local community
- To avoid significant traffic interruptions along the M5 East Motorway and the surrounding arterial and local road network.

Night works would generally commence after the evening traffic peak period when traffic volumes have reduced.

Works undertaken outside of standard hours are expected to be subject to relevant conditions of an environment protection licence issued under the *Protection of the Environment Operations Act 1997*. Environment protection licence conditions would potentially include measures relating to community notifications and procedures for recording and addressing complaints. Additional information regarding licences and approvals that may be required for construction of the project is provided in Chapter 2 of the EIS.

Some out-of-hours surface works would be required to minimise impacts on the efficiency of the road network, and to minimise safety impacts to the construction workforce and members of the public. Subject to permits and approvals from the Traffic Management Centre and/ or Roads and Maritime (where relevant), surface works to be undertaken outside of standard construction hours would generally include:

- Traffic switching of the M5 East carriageways, providing access tie-ins between the completed permanent works associated with the project and the M5 East Motorway, including asphalting, line marking and the installation of barriers
- Traffic switching along local roads to newly constructed pavement, including asphalting, line marking and the installation of traffic barriers and signals
- Demolition of infrastructure along the M5 East Motorway to accommodate construction of the project including concrete barriers, noise barriers and vegetation
- Installation of signage and tolling infrastructure in close proximity to traffic
- Relocation of services at locations close to traffic, and service cutovers
- Delivery of oversize items to construction ancillary facilities
- Crane lifts which require lane closures, or where the works are restricted by the operation of Sydney Airport and / or road travel restrictions.

Tunnelling works (including fitout work but excluding blasting) would be undertaken 24 hours a day, seven days a week to minimise the overall length of construction and the duration of any associated amenity impacts on the local community.

All activities that support tunnelling would also be required to be undertaken 20 hours a day, seven days a week. Handling of spoil at the surface would be required as stockpiling large amounts of spoil within the main alignment tunnels would not be feasible. Spoil is therefore required to be transported from the main alignment tunnels to stockpiles on the surface (within acoustic sheds and non-acoustic sheds), prior to haulage from the site.

Stockpiling spoil on the surface with no spoil haulage outside of standard construction hours would result in additional heavy vehicle movements during standard construction hours, which would have an adverse impact on the road network, particularly during the AM and PM peak periods. Spoil haulage outside of standard construction hours would be from:

- Kingsgrove North (C1) construction compound
- Commercial Road (C3) construction compound
- Bexley Road North (C4) construction compound
- Bexley Road South (C5) construction compound
- Arncliffe (C7) construction compound
- Canal Road (C8) construction compound.

Concrete and shotcrete deliveries for shotcrete to these construction compounds would also be required 24 hours a day, seven days a week, as the excavated tunnel would be progressively supported behind the roadheader by applying shotcrete to the excavated tunnel walls. The alternative would be a concrete batch plant at each construction compound that provides tunnelling support, which would have adverse noise impacts at sensitive receivers.

Spoil haulage from these construction compounds would be limited to the regional and State road network. Some additional activities at construction compounds across the project would be required to support out-of-hours works. Where possible, these activities would be kept to a minimum with only those required to support the works to be used.

Night time and weekend work would also be required for some construction activities associated with construction of the bridges over Alexandra Canal, works associated with the upgrades to local roads and for the western surface works, including:

- Road tie-in works, temporary diversions and traffic switches – Completing these construction works at night when traffic flows are low would minimise disruptions to traffic and minimise any potential safety conflict between construction personnel and traffic.
- Pavement works and linemarking – These works would require lane closures and, in some cases, total closure of roads in order to safely carry out the works. This means that pavement works cannot be undertaken during periods of high traffic volumes and would need to occur during evening and night-time periods. Carrying out these works at night would minimise disruptions to traffic flows along the M5 Motorway corridor and local roads, as the works would involve multiple traffic switched within a short period of time before traffic is allowed to use the completed sections of pavement.
- Other works that are proposed to be undertaken outside of standard daytime construction hours without any further approval (assuming this is consistent with the instrument of approval) would include any of the following circumstances:
- Works which are expected to comply with the relevant Noise Management Level at the nearest sensitive receiver
- The delivery of materials as required by the Police, Roads and Maritime Services and/ or other authorities for safety reasons
- Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency
- Where agreement is reached with affected receivers.

Where work is required outside of standard construction hours, measures would be implemented to minimise noise and other types of disturbance to residents and sensitive receivers.

An assessment of potential noise impacts associated with construction of the project as well as management measures, including for works outside of standard construction hours is included in Chapter 12 (Noise and vibration) of the EIS.

The construction noise assessment for the project (AECOM, 2015) was undertaken in accordance with the Interim Construction Noise Guidelines (DECC, 2009) and feasible and reasonable noise management measures have been identified as part of this assessment.

Noise management measures would be further refined during the detailed design phase of the project in consultation with the NSW Environment Protection Authority. Further, the environment protection licence for the project would provide for appropriate management of construction noise impacts.

Construction noise attenuation

Temporary noise attenuation at construction compounds would include:

- Noise barriers along the boundaries of construction compounds at locations that face sensitive receivers
- Acoustic sheds around tunnel shafts and associated stockpile sites at the following locations where out of hours works would be undertaken near sensitive receivers, including:
    - Kingsgrove North (C1) construction compound
    - Bexley Road North (C4) construction compound
    - Bexley Road South (C5) construction compound

- Non-acoustic sheds around tunnel shafts and associated stockpile sites at the following locations:
    - Commercial Road (C3) construction compound
    - Arncliffe (C7) construction compound.

Temporary noise barriers would be installed along the boundaries of construction compounds that face sensitive receivers. Acoustic sheds would be constructed around tunnel shafts and associated stockpile sites where out of hours spoil removal would occur near residential receivers.

A summary of temporary construction noise attenuation structures to be implemented as part of the project is provided in **Table J7** below. Further detail regarding construction noise mitigation and management is provided in Chapter 12 (Noise and vibration) of the EIS.

