NSW GOVERNMENT | Transport for NSW

New Intercity Fleet Maintenance Facility Project

Additional Species Impact Statement

Artist's impression of the new maintenance facility subject to detailed design.

May 2017

New Intercity Fleet Maintenance Facility Project

ADDITIONAL SPECIES IMPACT STATEMENT

Transport for NSW

REV	DATE	DETAILS
A	26/04/2017	Draft
B	16/05/2017	Address client comments
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GLOSSARY

Affected species	Subject species likely to be affected by the Project.
BioBanking Assessment Methodology (BBAM)	Assessment methodology for the NSW BioBanking Scheme – Office of Environment and Heritage 2014, BioBanking Assessment Methodology 2014, Sydney.
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: → Genetic diversity — the variety of genes (or units of heredity) in any population. → Species diversity — the variety of species. → Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. The study area is in the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell, 1995).
Biometric vegetation type (BVT)	Provides the occurrence of the PCT within a specific catchment management area. A BVT may be assigned catchment specific attributes such as benchmark data, percent cleared in the catchment area value and associations with threatened species, populations and communities. A PCT may be distributed across one or more major catchment areas and is assigned a BVT with each major catchment area occurrence. BVTs are managed in the VIS Classification Database.
Chief Executive	Chief Executive of the NSW Office of Environment and Heritage
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered Ecological Community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation, 2004). Critical habitat is listed under either the TSC Act or the EPBC Act and both the state (Department of Environment, Climate Change and Water) and Federal (Department of the Sustainability, Environment, Water, Population and Communities) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation.
Department of the Environment and Energy (Commonwealth)	The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the EPBC Act. The Commonwealth Department of Department of the Environment and Energy was previously known as: → Department of the Environment (DoE) → Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) → Department of the Environment, Water, Heritage and the Arts (DEWHA). → Department of Environment and Heritage (DEH). → Department of the Environment and Water Resources (DEWR).
DP	Deposited Plan is a plan number given to a subdivision that is registered by the Land Property Information.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.

EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Exotic	Introduced from outside the area (Stralberg et al., 2009). Used in the context of this report to refer to species introduced from overseas.
FM Act	NSW *Fisheries Management Act 1994*
GPS	Global Positioning System – a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Indigenous	Native to the area: not introduced (Stralberg et al., 2009).
Introduced	Not native to the area: not indigenous (Stralberg et al., 2009). Refers to both exotic and non-indigenous Australian native species of plants and animals.
Key threatening processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation, 2004). Key threatening processes are listed under the TSC Act, the FM Act and the EPBC Act. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation, 2004).
Local occurrence	The ecological community that occurs within the study area. However the local occurrence may include adjacent areas if the ecological community on the study area forms part of a larger contiguous area of that ecological community and the movement of individuals and exchange of genetic material across the boundary of the study area can be clearly demonstrated as defined by Department of Environment and Climate Change (2007c).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007c).
Locality	The area within a five kilometre radius of the study area.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
Noxious weed	An introduced species listed under the *Noxious Weeds Act 1993*. Under the Act, noxious weeds have specific control measures and reporting requirements.
NSW	New South Wales

Office of Environment and Heritage (OEH)	Broadly, the NSW Office of Environment and Heritage works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. Previously known as: → Department of Environment, Climate Change and Water (DECCW). → Department of Environment and Climate Change (DECC).
Plant community type (PCT)	A NSW plant community type identified using the PCT classification system.
Priorities action statements (PAS)	Priorities action statements outline the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of Threatened species, population and ecological communities and manage key threatening processes (Department of Environment and Climate Change, 2007b).
Project (the)	Construction and operation of the New Intercity Fleet Maintenance Facility in Kangy Angy (refer to Chapter 4 for a description of the Project).
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, as well as all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the TSC Act, FM Act or the EPBC Act to assist the recovery of a threatened species, population or ecological community.
Risk of extinction	The likelihood that the local population of a threatened species or the local occurrence of an ecological community will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the species or ecological community, and includes changes to ecological function Department of Environment and Climate Change (2007c).
Significant	Important, weighty or more than ordinary.
Significant Impact	A level of impact on threatened species, populations or ecological communities listed under the NSW *Threatened Species Conservation* (TSC) Act and/or Commonwealth *Environment Protection and Biodiversity Conservation (*EPBC) Act determined by undertaking an assessment of significance in accordance with: → Section 5A of the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act), triggering the requirement for the preparation of a Species Impact Assessment (SIS). → Matters of National Environmental Significance Impact Guidelines (Department of the Environment 2013), supporting a Referral to the Department of the Environment.
Significant species	Species not listed in the TSC Act but considered to be of regional or local significance.
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species (Matteson and Langellotto, 2010).

Study area	Is the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.
Subject site	The area proposed for development/activity.
Subject species	Those threatened and significant species, populations and ecological communities that are known or considered likely to occur within the study area.
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the TSC Act, FM Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as threatened) under the TSC Act, FM Act or the EPBC Act. Capitalisation of the terms 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
TSC Act	NSW *Threatened Species Conservation Act 1995.*
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change, 2007c).
VIS Classification Database	The standard operational classification hierarchy for native vegetation in NSW. The plant community types and their relationships to vegetation formations and classes are maintained in the Vegetation Information System (VIS) Classification database.
Weed	A plant growing out of place or where it is not wanted: often characterised by high seed production and the ability to colonise disturbed ground quickly (Stralberg et al., 2009). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

ABBREVIATIONS

AWS	All Weather Station
BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology
BVT	Biometric Vegetation Type
c.	Circa (about or around)
CER	Chief Executive Requirements
CMA	Catchment Management Authority (now known as Local Land Services)
CMP	Conservation Management Plan
CEMP	Construction Environmental Management Plan
DA	Development Application
DBH	Diameter at Breast Height
DoEE	Commonwealth Department of the Environment and Energy
DP	Deposited Plan
DP&E	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation of Australia
LEP	Local Environmental Plan
LGA	Local Government Area
OEH	NSW Office of Environment and Heritage
NSW	New South Wales
OEMP	Operational Environmental Management Plan
PAS	Priority Action Statement
PCT	NSW Plant Community Types
PEA	Preliminary Ecological Assessment
REF	Review of Environmental Factors
SIS	Species Impact Statement
Spp.	Species
TEC	Threatened Ecological Community

1 FORM OF THIS SPECIES IMPACT STATEMENT

This Species Impact Statement (SIS) has been prepared in accordance with the requirements of the Chief Executive of the NSW Office of Environment and Heritage (OEH) issued on 23 March 2017. It has been prepared in addition to the previous SIS prepared for the Project (June 2016) to specifically target Mahony's Toadlet (*Uperoleia mahonyi*). Mahony's Toadlet, which was identified in the previous SIS as an undescribed species of *Uperoleia*, was formally described in November 2016 (Clulow *et al.*, 2016) and was subsequently given a provisional listing as an Endangered species under the *Threatened Species Conservation Act 1995* (TSC Act) on 10 March 2017.

While the SIS has been prepared to specifically address the Project's impacts on Mahony's Toadlet, an updated assessment of the Wallum Froglet, which is listed as a Vulnerable species under the TSC Act, is also included after this species was recorded in the study area during surveys for Mahony's Toadlet in March 2017. The inclusion of the Wallum Froglet as an affected species in this SIS provides an updated assessment of potential Project related impacts, however the previous SIS conclusions with regard to the project having a non-significant impact on this species have not changed.

Certification of this Species Impact Statement is provided below.

1.1 Certification of the SIS by the principal author

This is to certify that this Species Impact Statement (SIS) prepared by WSP | Parsons Brinckerhoff for Transport for NSW, has been prepared in accordance with the requirements of Sections 109 and 110 of the New South Wales (NSW) *Threatened Species Conservation Act 1995* (TSC Act) and in accordance with the requirements of the Chief Executive of the OEH.

24 May 2017

Alex Cockerill
BSc (Hons), Principal Ecologist, WSP | Parsons Brinckerhoff

1.2 Declaration of the SIS by the applicant

'I, Louise Sureda, of Level 5, Tower A, Zenith Centre, 821 Pacific Highway, Chatswood NSW 2067, being the applicant for the proposed New Intercity Fleet Maintenance Facility being assessed under Part 5 of the Environmental Planning and Assessment Act (consisting of the Main North railway corridor and Lot 1 of DP 656505, Lot 82 of DP 737040, Lot 121 of DP 874787, Lot 32 of DP 1033784 and Lots 34 to 41 [inclusive] of DP 2877), north west of Enterprise Drive, Kangy Angy, Central Coast Local Government Area in NSW have read and understood this species impact statement. I understand the implications of the recommendations made in the statement and accept that they may be placed as conditions of consent or concurrence for the proposal.'

24 May 2017

Louise Sureda
Director Planning and Environment Services, Transport for NSW

2 CONTEXTUAL INFORMATION

Transport for NSW (TfNSW) commissioned WSP | Parsons Brinckerhoff to prepare this Species Impact Statement (SIS) for the proposed New Intercity Fleet Maintenance Facility Project (hereafter, referred to as 'the Project').

The likely impacts of the Project on threatened biodiversity listed under the *Threatened Species Conservation Act 1995 (*TSC Act) has previously been assessed by the SIS prepared for Chief Executive Requirements (CERs) issued on 11 February 2016, with a concurrence subsequently issued by the Office of Environment and Heritage (OEH) on 22 August 2016 (WSP | Parsons Brinckerhoff, 2016c). Whilst concurrence has been obtained, TfNSW has yet to determine the Project under Part 5 of the EP&A Act, and are now seeking additional concurrence.

During the course of surveys undertaken for the previous SIS, an undescribed species of *Uperoleia* frog was recorded within the study area. This undescribed species of *Uperoleia* frog was formally described as Mahony's Toadlet (*Uperoleia mahonyi*) in November 2016 (Clulow *et al.*, 2016) and was subsequently given a provisional listing as an Endangered species under the TSC Act on 10 March 2017.

Following the provisional listing, TfNSW formally requested CERs under Section 111 of the TSC Act for the preparation of an additional SIS to assess the impact of the Project on the Mahony's Toadlet on 21 March 2017. The CERs were subsequently issued on 23 March 2017.

In March 2017 while undertaking surveys for the Mahony's Toadlet for this SIS, a small number of Wallum Froglet individuals were also recorded in the study area. The Project's impacts on the Wallum Froglet were assessed in the previous SIS (WSP | Parsons Brinckerhoff, 2016c, Biosphere Environmental Consultants Pty Ltd, 2016a). However, due to the relatively small area of potential habitat and absence of records from the site, the Wallum Froglet was previously not considered an affected species. An updated assessment of the Wallum Froglet as an affected species, incorporating the additional survey results is also provided in this SIS.

This SIS provides a detailed technical assessment of the impacts of the Project on Mahony's Toadlet and Wallum Froglet, and is in support of the Review of Environmental Factors (REF), dated June 2016, for the Project. The OEH are the concurrent determining authority for the Project (in addition to TfNSW) in accordance with Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The locality of the Project is provided in Figure 2.1.

2.1 Description of the Project, subject site and study area

This section provides a description of the proposed works associated with the Project as well as a description of the subject site and study area.

2.1.1 Description of the proposal

TfNSW proposes to deliver a new train maintenance facility at a site in Kangy Angy on the Central Coast of NSW to support the procurement of the New Intercity Fleet. The facility would undertake light and heavy train maintenance activities for the New Intercity Fleet, including but not limited to:

- Regular maintenance/servicing
- Repair/replacement of train components
- Interior and exterior cleaning.

The proposed facility would include about six kilometres of electrified railway (in total), would be seven tracks wide at its widest point, covering an area of approximately 44.07 hectares, and would be bounded by a perimeter fence (area identified as the 'subject site' in Figure 2.2). The proposed facility would comprise:

Maintenance facility elements:

- Fleet maintenance building
- Six standing roads (for maintenance works on the train sets and to hold trains) and one standing road for wheel lathe operations
- Auxiliary workshops
- Electronic clean room
- Material storage, including flammable liquid storage
- Wheel lathe
- Automatic train wash
- Site access roads.