Table J7 Construction hours at construction compounds

Construction compound	Temporary noise attenuation
Kingsgrove North (C1)	• *Two and a half metre high noise barrier along northern and eastern boundaries of the facility* • *Acoustic shed surrounding shaft and associated spoil stockpile no more than 20 metres high.*
Commercial Road (C3)	• *Non-acoustic shed surrounding tunnel shaft and associated spoil stockpile.*
Bexley Road North (C4)	• *Four and a half metre high noise barrier along entire boundary of facility* • *Acoustic shed surrounding tunnel shaft and associated spoil stockpile no more than 20 metres high.*
Bexley Road South (C5)	• *Four and a half metre high noise barrier along almost all boundaries of the facility* • *Acoustic shed surrounding tunnel shaft and associated spoil stockpile no more than 20 metres high.*
Bexley Road East (C6)	• *Four and a half metre high noise barrier along northern and eastern boundaries of the facility.*
Arncliffe (C7)	• *Three metre high noise barrier along the northern and western boundaries of the facility* • *Non-acoustic sheds surrounding tunnel shaft and associated spoil stockpile.*
Canal Road (C8)	• *Two and a half metre high noise barrier along the Canal Road and Princes Highway boundaries of the facility.*
Campbell Road (C9)	• *Two and a half metre high noise barrier along Campbell Road adjacent to the hardstand and laydown area* • *Two and a half metre high noise barrier along part of the western boundary of the facility.*

Appendix K Green and Golden Bell Frog Plan of Management

Green and Golden Bell Frog Plan of Management

Kogarah Golf Course

Prepared for
Roads and Maritime Service

November 2015

DOCUMENT TRACKING

Item	Detail
Project Name	Green and Golden Bell Frog Plan of Management – Arncliffe
Project Number	14SYD-349
Project Manager	Meredith Henderson (02) 8536 8671 Level 6 299 Sussex Street Sydney NSW 2000
Prepared by	Matthew Dowle
Reviewed by	Meredith Henderson
Approved by	Mark Adams
Status	Final
Version Number	8
Last saved on	19 November 2015
Cover photo	Green and Golden Bell Frog (*Litoria aurea*) hiding among reeds (Eco Logical Australia).

This report should be cited as 'Eco Logical Australia 2015. *Green and Golden Bell Frog Plan of Management - Arncliffe*. Prepared for NSW Roads and Maritime Service.'

ACKNOWLEDGEMENTS

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Abbreviations

Abbreviation	Description
CEMP	Construction and Environmental Management Plan
DotE	Commonwealth Department of the Environment
ELA	Eco Logical Australia Pty Ltd
EPA Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
LEP	Local Environmental Plan
LGA	Local Government Area
MNES	Matters of National Environmental Significance
OEH	NSW Office of Environment and heritage
Roads and Maritime	NSW Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
TSC Act	*Threatened Species Conservation Act 1995* (NSW)

1 Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) are proposing to construct a new 33 kilometre Motorway, linking the M4 Motorway to Sydney's CBD, Sydney Airport and the M5 East Motorway (the project). The project is declared to be State Significant Infrastructure (SSI) and approval is being sought under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). In addition to State approval, the project is a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The WestConnex Delivery Authority (WDA) was established by the NSW Government to manage the delivery of the WestConnex series of projects for Roads and Maritime on behalf of the State. The WDA was a public subsidiary corporation of the Roads and Maritime. Following the achievement of early milestones for the WestConnex program of works, the NSW Government took the opportunity to evolve this early governance model.

On 1 October 2015 the transfer of the project delivery functions of WDA to Sydney Motorway Corporation (SMC) was finalised, forming a single decision-making entity to finance and deliver the WestConnex program of works. SMC is a private corporation, the shareholders of which are the Minister for Roads, Maritime and Freight and the Treasurer, with a majority independent board of nine directors.

Roads and Maritime is the Government client agency for the WestConnex program of works. In that capacity Roads and Maritime will enter into contractual arrangements with SMC subsidiary entities which will design, build, own and operate the motorway on behalf of Roads and Maritime. Roads and Maritime and SMC are working together to manage the planning approval process for the project. However, for the purpose of the planning application for the project, Roads and Maritime is the proponent.

Construction activities associated with the New M5 project would affect habitat of *Litoria aurea* (Green and Golden Bell Frog) at the proposed Arncliffe surface works area. There are expected to be direct and indirect impacts. Permanent road facilities are proposed on land owned by Roads and Maritime, adjacent to existing purpose built breeding ponds. The impacts to the breeding ponds relate to impacts arising from construction within around 32 metres of the ponds and would not arise from direct physical removal of habitat. Direct impacts do involve removal of around 7.82 hectares of foraging, sheltering and dispersal habitat.

The Green and Golden Bell Frog is a threatened species listed as 'Endangered' under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and as 'Vulnerable' under the EPBC Act.

Green and Golden Bell Frogs at this location form the Arncliffe key population, which is covered in *The Green and Golden Bell Frog Key Population of the Lower Cooks River Management Plan* (DECC 2008a). The plan addresses threats and issues affecting the conservation of the species in the Lower Cooks River, in accordance with the draft species Recovery Plan (DEC 2005).

Green and Golden Bell Frogs have been continuously recorded at the Arncliffe location for over 20 years (White 2015). The species has been breeding and foraging at this site, which contains both suitable terrestrial and aquatic habitat (White 2015). Purpose built breeding ponds for the species are currently located on Roads and Maritime land adjacent to Marsh Street and the proposed Arncliffe

surface works area. These breeding ponds are regularly managed through the manipulation of water levels to control vegetation and predators, including the Plague Minnow (*Gambusia holbrooki*), and Chytrid fungus (a specific frog fungal disease) through salt water flushing. The ponds are known as the 'RTA ponds' and referred to as the RTA ponds hereon.

The local population centres around the artificially created habitat at the RTA ponds. The RTA ponds are considered to be the key source for adult frogs for the local population, which disperse across the Kogarah Golf Course. It is unlikely that other ponds within the golf course provide suitable significant breeding habitat as they contain Plague Minnow. However, occasional breeding events in the golf course ponds have been recorded (Dr Arthur White pers. comm 2015).

1.2 Purpose of the Plan of Management

This Plan of Management has been prepared to support the Commonwealth and State environmental approvals process. The Plan has also been developed to provide a framework for the construction team to incorporate Green and Golden Bell Frog management actions in their Construction Environmental Management Plans (CEMP), and to ensure that any actions are consistent with relevant Roads and Maritime guidelines and the impact assessment process.

In particular, this Plan of Management outlines mitigation and management measures to be implemented prior to construction and in the event the species is found in the construction zone during the proposed works. The Plan of Management also outlines management measures to enhance habitat adjacent to the RTA ponds within the Kogarah Golf Course for the duration of the construction activities.

The Plan of Management also sets out strategies to create new artificial habitat on Roads and Maritime land at Marsh Street supported by a captive breeding program. These strategies will be further detailed in a Habitat Creation and Captive Breeding Plan which will be prepared with the advice of independent expert ecologists prior to the commencement of any works in the vicinity of the RTA ponds.

The Plan of Management has been considered in relation to available management guidelines and policies outlined in **Section 2**.

1.3 Objective of plan

This plan has the following objectives:

- Minimise or eliminate all avoidable construction impacts by removing and excluding frogs from the construction zone and implementing strict ongoing construction protocols and exclusions.
- Compensate for unavoidable construction impacts by augmenting existing foraging habitat
- Insure against stochastic impacts on RTA ponds by establishing a captive breeding colony and managing non construction related threats known to adversely impact the RTA ponds.
- At least double the availability of suitable habitat in the vicinity by creating new habitat at Marsh Street wetlands and re-instating habitat within Kogarah Golf Course post construction.

Together these objectives are designed to ensure the long term persistence of the species at Arncliffe which is the ultimate aim of this management plan.

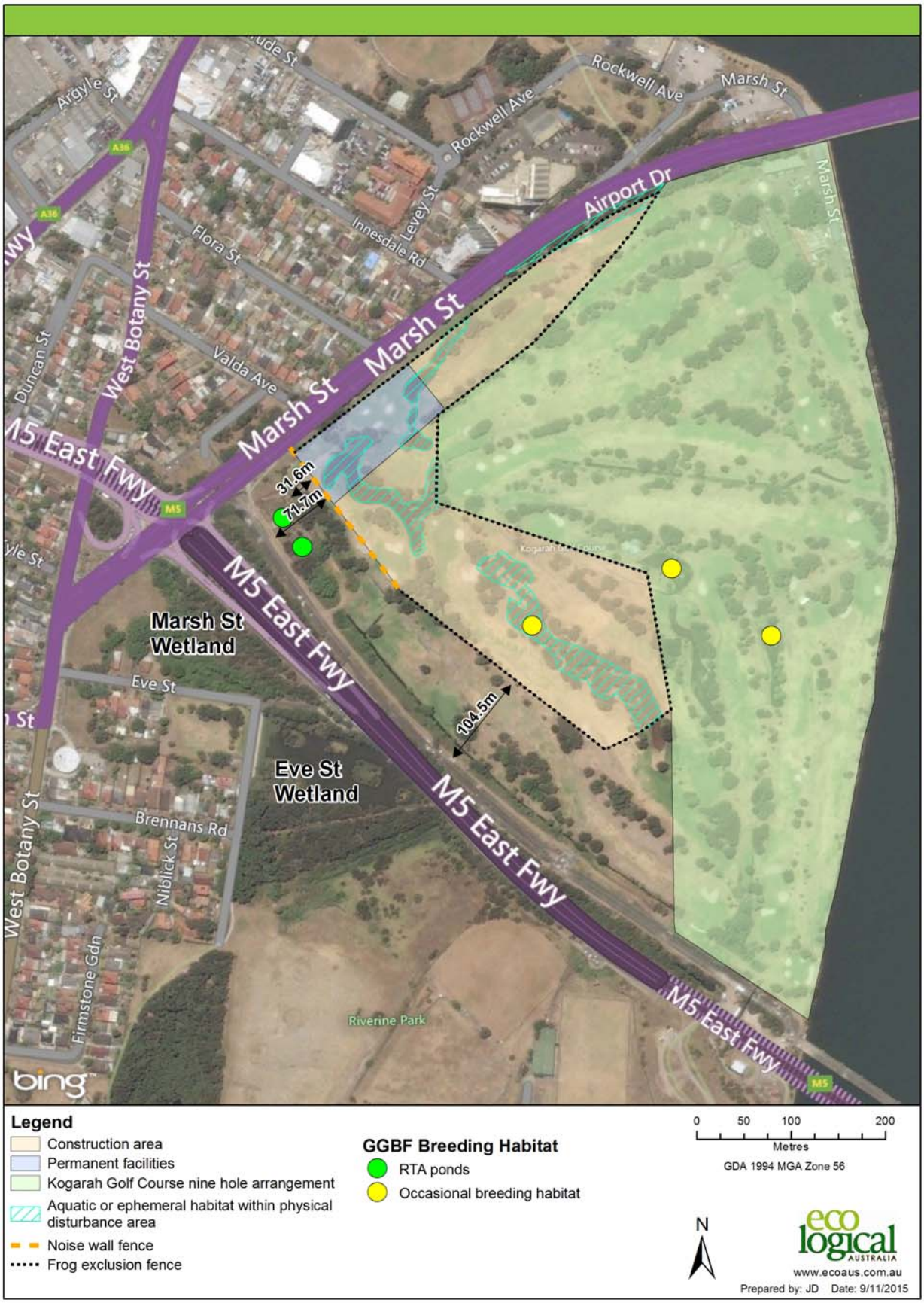

Figure 1: Proposed impact area and Green and Golden Bell Frog habitat

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2 Legislative context and related documents

2.1 Threatened Species Conservation Act 1995

The Green and Golden Bell Frog is listed as 'Endangered' under the NSW *Threatened Species Conservation Act 1995* (TSC Act). The TSC Act requires that a public authority take appropriate measures to implement actions included in a Recovery Plan for which they have agreed to be responsible. In addition, the TSC Act specifies that public authorities must not make decisions that are inconsistent with the provisions of the draft species Recovery Plan (DEC 2005).