Miscellaneous buildings:

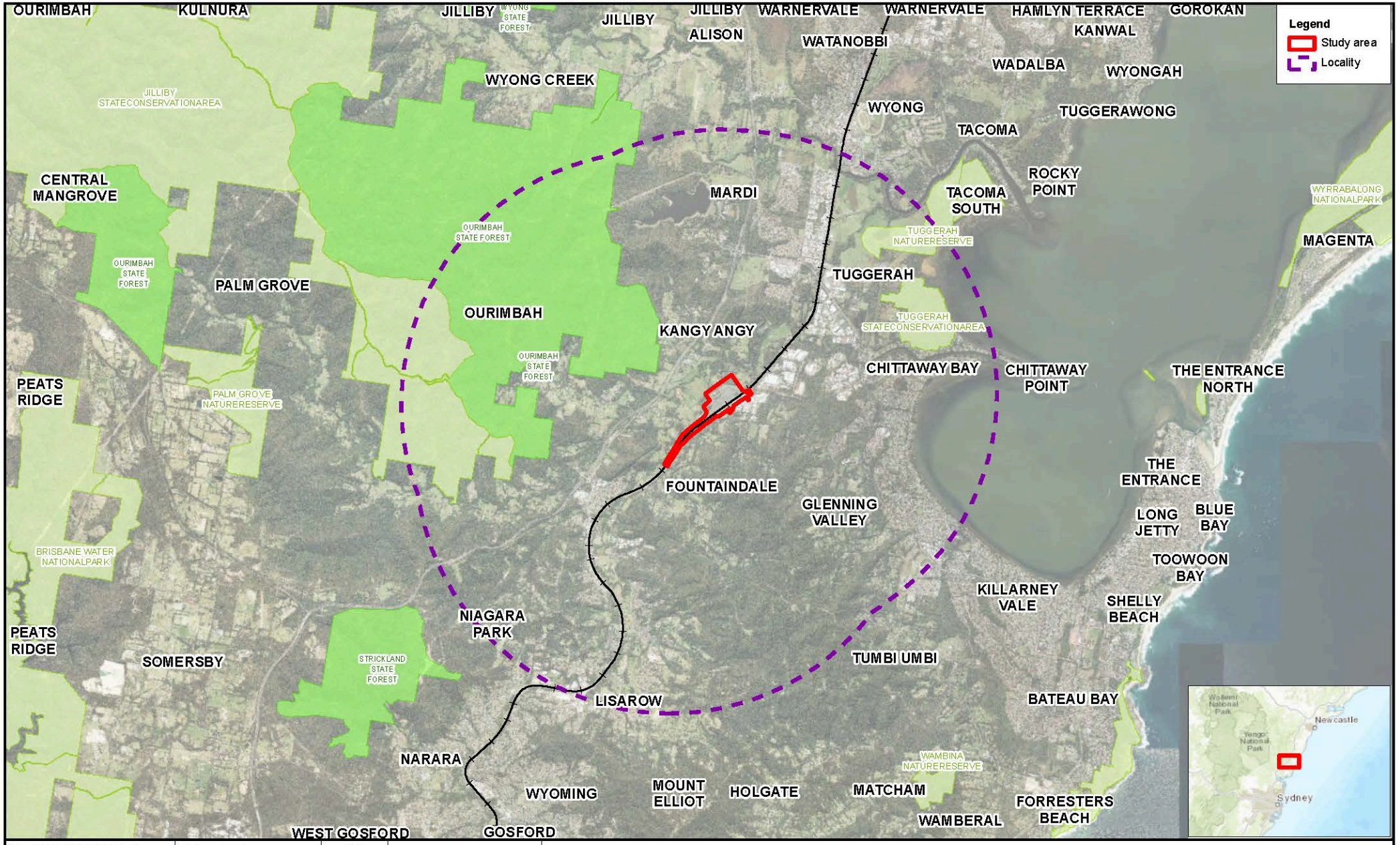
- Administration (including training rooms)
- Facilities for presentation and train maintenance staff
- Signalling buildings
- Security
- Compressed air building
- Water treatment plant
- Substation building
- Power supply (traction power, bulk power and signalling power supply).

Other infrastructure including:

- New railway track infrastructure on the western side of the existing rail corridor to allow for trains to enter and exit the maintenance facility site from the Main North railway line
- A new rail bridge (consisting of two separate structures) over Chittaway Creek and Turpentine Road
- A new access roadway and bridge to the maintenance facility site off Enterprise Drive
- A new flood access road between Orchard Road and the proposed new access roadway
- A series of drainage detention ponds
- Staff car park
- Relocation of the existing high voltage (HV) power transmission lines (Ausgrid and Sydney Trains HV assets) and combined services route (i.e. rail related utilities such as power, communications and signalling cables).

Subject to determination and approval, construction of the New Intercity Maintenance Facility is expected to commence in 2017. Operation of the maintenance facility, including commissioning is scheduled to commence in 2020. Based on the current construction program and activities, the total construction program for the Project would be approximately 33 months.

Further detail regarding the design and different elements of the New Intercity Fleet Maintenance Facility Project is provided in Chapter 4 of the REF.



Map: 2202522A_GIS_F052_A1	Author: mitchellem
Date: 21/04/2017	Approved by: -

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Scale ratio correct when printed at A4

Note: Design is indicative only. Subject to detailed design

Data source: - Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community © Land and Property Information 2015

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New Intercity Fleet Maintenance Facility Project
Figure 2.1
Project locality

2.1.2 Definitions of SIS study area

2.1.2.1 Subject site

The subject site refers to the land which is proposed for development and therefore directly affected by the Project. The Project's subject site includes all land that will be cleared and/or modified as a result of the proposed works associated with the Project, including a nominal six metre wide buffer for construction of the Project. The subject site encompasses an area of approximately 36.6 hectares including 22.6 hectares of Swamp Sclerophyll Forest EEC. The extent of the Project's subject site is provided in Figure 2.2.

The subject site has been modified from the previous SIS to account for additional exclusion zones proposed for Mahony's Toadlet and Wallum Froglet, which are discussed in Section 5 and Section 6.

2.1.2.2 Study area

The study area refers to the subject site and any additional areas which are likely to be affected by the Project either directly or indirectly. The Project's study area includes all land that will directly and indirectly be impacted as a result of the proposed works associated with the Project. The extent of the Project's study area is provided in Figure 2.2. The study area has been modified from the previous SIS to account for additional exclusion zones proposed for Mahony's Toadlet and Wallum Froglet.

2.1.2.3 Locality

Locality refers to the area within a 5 kilometre radius of the study area.

2.1.3 Description of SIS study area

The study area is located in the suburb of Kangy Angy, within the former Wyong Shire Local Government Area (LGA), now known as the Central Coast Council on the NSW Central Coast. The study area is generally bordered by the Main North Rail Line rail corridor to the south, and Orchard Road to the north-west. Residential receivers on rural properties generally surround the site to the north, south and west, with industrial precincts to the south-east and north-east (on the opposite side of the rail corridor to the study area).

The M1 Pacific Motorway is located approximately 0.85 kilometres to the north-west, and Tuggerah Lake is approximately 3.5 kilometres to the east of the study area. Chittaway Creek crosses the Project at the southern end and Ourimbah Creek is to the north of the study area. Details of the vegetation communities and fauna habitats supported therein are described in detail in section 4 of this report.

2.1.3.1 Previous ecological studies

CENTRAL COAST TRAIN STABLING AND MAINTENANCE FACILITY COMPARATIVE SITE ANALYSIS

As part of the site selection process, desktop ecological surveys were undertaken at a number of potential locations along the Central Coast to identify potential ecological constraints. The results of those surveys are provided in the *Central Coast Train Stabling and Maintenance Facility Comparative Site Analysis* (GHD, 2015). The results from the preliminary survey at the Kangy Angy site suggested that two threatened ecological communities listed under the TSC Act occur within the subject site:

- River Flat Eucalypt Forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.
- Swamp Sclerophyll Forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.

In addition, one threatened plant species (*Corunastylis* sp. Charmhaven) was predicted to occur at the Kangy Angy site. A targeted survey was undertaken as part of the study during the species flowering period (February 2015), however this species was not detected. The Wallum Froglet was not recorded or

considered a likely occurrence by this previous study. Mahony's Toadlet was also not known as a species at the time of this study (c. 2014).

PRELIMINARY ECOLOGICAL ASSESSMENT – NEW INTERCITY FLEET MAINTENANCE FACILITY

A Preliminary Ecological Assessment (PEA) was completed by EMM (2015) for the Kangy Angy site to determine the likely significance of the Project impacts on biodiversity. Desk-based investigations completed for the PEA indicated that 16 threatened ecological communities are known to occur within 10 kilometres of the study area. The field surveys reported the presence of two threatened ecological communities:

- Swamp Sclerophyll Forest on the coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion listed as Endangered under the TSC Act.
- Lowland Rainforest in the North Coast and the Sydney Basin Bioregion listed as Endangered under the TSC Act.

Desk-based searches and field surveys identified potential habitat for seven threatened flora species to occur within the study area.

The seven species considered likely to occur included:

- Biconvex Paperbark (*Melaleuca biconvexa*)
- Charmhaven Apple (*Angophora inopina*)
- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Tranquillity Mintbush (*Prostanthera askania*)
- Variable Midge Orchid (*Genoplesium insigne*)
- Wyong Sun Orchid (*Thelymitra adorata*)
- Wyong Midge Orchid (*Corunastylis* sp. Charmhaven).

Surveys undertaken to inform the PEA identified several hundred individuals of the threatened plant, *Melaleuca biconvexa* within the subject site which is a threatened species listed as Vulnerable under both the TSC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Potential habitat for the following species was also considered however none of these species were recorded during the surveys:

- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Tranquillity Mintbush (*Prostanthera askania*)
- Rainforest Cassia (*Senna acclinis*).

Fauna habitat assessments undertaken as part of the survey indicated that potential habitat occurred for the following threatened and migratory species:

- Eleven threatened species of bird; Black-necked Stork, Gang-Gang Cockatoo, Glossy Black-Cockatoo, Little Lorikeet, Little Eagle, Masked Owl, Sooty Owl, Powerful Owl, Wompoo Fruit-Dove, Regent Honeyeater and Swift Parrot.
- Three migratory species of bird; Rainbow Bee-eater, Black-faced Monarch and Spectacled Monarch.
- Two threatened amphibians; Wallum Froglet and Green-thighed Frog.
- Two threatened reptiles; Pale-headed Snake and Stephen's Banded Snake.
- Nine threatened mammals; Golden-tipped Bat, Greater Broad-nosed Bat, Eastern Bent-wing Bat, Eastern False Pipistrelle, Grey-headed Flying-fox, Koala, Long-nosed Potoroo, Squirrel Glider and Yellow-bellied Glider.

Mahony's Toadlet was not known as a species at the time of this study (c. 2015).

The assessment undertook preliminary assessments of significance which concluded that the Project was likely to have a significant impact on Swamp Sclerophyll Forest threatened ecological community and *Melaleuca biconvexa*. In light of the results of the PEA, it was recommended that additional targeted surveys should be completed to inform the environment impact assessment process moving forward for species considered likely to occur within the study area. Specifically, this would require a SIS under Part 5 of the NSW EP&A Act.