Construction activities associated with the proposed project, will affect habitat of the Green and Golden Bell Frog. The management of potential habitat and mitigation measures for the project is to be undertaken in a manner consistent with the TSC Act requirements and the draft species Recovery Plan.

2.2 Environment Protection and Biodiversity Conservation Act 1999

The Green and Golden Bell Frog is listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPBC Act significant impact guidelines (DEWHA 2009) for this species consider that a significant impact is possible if actions result in the removal or degradation of terrestrial habitat within 200 metres of known habitat. The current project footprint proposes to remove known Green and Golden Bell Frog habitat as part of the construction activities for permanent and temporary facilities. The project has been referred to the Commonwealth for approval under the EPBC Act and has been determined to be a controlled action on the basis of impacts to Green and Golden Bell Frog.

2.3 Secretary's Environmental Assessment Requirements

The NSW Secretary's Environmental Assessment Requirements (SEARs) for the project were issued on 5 March 2015 and a revised SEARs issued on 26 August 2015 and included a requirement to undertake an assessment of potential impacts of the project on biodiversity values. In addition, matters for further consideration were provided by the NSW Office of Environment and Heritage (OEH), which included specific consideration of the Green and Golden Bell Frog.

2.4 Guidelines and related documents

This Plan of Management has been considered in relation to available management guidelines and policies including:

- Draft Recovery Plan for the Green and Golden Bell Frog (DEC 2005).
- Plan of Management – Green and Golden Bell Frog Key Population of the Lower Cooks River (DECC 2008a).
- EPBC Act Policy Statement 3.19. Significant Impact Guidelines for the vulnerable green and golden bell frog *Litoria aurea* (DEWHA 2009).
- Best Practice Green and Golden Bell Frog Habitat Guide (DECC 2008b).
- Protecting and restoring Green and Golden Bell Frog habitat (DECC 2008c).
- Hygiene protocol for the control of disease in frogs (DECC 2008d).
- Environmental Impact Assessment Guidelines: Green and Golden Bell Frog (NPWS 2003).
- Species expert reports and annual monitoring at Kogarah Golf Course (White 2015).

- Biodiversity Guidelines – protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority 2011).

In addition, the translocation plan contained at **Appendix A** has been prepared with reference to:

- The Commonwealth EPBC Act Policy Statement - Translocation of listed threatened species – assessment under chapter 4 of the EPBC Act (SEWPaC, 2013).
- Policy and Procedure Statement No 9 – policy for the translocation of threatened fauna in NSW (NPWS, 2001).

Approvals required to implement this plan

In anticipation that implementation of this plan, including the proposals to undertake habitat creation and captive breeding activities, will be part of the conditions of the planning approval under the EP&A Act, separate TSC Act licensing of these activities will not be required. The program and plan requires Animal Ethics Committee approval according to the “Code of practice for the care and use of animals in research in Australia” (National Health and Medical Research Council and Commonwealth Scientific and Industrial Research Organisation).

3 Green and Golden Bell Frog

3.1 Description

The Green and Golden Bell Frog is a relatively large dull olive to bright emerald green frog that can range in size from around 45 millimetres to 100 millimetres snout to vent length (Cogger 2000, OEH 2015). Its distinctive characteristics are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye. It also has a blue or bluish-green colour on the inside of the thighs (OEH 2015). The Green and Golden Bell Frog can be distinguished from similar species by its wart-free skin, expanded finger and toe pads, and lack of spotting or marbling on the hind side of the thigh.

Tadpoles of the species are relatively large (65 – 100 millimetres at limb bud development stage) and juvenile frogs are smaller versions of the adults that metamorphose at around 25 – 30 millimetres snout to vent length (DEC 2005).

It is active by day and usually breeds in summer when conditions are warm. However, the breeding has been recorded from September to February, with a peak breeding period following heavy rains in the warmer January to February months. Breeding patterns are influenced by geography with southerly and higher altitude populations having a narrower window of opportunity for breeding than more northerly and lower altitude populations (DEC 2005, DotE 2015).

The species is known to be highly mobile, and may move among breeding sites with large distances travelled in a single day/night or up to one to 1.5 kilometres (Pyke and White 2001). Male frogs call while floating in water and amongst fringing vegetation and females produce a raft of eggs that initially float before settling to the bottom of the water body (DEC 2005). Tadpoles are known to feed on algae and other plant-matter within the water body, while adult frogs are known to eat mainly insects, but may also eat other frogs.

3.2 Habitat

Green and Golden Bell Frogs can occupy a broad range of habitats, including natural, artificial and disturbed habitats, and breed in ephemeral ponds (Pyke & White 1996, DEC 2005). They have been recorded associated with coastal swamps, marshes, dune swales, lagoons, lakes and other estuarine wetlands as well as riverine floodplain wetlands and billabongs and constructed water bodies such as storm water detention basins, farm dams, bunded areas, drains and ditches (DEC 2005).

Green and Golden Bell Frog need various habitats for different aspects of their life cycle including foraging, breeding, sheltering, over-wintering and dispersal. They will also use different habitats or habitat components on a temporal or seasonal basis (DotE 2015). The species has been found in a wide range of water bodies except fast flowing streams (Pyke & White 1996) and has been associated with habitats such as marshes, dams and stream-sides, particularly those containing *Typha* spp. (Bullrushes) or *Eleocharis* spp. (Spikerushes).

Breeding habitat consists of water bodies that are still, shallow, ephemeral, unpolluted, unshaded, with aquatic plants present and free of Plague Minnow (*Gambusia holbrooki*) and other predatory fish. Breeding habitats also occur near terrestrial habitats containing grassy areas and vegetation no taller than woodlands for foraging and dispersal, and a range of diurnal shelter sites, such as rocks, logs, tussock forming vegetation and other cover for refuge (Pyke & White 1996, DotE 2015).