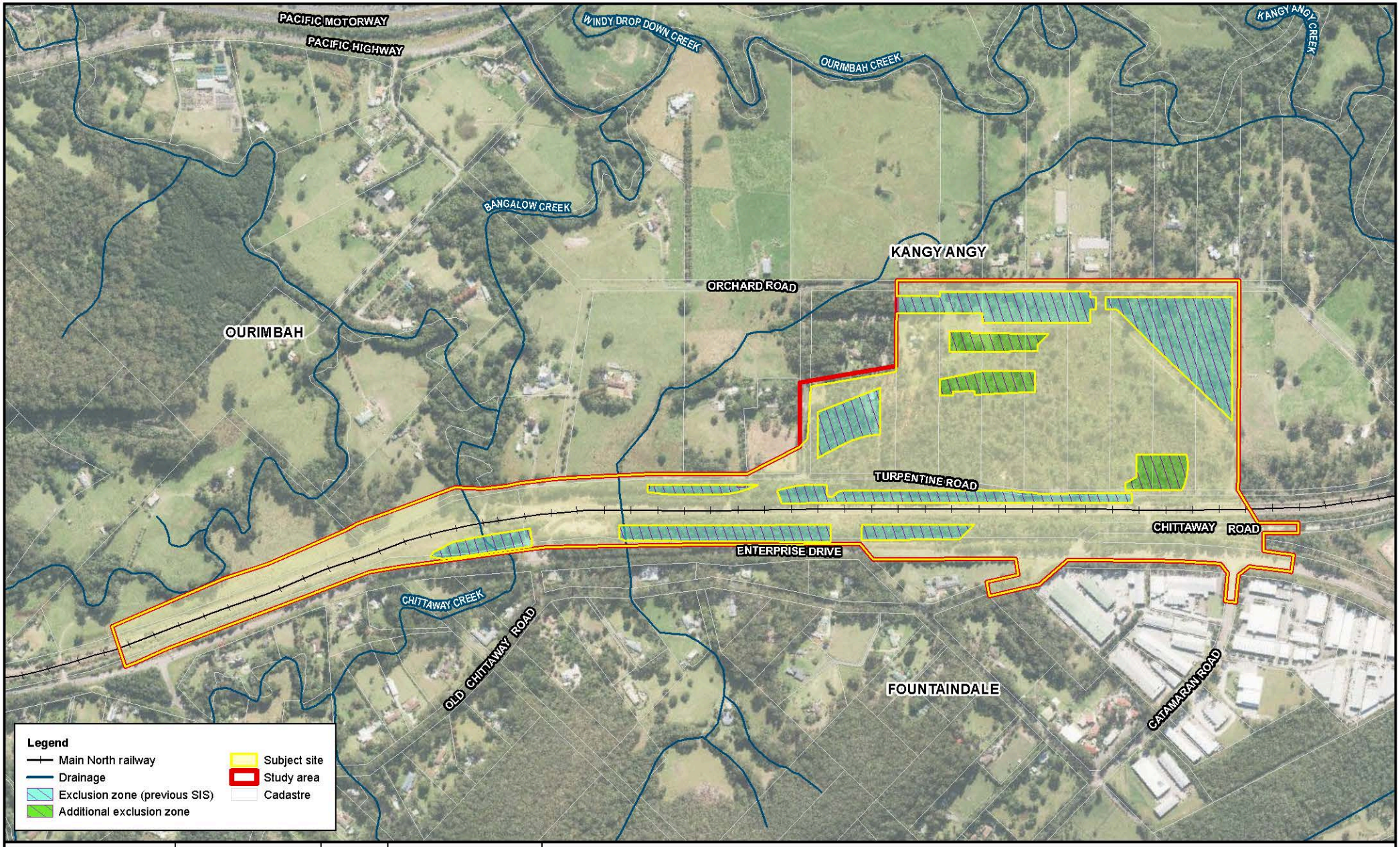
BIODIVERSITY ASSESSMENT REPORT AND PREVIOUS SPECIES IMPACT STATEMENT

In light of the results of the PEA, a Biodiversity Assessment Report (BAR) was required to assess potential ecological impacts to support the REF for the Project, in addition to informing the preparation of the previous SIS in accordance with the OEH CER's. The assessment for the BAR and SIS included desktop review of available databases and relevant literature as well as targeted field surveys completed over nine days between late February and April 2016 (WSP | Parsons Brinckerhoff, 2016c).

During the preparation of the previous SIS prepared for this Project (WSP | Parsons Brinckerhoff, 2016c), an undescribed frog species was recorded in the study area as part of an expert report on the likelihood of occurrence of threatened frog species (Biosphere Environmental Consultants Pty Ltd, 2016a). The frog was recorded as Undescribed Red-groined Toadlet (*Uperoleia sp.*). Throughout the preparation of the previous SIS and subsequent OEH concurrence on 22 August 2016, the then undescribed *Uperoleia* sp. was treated as a 'protected' species under the *National Parks and Wildlife Act 1974*.

On 4 November 2016, the previously undescribed Red-groined Toadlet was officially named as a new species (*Uperoleia mahonyi* sp. nov. Mahony's Toadlet) and described in the scientific journal Zootaxa (4184 (2): 285-315, dated 4 November 2016) (Clulow *et al.*, 2016). On 10 March 2017, the NSW scientific Committee made a determination for the provisional listing, on an emergency basis, of the frog; Mahony's Toadlet, as an Endangered Species in part 1 of Schedule 1 of the TSC Act (NSW Scientific Committee, 2017).

In addition, the study area was assessed as supporting potential habitat for the Wallum Froglet (WSP | Parsons Brinckerhoff, 2016c, Biosphere Environmental Consultants Pty Ltd, 2016a). However, due to the relatively small area of potential habitat and absence of records from the site despite targeted surveys, the Wallum Froglet was not considered an affected species in the previous SIS. In March 2017 several Wallum Froglet individuals were recorded in the study area during targeted surveys for the Mahony's Toadlet. Therefore the Wallum Froglet has also been considered as an affected species in this assessment.



Map: 2202522A_GIS_F062_A3	Author: suansrir
Date: 11/05/2017	Approved by: -

Data source: -© Land and Property Information 2015

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1:9,500

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

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New Intercity Fleet Maintenance Facility Project
Figure 2.2
Project study area and subject site

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3 INITIAL ASSESSMENT

3.1 Identifying subject species

Determining authorities have a statutory obligation under the EP&A Act to consider whether a Project is likely to significantly affect threatened species, populations or ecological communities, or their habitats by applying an Assessment of Significance (the seven-part test). The likely impacts of the Project on threatened biodiversity was assessed by way of an SIS prepared in June 2016, which was subsequently granted concurrence from OEH on 22 August 2016.

Subsequent to concurrence of the previous SIS, the NSW Scientific Committee made a Determination for the provisional listing of the frog, Mahony's Toadlet (*Uperoleia mahonyi*), as an Endangered species under Part 1 of the TSC Act. It has since been confirmed that the previously undescribed species of *Uperoleia* frog recorded within the subject site during surveys undertaken for the SIS in 2016 was Mahony's Toadlet.

Mahony's Toadlet was considered in the previous SIS as a 'protected' species under the *National Parks and Wildlife Act 1974*, however was not assessed as a threatened species under the TSC Act as it was not recognised by the legislation at that time.

In response to the classification and subsequent listing of Mahony's Toadlet an Assessment of Significance (AoS) was undertaken to consider the likely impacts of the Project on Mahony's Toadlet under the EP&A Act, which concluded:

- One individual Mahony's Toadlet has been recorded in the study area only
- Based on a precautionary approach being applied due to the new provisional listing of the Mahony's Toadlet under the TSC Act, the Project is considered likely to have a significant impact on the Mahony's Toadlet.

Accordingly, CERs were formally requested for the preparation of a single species SIS to support an approval pathway for the Project under Part 5 of the EP&A Act. CERs were subsequently issued on 23 March 2017.

3.2 Subject species

'Subject species' are those threatened species, populations and ecological communities that may be present or using the study area. Due to the potential for the Project to impact such species, subject species are considered further as part of this SIS.

In accordance with the CERs and acknowledging the subject species assessed under the previous SIS (WSP | Parsons Brinckerhoff, 2016c) Mahony's Toadlet is the focus 'subject species' of this SIS.

In addition to the Mahony's Toadlet, one additional species, the Wallum Froglet, has also been included as a subject species. The Wallum Froglet was assessed in the previous SIS (WSP | Parsons Brinckerhoff, 2016c) based on limited potential habitat and no records of this species within the study area. However the Wallum Froglet was subsequently recorded during recent targeted surveys in the study area for Mahony's Toadlet and therefore has also been considered in this assessment.

In summary, the subject species of this SIS include Mahony's Toadlet and the Wallum Froglet (Table 3.1).

Table 3.1 List of subject species

SCIENTIFIC NAME	COMMON NAME	TSC ACT[1]	EPBC ACT
Uperoleia mahonyi	Mahony's Toadlet[2]	E	–
Crinia tinnula	Wallum Froglet	V	–

(1) E = Endangered, V = Vulnerable under the TSC Act.
(2) The NSW Scientific Committee, established by the TSC Act, made a determination for the provisional listing, on an emergency basis, of the frog Mahony's Toadlet as an Endangered species in Part 1 of Schedule 1 of the TSC Act. Provisional listing of Endangered species on an emergency basis is provided for by Part 2 of the TSC Act.

4 SURVEY

This section provides details regarding the surveys undertaken as part of this SIS, including requirements to survey, survey effort and technique and results of the surveys undertaken.

4.1 Requirement to survey

The survey methodology used to complete the targeted frog surveys were undertaken in accordance with all relevant survey methodology guidelines for each identified subject species. Minimum survey effort is defined in *Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, 2004) and *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians* (Department of Environment and Climate Change, 2009). Suggested minimum survey effort for amphibians typically include:

- Systematic day habitat search for one hour per habitat stratification unit.
- Night habitat search of damp and watery sites for 30 minutes on two separate nights per stratification unit.
- Nocturnal call playback completed at least one location on each of two separate nights.
- Minimum of one 200 metre transect per water body or inundated area, repeated on a minimum of two separate nights (Department of Environment and Conservation, 2004) (Department of Environment and Climate Change, 2009).

A total effort of 38 survey days targeting Mahony's Toadlet and Wallum Froglet, encompassing a variety of survey methodologies and climatic conditions, were undertaken to inform this SIS (Table 4.2). The survey effort significantly exceeded the suggested industry minimum standard 2 days/ nights. Surveys were conducted in accordance with the CERs and in consideration of the following survey methodology guidelines:

- *Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, 2004).
- *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians* (Department of Environment and Climate Change, 2009).
- *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change, 2007c).
- *Survey guidelines for Australia's threatened frogs* (Department of the Environment Water Heritage and the Arts, 2010).

The aim of surveys completed for this SIS was to target Mahony's Toadlet, as identified in the CERs, and the Wallum Froglet. Although comprehensive field surveys have been completed in the study area (and locality), it is acknowledged that no sampling technique can totally eliminate the possibility that a species is present on a site.

4.2 Documentation of survey effort and technique

4.2.1 Description of survey techniques and survey sites

A total 53 days of targeted and opportunistic surveys have been undertaken in the study area, including:

- 38 days targeted surveys for the BAR (WSP | Parsons Brinckerhoff, 2016b, WSP | Parsons Brinckerhoff, 2016c), previous SIS (WSP | Parsons Brinckerhoff, 2016b, WSP | Parsons Brinckerhoff, 2016c) (Biosphere Environmental Consultants Pty Ltd, 2016a, Biosphere Environmental Consultants Pty Ltd, 2016b), and this SIS. The weather conditions experienced during surveys is provided in (Table 4.1).
- Onsite ecological advice for boundary maintenance and installations (14 March 2016) (EMM, 2016)
- 11 days onsite ecological services during geotechnical and contamination investigations (7-17 December 2015) (EMM, 2016).
- Three days during surveys informing Preliminary Ecological Assessment (10, 16 and 17 September 2015) (EMM, 2015a).

Table 4.1 Field survey dates and weather conditions

DATE	TEMP ºC (MIN)	TEMP ºC (MAX)	RAIN (mm)	WIND (MAX SPEED (km p/hr)/DIRECTION)
22 February 2016	18.5	28.8	0	30/ENE
23 February 2016	17.0	30.0	0	30/NE
26 February 2016	22.8	26.7	0	48/S
29 February 2016	16.9	27.9	0	24/SE
17 March 2016	18.9	25.2	40	20/ENE
21 March 2016	15.8	21.4	18	31/SSW
22 March 2016	15.7	23.0	2.0	39/S
23 March 2016	15.2	24.6	0	13/WNW
24 March 2016	13.6	27.6	0	26/NE
29 April 2016	13.1	25.2	0	15/E
12 May 2016	12.3	23.6	0	33/WNW
13 May 2016	10.6	25.3	0	56/WNW
20 May 2016	9.0	23.0	0	30/NW
19 August 2016	6.5	23.4	0	30/NNE
23 November 2016	16.7	29.5	0	44/S
11 December 2016	17.7	27.9	0	33/NE
12 December 2016	17.6	29.9	0	41/ENE
17 December 2016	18.6	26	1.8	50/S
24 January 2017	22.5	39.1	0	59/S
25 January 2017	19.2	23.4	31.6	26/S
27 January 2017	20.4	25.8	4.6	28/S
8 February 2017	21.5	27.2	12.6	41/E
9 February 2017	21.	31.9	9.6	35/ENE
1 March 2017	20.3	25.6	29.4	28/ENE
2 March 2017	19	26.7	1.6	24/ENE
6 March 2017	19.9	24.3	3.4	52/S
7 March 2017	18	22.7	0	44/S
8 March 2017	16.7	22.9	3.2	31/SSE
9 March 2017	16.9	23.7	4.8	35/S
10 March 2017	18.3	23.8	0.4	41/S
14 March 2017	20.8	23.9	33	33/E
15 March 2017	19.6	25.4	48.4	41/ENE
16 March 2017	20.8	26.3	29	41/ENE
17 March 2017	20.4	23	25	56/S

DATE	TEMP ºC (MIN)	TEMP ºC (MAX)	RAIN (mm)	WIND (MAX SPEED (km p/hr)/DIRECTION)
28 March 2017	19.9	23.8	0	38/S
29 March 2017	21.5	31.8	0.2	20/NNE
30 March 2017	22.6	24.9	0.2	46/SW
25 April 2017	16.1	27.7	0	33/W

Note: Weather data obtained from Bureau of Meteorology Gosford AWS (Station 061425). Rainfall data obtained from Wyong (Jilliby Creek: Station 61380)

Importantly, between 14 and 20 March 2017, 187.6 mm of rain was recorded from the Jiliby Creek weather station (61380) (Bureau of Meteorology, 2017) which is located approximately 1.9 kilometres from the Project site. This above average heavy rainfall event provided ideal survey conditions for amphibian's (Department of the Environment Water Heritage and the Arts, 2010).

4.2.1.1 Nomenclature

Names of plants used in this document follow Harden (Harden, 1992, Harden, 1993, Harden, 2000, Harden, 2002) with updates from PlantNet (Royal Botanic Gardens, 2016). Scientific names are used in this report for species of plant.