3.3 Species status and distribution

The Green and Golden Bell Frog is listed as ‘Endangered’ under the NSW TSC Act and as ‘Vulnerable’ under the Commonwealth EPBC Act.

The NSW Scientific Committee, when producing the original schedules for listing of the species as endangered stated that: *“[the] Population [was] severely reduced over entire range; [and] severe threatening processes [operate].”*

The Green and Golden Bell Frog has declined from a status where it was regarded as an extremely abundant species, with a widespread and almost continuous distribution between the north coast near Brunswick Heads, south along the coast to Victoria, to one where it now has only a fragmented distribution throughout this former range. It is currently considered to be absent from at least 90% of its former distribution (White and Pyke 1996; DEC 2005).

The Green and Golden Bell Frog occurs mainly along the coastal lowland areas of eastern NSW and Victoria. Its distribution now extends from Yuraygir National Park near Grafton on the North Coast of NSW, to the vicinity of Lake Wellington, just west of Lakes Entrance in south-eastern Victoria. The furthest inland record of the species is near Hoskinstown in the Southern Tablelands, just outside the ACT (DotE 2015).

At the time of the Recovery Plan production, there were 43 populations described as ‘key’ populations, known or considered likely to persist throughout the species range within NSW.

3.3.1 Sydney Key Populations

Sydney still contains some of the largest but also most disturbed and isolated populations of the Green and Golden Bell Frog, as a result of development and other human disturbances rather than a naturally patchy distribution.

Eight key populations exist within the greater Sydney Region, with other transient sites believed to also exist, consisting of small populations of migrating individuals. The Sydney based eight key populations are at:

- Kurnell
- Homebush Bay (Sydney Olympic Park lands)
- Greenacre
- Clyde/Rosehill (wetlands at the confluence of the Parramatta and Duck Rivers)
- Merrylands (Holroyd Gardens estate)
- Arncliffe (Marsh Street Wetlands) – this location
- St Marys
- Hammondville.

3.4 Key threatening processes

A number of factors associated with direct and indirect consequences of human activity have contributed to the decline of Green and Golden Bell Frogs, including (extracted from DEC 2005):

- *Habitat loss, modification and disturbance*. The removal of and disturbances to habitat has occurred across large areas as a result of development, and is considered the most significance key threatening process. This includes the reduction of wetlands and poorly drained coastal flood plain land that formerly constituted prime habitat, which has been drained, in-filled or developed.
- *Habitat fragmentation*. This has historically occurred over wide areas as a result of developments or through construction of significant barriers to natural movement (e.g. major roads). In some cases, this has prevented connections within a population, effectively limiting gene flow and dispersal.
- *Predation by introduced fish.* Predation occurs on the eggs and tadpoles of frogs by the introduced Plague Minnow (*Gambusia holbrooki*). Other introduced fish are likely to be the European Carp (*Cyprinus carpio*) and Gold Fish (*Carassius auratus*).
- *Disease – Chytrid fungus*. The Chytrid fungus (*Batrachochytrium dendrobatidis*) has been implicated in the decline of frogs across the world, and is thought to be a significant contributor to the decline of frogs in Australia.
- *Water quality and pollutant issues*. Developments and other activities occurring within a catchment have consequences for downstream areas and may include altered flow regimes, increased nutrient loads, weed infestation, other contaminants and rubbish. Deteriorating run-off water quality and increased soil erosion and sedimentation reduces the area's suitability for frogs.
- *Other threats*. Other possible threats indicated by anecdotal evidence includes predation by the foxes, cats, dogs and rats, road mortality, mowing near breeding and foraging habitat, predator/prey interactions with Cane Toads, artificial and natural opening of coastal lagoon estuaries, changes to flow regimes of streams and associated wetlands and excessive grazing and trampling of habitat.

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4 Impacts, mitigation and management measures

4.1 Description of impacts

Construction activities of the project are likely to result in direct and indirect impacts to Green and Golden Bell Frog habitat. Proposed activities of the project include permanent facilities to be established on land adjacent to the existing RTA ponds. However, a construction area and temporary facilities are also proposed around 32 metres from the RTA ponds, which will extend onto land owned by Rockdale City Council (**Figure 1**). This construction area is known as the Arncliffe surface works area.

The proposed temporary and permanent activities are likely to impact on Green and Golden Bell Frogs within the site area, shown on Figure 1**,** resulting in:

Potential direct impacts:

- Removal of around 7.82 hectares of foraging, sheltering and dispersal habitat
- Potential mortality of frogs from heavy machinery movements within the construction zone
- Removal of one ephemeral pond that has previously been recorded as containing a breeding event.

Potential indirect impacts:

- To the RTA ponds (leading to reduction in the capacity of the ponds to function as habitat) by:
    - Increase in shading by construction exclusion fence
    - Increase in shading from the permanent facilities during winter
    - Increase in dust from heavy vehicle movements
    - Increase in noise by heavy vehicle movements and tunnel boring
    - Increase in light from 24 hour construction operation
    - Increase in vibration from heavy vehicle movements, tunnel boring and stockpiling
    - Reduction of water quality through sedimentation and contaminants originating from construction zone
    - Accidental introduction of predatory fish.
- A reduction of habitat connectivity to other areas within the golf course
- Limiting foraging habitat
- Reduction in breeding success
- Potential mortality of individuals as a result of habitat modification.

Temporary impacts for up to four years represent the bulk of the impacts to Green and Golden Bell Frog habitat at the Arncliffe surface works area. The habitat temporarily affected will be reinstated, to the current levels of habitat, at the completion of the project. Water quality monitoring of the RTA ponds would be undertaken during construction. More detail on the water quality monitoring regime including frequency, sampling locations and parameters would be provided in the Habitat Creation and Captive Breeding Plan due for completion by March 2016.

4.2 Current management

Current management of Green and Golden Bell Frog habitat within the RTA ponds includes regular manipulation of water levels and drainage of breeding ponds. This creates habitat preferred for breeding by the frog and enables the flushing of salt water and periods of dryness for the management of:

- Predators, including Plague Minnow (*Gambusia holbrooki*)
- Chytrid fungus, a disease that affects all frog species, including the Green and Golden Bell Frog.