Vegetation community names have followed that of the NSW Plant Community Types (PCT) & Biometric Vegetation Type (BVT) (Office of Environment & Heritage, 2016a). Corresponding vegetation community names from the local broad scale vegetation mapping project and corresponding threatened ecological communities have been also provided in section 4.3.

Names of vertebrates follow the Australian Faunal Directory (Department of the Environment, 2016), maintained by the Commonwealth Department of the Environment and Energy (DoEE). Common names are used in the report for species of animal.

4.2.1.2 Study area surveys

MAHONY'S TOADLET HABITAT MAPPING

Current observations of Mahony's Toadlet indicate the species is a habitat specialist, inhabiting coastal ephemeral and semi-permanent swamps and swales, and occasionally man made dams, in heath or wallum habitats almost exclusively on a substrate of white/leached sand. It is thought to be totally confined to Quaternary sediments (Clulow *et al.*, 2016). The species is commonly associated with acid paperbark swamps. Given the relatively recent description and understanding of this species, multiple methodologies were employed to adequately describe, quantify and survey Mahony's Toadlet habitat in the study area. The methods included understory vegetation sampling, surficial sand mapping, mapping of semi-permanent and ephemeral water habitat, and targeted Mahony's Toadlet surveys. A description of each of these methods is provided below.

Vegetation mapping

Vegetation within the subject site and locality has been previously mapped at the regional scale in *'The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales*' (Bell, 2002). Additionally the subject site was previously mapped in a site-specific ecological report '*Preliminary Ecological Assessment: New Intercity Maintenance Facility'* prepared by EMM (2015b). Field validation (ground-truthing) of the initial vegetation classifications identified from aerial photograph interpretation, existing vegetation mapping (Bell, 2002, EMM, 2015b) and associated PCTs was undertaken to determine the vegetation types present and their condition in the previous SIS (WSP | Parsons Brinckerhoff, 2016c).

Surficial sand mapping

Due to the Mahony's Toadlet preference for sandy substrate (Clulow *et al.,* 2016), a review of Coastal Quaternary Geology Mapping for NSW (Troedson *et al.,* 2015) and a separate geotechnical investigation (WSP | Parsons Brinckerhoff, 2017) were completed in the study area to identify variations in substrate type which may aid the process of determining where habitats preferred by Mahony's Toadlet might occur in the study area. In total, 47 locations were sampled using a 40 mm diameter hand auger (Figure 4.1) (WSP | Parsons Brinckerhoff, 2017). Soil samples recovered from the hand auger were visually assessed by eye and a 10x loupe (magnifying glass) and described by a Senior Geotechnical Engineer. The 'gritty' feel of the soil was used to supplement the visual assessment. The distribution of soil samples were then used to produce a map (Figure 4.1) of sediment types within the subject site (WSP | Parsons Brinckerhoff, 2017).

Semi-permanent and ephemeral water body mapping

Clulow *et al.* (2016) note that breeding for Mahony's Toadlet would likely be similar to other *Uperoleia* spp. That is, reliant on the presence of ephemeral and semi-permanent water. Therefore onsite wetland type habitats (in conjunction sandy substrates) should determine the distribution of potential breeding habitat for Mahony's Toadlet within the study area. The densely vegetated nature and relatively flat topography of the study area made it difficult to determine the exact distribution of semi-permanent and ephemeral water beyond access tracks. However micro-elevational variations affecting the retention of water in the study area are expressed by different tolerances of understorey vegetation assemblages to inundation. Therefore the distribution of water during wet periods was mapped from a combination of information noted during wet period surveys, on the ground understorey vegetation surveys and the mapping of understorey vegetation types from aerial photos.

TARGETED MAHONY'S TOADLET SURVEYS

Mahony's Toadlet is known in the study area from one individual recorded on 12 May 2016. Within the greater locality, Mahony's Toadlet is also known to occur in the Wyrrabalong National Park at Norah Head on the eastern side of the Tuggerah Lake.

Frog calling is generally restricted to the breeding season and when conditions are conducive to calling (Department of Environment and Climate Change, 2009). Mahony's Toadlet is known to inhabit coastal ephemeral and semi-permanent swamps and swales with breeding known to occur in autumn (March) and spring (October – November) (Clulow *et al*., 2016). Accordingly, targeted searches for Mahony's Toadlet in the study area primarily focused on nocturnal searches and auditory surveys in areas identified as suitable habitat. And as far as reasonably practicable, these surveys were completed in an appropriate time of the year when potential ephemeral breeding habitat was likely to be holding water.

Reference populations

To gauge Mahony's Toadlet activity the known population occurring off Pelican Beach Road Norah Head was visited on 24 January 2017 and 22 March 2017. In addition, the type locality at Oyster Cove was visited on 24 April 2017, with six individual Mahony's Toadlets confirmed to be actively calling following rainfall in late April.

Nocturnal searches (including spotlighting)

Nocturnal searches for Mahony's Toadlet involved experienced surveyors walking through areas identified as suitable Mahony's Toadlet habitat looking for active frogs and eyeshine. Searches were completed after dusk by actively walking through areas of suitable habitat using high-powered headlamps and hand torches. Nocturnal searches primarily targeted areas where *Uperoleia* type calls were detected to focus survey effort. Where *Uperoleia* type calls were not detected, randomised searches were completed along access tracks, within and adjacent to semi-permanent and ephemeral ponds and amongst drier perched habitat (Figure 4.2). Searches included turning over suitable ground shelter, such as fallen timber and raking ground debris.

Nocturnal searches were generally completed by one or two people over a 30 minute to 60 minute period and completed simultaneously with auditory surveys. Specimens were identified visually or by aural recognition of call.

Auditory survey (including call playback)

Auditory surveys were completed simultaneously with nocturnal searches. Auditory surveys typically encompassed static surveys, whereby field ecologists would listen for *Uperoleia* type calls at particular locations within identified Mahony's Toadlet habitat; inclusive of semi-permanent and ephemeral ponds, and drier perched habitats. In addition, call playback was used to survey for Mahony's Toadlet after dusk, using standard methods (Kavanagh and Debus, 1994, Debus, 1995), in habitat appropriate for this species. Mahony's Toadlet vocalisation was used to facilitate call playback methodology with the primary purpose being to elicit a response from the target species.

Pitfall trapping

Due to the small and cryptic nature of Mahony's Toadlet (and Wallum Froglet), pit trapping was employed in four discrete locations as a means of potentially determining frog numbers and actual distribution within the identified Mahony's Toadlet habitat area (Figure 4.2). Trap lines were deployed in areas considered to be potential habitat with suitable topography to maximise capture opportunities, inclusive of semi-permanent and ephemeral water habitat, and drier perched habitat.