Ponds on the Kogarah Golf Course are also artificial, but are not purpose built for frog habitat and water levels are not manipulated to manage threats to the frogs or to provide suitable habitat. Many of the golf course ponds contain fringing vegetation such as *Typha* spp. (Cumbungi) and *Juncus* spp., suitable for a diversity of frog species, including the Green and Golden Bell Frog.

Water quality in many of the golf course ponds is low as a result of nutrient run-off from management activities on the golf course along with saline influences. In addition, adjacent vegetation exists as exotic grasses that are regularly mown for the purposes of golf course maintenance and use as fairways.

Habitat types within the golf course are described as follows (extracted from Management Plan Green and Golden Bell Frogs Lower Cooks River Key Populations, DECC 2008):

- *Breeding habitat:* primarily consists of the purpose built artificial ponds (RTA ponds). These ponds were built as a requirement of a previous development approval. Other breeding habitat (ephemeral) also exists and includes golf course water hazards, although breeding in these ponds is occasional.
- *Foraging habitat:* Includes grassed areas (native or exotic), tussock vegetation and emergent sedges and reeds bordering water features and ponds. The drainage channel and reed beds that border the southern extremity of the golf course may also provide foraging and dispersal habitat.
- *Sheltering habitat*: includes similar vegetation to that used as foraging areas that contain rock piles, fallen timber, tussock grasses and other artificial sheltering sites. Sheltering habitat is present around the RTA ponds.
- *Dispersal habitat*: typically includes wet areas such as creek lines, drains, stormwater canals, connecting vegetation, and other easements and depressions. However, in the golf course, fairways currently provide movement habitat between the RTA ponds and foraging habitat. An artificial frog passage was built underneath the M5 to facilitate movement between the golf course and habitat to the west and south (Marsh Street Wetlands and Old Spring Creek Wetland site). However, this passage is not used because of the relatively hostile environment across which frogs would need to travel (White A., pers. comm. 2015). Frogs have been reported to use the cycleway to the east of the artificial frog passage.
- *Over-wintering habitat*: Boulder piles were constructed surrounding the RTA ponds to provide over-wintering habitat. However it is unclear whether the frogs actually use the boulders as over-wintering habitat.

4.3 Proposed management

Roads and Maritime is seeking to manage impacts to Green and Golden Bell Frog habitat. The actions include the implementation of mitigation and management measures, and enhancement of habitat. These are to be delivered by those undertaking the construction works and Roads and Maritime.

It is anticipated that Roads and Maritime will provide the successful tender with this Plan of Management and a range of supporting documentation.

These reference documents are to be used by the successful tender of the project for detailed design and construction and are to be implemented as part of their works through a Construction Environmental Management Plan (CEMP).

The mitigation and management measures outlined in **Section 4.4** of this Plan of Management will be implemented to minimise potential impacts to Green and Golden Bell Frog individuals and known habitat.

The framework for implementation of the project specific mitigation and management actions are to be provided in the CEMP and should require all elements associated with the design, construction, cost and responsibilities.

4.4 Project specific mitigation measures

All measures are to be incorporated in a CEMP. They are to follow an adaptive approach that seeks for continued improvement of the Plan of Management and its mitigation measures. The actions and measures are outlined in the tables below:

- Construction related activities within the construction zone (**Section 4.4.1**)
- Habitat enhancement and management within adjacent habitat including the RTA ponds (**Section 4.4.2**)
- Habitat creation at Marsh Street and captive breeding (**Section 4.4.3**).

4.4.1 Construction mitigation measures

Management measures relating to construction activities within the construction zone are outlined in **Table 1**. These measures should be considered as a minimum requirement and will be the responsibility of the construction environmental manager.

Table 1: Construction mitigation and management measures within the construction zone

Mitigation measure	Description	Who	Timing
Define the construction clearing areas	Clear delineation of the construction boundary. Areas to be cleared should be marked and checked with surveyors pegs and equipment to ensure that the minimum area of take is adopted. Clearing should only occur within these areas. Once areas are cleared, the area of take should be calculated to ensure that no additional areas have been cleared. The distance between the RTA ponds and the edge of the clearing required for the construction zone is expected to be at least 32 metres.	Contractor Project ecologist	Pre-construction
Establish a Frog exclusion zone	Establishment of a physical barrier, using frog exclusion fencing between all construction works, existing RTA Ponds and reminder of the Golf Course. This frog fencing should be designed in consultation with a person who has had at least five years' experience in the management of Green and Golden Bell Frogs. There should be a section of fence directly adjacent to the RTA ponds (marked in **Figure 1** as noise wall fence and yellow dashes) which will: • Reduce sound and dust • Not exclude daylight • Exclude frogs • Exclude construction activities to clearly separate frog habitat to be retained from construction zone. This section of fence is to be inspected daily. Any breaches of the fence are to be raised with the Contractor for remediation. The remainder of the construction zone should be fenced to clearly separate frog habitat from the construction zone (marked in **Figure 1** as frog exclusion fence and black dots). This fence should: • Exclude humans from entering the construction zone • Exclude frogs from the construction zone. The remaining section of fence is to be inspected weekly. Any breaches of the fence are to be raised with the Contractor for remediation.	Contractor Project ecologist	Pre-construction

Mitigation measure	Description	Who	Timing
Undertake pre-clearance survey and salvage activities	Conduct a pre-clearance survey within the construction zone immediately prior to constructions works being undertaken. An ecologist with a minimum of five years' experience in the management of frogs is to conduct the pre-clearing survey. The survey should include two diurnal and two nocturnal surveys, with the last nocturnal survey conducted the night prior to works being undertaken. **Winter to spring frog encounters:** If Green and Golden Bell Frogs are encountered sheltering underneath rock, rubble or wood they need to be assessed for an over wintering position or torpor. Then the frogs are to be collected in accordance with the following protocol: • Placed in a clean, plastic holding container with a small amount of purified water • Frogs should be micro-chipped if not already tagged • Adult frogs should be sexed, snout-vent length measured, weight recorded, condition of the frog, date and location of collection • Transported to a suitable over-winter location in consultation with the project ecologist and based on the advice of an independent expert • If frogs are injured, they are to be taken to a vet or suitably experienced frog keeper and euthanased. • If frogs are not in torpor, the procedure for spring to autumn encounters applies. **Spring to autumn frog encounters:** If active frogs are encountered during the pre-clearance surveys or daily checks, then they are to be collected in accordance with the following protocol: • Placed in a clean, plastic holding container with a small amount of purified water • Frogs should be microchipped if not already tagged • Adult frogs should be sexed, snout-vent length measured, weight recorded, condition of the frog, date and location of collection • Relocated to Taronga Zoo, the artificial habitat created at Marsh Street, or the RTA ponds based on the advice of the project ecologist	Contractor Project ecologist	Pre-construction and construction

Mitigation measure	Description	Who	Timing
	Prior to works commencing, a number of water bodies within the construction zone will need to be decommissioned. Dam decommissioning needs to be done in the presence of a suitably qualified and experienced ecologist. Any frogs encountered will need to be collected as per above.		
Site inductions	Site inductions should contain a relevant section on the Green and Golden Bell Frog. The induction should incorporate: • What to do in the event of unexpected finds of frogs within the construction zone. • Highlighting the enhanced frog habitat area and why this is a 'no-go' zone.	All persons working in the construction zone Construction Environmental Manager	Construction
Stop work procedure	Implement a stop work or unanticipated find procedure for when Green and Golden Bell Frogs are observed within the construction zone (**Appendix A**). The procedure will include a process to notify the construction environmental manager and suitably qualified ecologist, a relocation procedure and when it is okay to re-commence works.	All persons working in the construction zone Construction Environmental Manager	Construction
Sediment and erosion control	Establish appropriate sediment and erosion control to prevent silt, sediments, spills and other contaminants from reducing water quality in frog habitat. These controls should be regularly inspected, particularly after heavy rain events.	Contractor Construction Environmental Manager	Pre-construction and Construction
Light spill management	Directional lighting should be used in the vicinity of the transparent frog exclusion fence. Directional lighting should aim to reduce night time light spill onto the RTA ponds.	Contractor	Construction
Dust suppression	Dust from heavy vehicle haulage, dumping and storing of spoil and general vehicle movements will need to be minimised. Dust may reduce water quality in the RTA ponds. Bulk water carriers and sprayers should apply town water only to reduce dust. Slurry run-off should be managed in accordance with the sediment and erosion control measures.	Contractor	Construction
Contaminated lands management	Develop appropriate procedures to manage contaminated fill that may occur in surrounding soils during the construction works and any habitat enhancement, if applicable.	Contractor	Construction

Mitigation measure	Description	Who	Timing
Acid sulphate soils management	Develop appropriate procedures to manage acid sulphate soils during construction and operation, if applicable. Management of acid sulphate soils should be carried out in accordance with the Roads and Maritime guideline or approved procedure. Relevant documents include: • RMS Guidelines for the Management of Acid Sulphate Materials, April 2005 • NSW Acid Sulphate Soils Manual (ASSMC, 1998) • NSW EPA publication “Assessing and Managing Acid Sulphate Soils”.	Contractor	Construction
Use of herbicides and other chemicals	Herbicides should not be used near the RTA ponds and within the enhanced frog habitat area. If herbicides are to be used within the construction zone, spray drift must not be able to reach aquatic habitat. This applies to herbicides in solution in surface water run-off.	Contractor	Construction
Habitat re-instatement	Re-instate all habitat that was temporarily impacted from the construction activities within the Arncliffe surface works area. Habitat reinstatement should be conducted in accordance with relevant guidelines and policies and be conducted in consultation with the Kogarah Golf Course and the Rockdale City Council.	Contractor	Post construction

4.4.2 Habitat enhancement and management within adjacent habitat including the RTA ponds

To compensate for loss of foraging habitat and to encourage frog movement to other areas within the Kogarah Golf Course, habitat adjacent to the RTA ponds and between the existing M5 East Motorway and the construction zone will be enhanced. These measures are shown in **Table 2**.

These measures should be considered as a minimum requirement. The detailed design and construction of the habitat management works, associated costs and implementation should be outlined in the CEMP. The implementation of the measures will be the responsibility of the construction environmental manager.

Table 2: Habitat enhancement measures

Mitigation measure	Description	Where	Who	Timing
Enhance habitat adjacent to RTA frog ponds	Enhanced frog habitat will consist of the following: • Improved areas of foraging habitat consisting of tussocky grasslands and swales • Areas of vegetation and other structures, such as logs, suitable for sheltering • At least three wet areas that will act as stepping stones to encourage frogs to move between the RTA ponds and the remainder of the golf course. Establishment and enhancement of frog habitat is to be conducted in accordance with: • Best Practice Green and Golden Bell Frog Habitat Guide (DECC 2008b). • Protecting and restoring Green and Golden Bell Frog habitat (DECC 2008c). • To be designed by person with at least five years' experience in the design of frog fencing or by a frog expert.	Adjacent habitat	Contractor Project ecologist Frog expert	Construction

Mitigation measure	Description	Where	Who	Timing
Hygiene protocol	Develop a hygiene protocol for persons working outside the construction zone and within the Kogarah Golf Course. This is to reduce the risk of the introduction and spread of Chytrid Fungus. The hygiene protocol is to be developed in accordance with the following: • Hygiene protocol for the control of disease in frogs (DECC 2008d). Environmental Impact Assessment Guidelines: Green and Golden Bell Frog (NPWS 2003). • RTA Biodiversity Guidelines – protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority 2011). Any other specific guideline to manage the risks of disease in this population.	Adjacent habitat	Any person entering the enhanced frog habitat Any person responsible for daily checks of frog fencing	Pre-construction and maintenance
Maintain the existing RTA ponds	Maintain RTA ponds and enhanced frog habitat zone, including: • Water supply systems • Water level management • Salt water supply. *Water supply*: Develop sustainable water supply plans to supply fresh water for the existing breeding ponds and any enhanced frog habitat ponds. Considerations to include stormwater harvesting, reuse from the groundwater treatment plant and groundwater bores. *Water level management*: Develop water level management requirements for regular emptying of breeding and sheltering ponds for vegetation and Plague Minnow management of existing ponds and enhanced habitat. *Salt water supply*: Develop arrangements for regular (six monthly) saline flushing of breeding and sheltering ponds for Chytrid fungus control.	RTA ponds and adjacent habitat	Contractor Project ecologist	Construction

Mitigation measure	Description	Where	Who	Timing
	Use of herbicides: Herbicides are not to be used near the RTA ponds or areas of aquatic habitat or in such a way that could impact upon aquatic habitat			
Control threats	Develop measures to reduce threats of Chytrid, Plague Minnow, noxious weeds and predation by feral cats and foxes.	RTA ponds and adjacent habitat	Contractor Project Ecologist	Construction

4.4.3 Habitat creation at Marsh St and the establishment of a captive breeding population

New Green and Golden Bell Frog habitat comprising at least three new ponds will be created and managed in perpetuity for the species on Roads and Maritime land at Marsh Street. See **Figure 2.**

A habitat creation and captive breeding plan will be prepared by a suitably experienced Green and Golden Bell Frog expert which

- Details the results of further population survey to be undertaken from October 2015 to February 2016. The purpose of this survey is to improve our understanding of the population structure in the RTA ponds and adjacent habitat including the number, age, breeding status and sex ratio of the population.
- Details how a captive population will be established including the objectives of the program, details of the suitable conservation facility to host the animals, husbandry techniques, welfare protocols, hygiene protocols, collection and transportation protocols, duration of the program and final release proposals.
- Details how the new habitat will be prepared, populated and managed in perpetuity at Marsh Street. This will include arrangements to secure a suitable water supply to the facility, fencing and site security protocols, weed removal and site remediation. New breeding habitat will involve the construction of at least three ponds capable of being managed as frog habitat over the long term
- Details of the long-term management framework to apply to the lands, which will include exploring the option of entering into a BioBanking agreement over the land.
- Details the steps to be taken to encourage the voluntary colonisation of the frogs from the golf course.
- Details of long term monitoring protocols.

The plan is to be reviewed by two independent frog experts and their advice will be considered in the finalisation of the plan. The plan is to be prepared prior to the commencement of construction activities within the vicinity of the RTA ponds.

Figure 2: Area proposed for habitat at Marsh Street

5 Monitoring and Reporting

5.1 Monitoring implementation of mitigation strategies

A monitoring and reporting program is to be incorporated into the CEMP to monitor the implementation of the Plan of Management and provide a basis for adaptive management. A report detailing the implementation of the actions set out in **Table 2** of the plan will be prepared by the contractor on a quarterly basis during construction.

In addition a monitoring and reporting program will also be prepared as part of the preparation of the Habitat Creation and Captive Breeding Plan. The purpose of the monitoring and reporting plan will be to report on the progress towards establishing new habitat at Marsh Street and towards the establishment of a captive breeding program. Reporting is expected to occur on a quarterly basis.

5.2 Population monitoring

Population monitoring will be put in place to monitor any impacts of the project on frogs within the RTA ponds and within adjacent habitat during the construction period. Monitoring will occur on a weekly basis between September and April and a monthly basis between May and August. All monitoring will be done in accordance with survey guidelines.

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Appendix A Unanticipated find procedure

Step One: Frogs observed during course of construction

Step Two: STOP WORK IMMEDIATELY in the vicinity of the sighting and notify your supervisor.
Try to photograph the frog to assist in confirmation of species.
DO NOT recommence work until directed by the approved Environmental Representative

Step Three: Supervisor to immediately notify the Environmental Manager.

Step Four: Environmental Manager to inform:
Project Director
Construction manager
Environmental Representative
Roads and Maritime Environmental Representative
Project Ecologist

Step Five: Project Ecologist OR Environmental Representative place frog in re-sealable plastic bag, or clean holding container.
Pour approximately 5 -10 mm bottled spring water into bag or container.
Project Ecologist or Environmental Representative to transport container / bag to site office and commence assessing the health of the frog. Details of the frog to be taken (e.g. lifecycle stage, sex, location and date where found, tag number, weight, snout-vent length). Frog to be microchipped if not already tagged.

Step Six: If frogs are detected between winter and spring, they should be checked for over-winter activity. If frogs are in torpor, they must not be released. Over-wintering frogs should be retained in an approved over-winter facility or be included in the captive breeding colony.

If frogs are detected between spring and autumn, they should be released by the Project Ecologist the Taronga Zoo, RTA ponds or the Marsh Street habitat.

Step Seven: Project Ecologist and Environmental Representative declare works 'okay' to re-commence.

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T 02 6103 0145
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Suites 28 & 29, Level 7
19 Bolton Street
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Appendix L Biodiversity Credit Report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 4/11/2015 Time: 2:50:05PM Calculator version: v4.0

Major Project details

Proposal ID:	0155/2015/2084MP
Proposal name:	The New M5 - Option X
Proposal address:	M5 East Freeway Kingsgrove NSW 2208
Proponent name:	Roads and Maritime Service
Proponent address:	Locked Bad 928 North Sydney NSW 2059
Proponent phone:	02 8588 5740
Assessor name:	Meredith Henderson
Assessor address:	PO Box 20529 WORLD SQUARE NSW 2002
Assessor phone:	(02) 85368671
Assessor accreditation:	0155

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion	1.40	31.44
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion	1.82	27.12
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	0.09	0.93
Total	3.31	59

Credit profiles

1. Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (ME002)

Number of ecosystem credits created	31
IBRA sub-region	Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (ME002)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (ME029)

Number of ecosystem credits created	1
IBRA sub-region	Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion, (ME029) Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion, (ME012) Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion, (ME014) Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin Bioregion, (ME039)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (ME050)

Number of ecosystem credits created	27
IBRA sub-region	Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion, (ME050)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Green and Golden Bell Frog	Litoria aurea	7.82	203

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WestConnex