Pit traps, consisting of two lines of three 20 litre buckets, and two lines of four 20 litre buckets, were used in conjunction with drift fences to target amphibians. Pit traps were buried in the ground with the lip flush to the ground's surface and the base of the drift fence was dug into the substrate to a depth of at least ten centimetres. At both ends the drift fence extended at least two metres beyond the last pit trap. Traps were inspected at dawn and from two hours after last light. Optimal timing for amphibian surveys and trapping is known to be during their breeding period, which has been identified as spring (October to November) and autumn (March to May) for Mahony's Toadlet (Clulow et al., 2016, Department of the Environment Water Heritage and the Arts, 2010).

Pit trapping was completed over two, four night sessions, with 14 trap nights recorded per night and 112 trap nights recorded in total:

- 6–9 March 2017
- 14–17 March 2017.

Bioacoustic recording

Two Song Meters (Song Meter SM4 Acoustic Recorder, Wildlife Acoustics Inc.) were used to record and identify the calls of frogs across two locations in the study area. Passive monitoring of these survey sites was achieved by setting the Song Meters to record day and night across a three week period in March, when the species is known to breed.

TARGETED WALLUM FROGLET SURVEY

Wallum Froglets were targeted using a combination of methodologies, as described for Mahony's Toadlet, inclusive of auditory surveys, call playback, nocturnal searches, pit trapping and bioacoustic recording.

Auditory surveys were completed simultaneously with nocturnal searches and encompassed static surveys and call playback. Static surveys were completed throughout the study area with particular attention afforded to semi-permanent water habitat. Semi-permanent water habitat corresponded with wallum type habitat with which this species is largely associated. It is recognised however, that surrounding swamp forest type habitats provide a favourable habitat matrix for this species to disperse within the study area. In addition, call playback was used to survey for Wallum Froglet after dusk, using standard methods (Kavanagh and Debus, 1994, Debus, 1995), in habitat appropriate for this species.

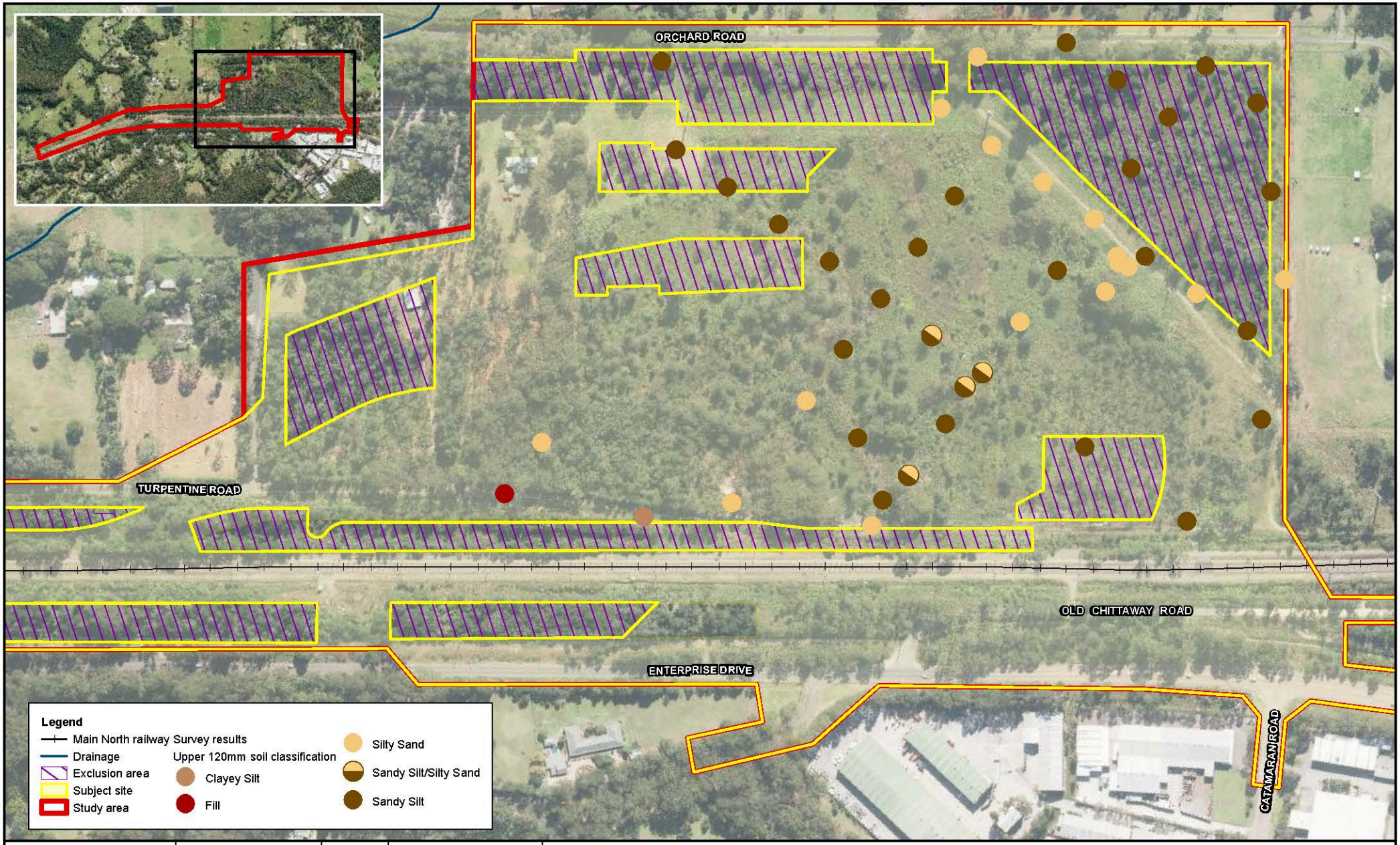
Nocturnal searches for Wallum Froglet were completed after dusk by actively walking through areas of suitable wallum type habitat using high-powered headlamps and hand torches. Nocturnal searches primarily

targeted semi-permanent water habitat, however, randomised searches were completed along access tracks and within and adjacent to semi-permanent and ephemeral water habitat.

Targeted surveys completed for Wallum Froglet are shown in Figure 4.2.

OPPORTUNISTIC FROG SIGHTINGS

Frogs were also surveyed opportunistically during all other surveys by WSP | Parsons Brinckerhoff within the study area over a total of 38 days.



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Data source: - © Land and Property Information 2015

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

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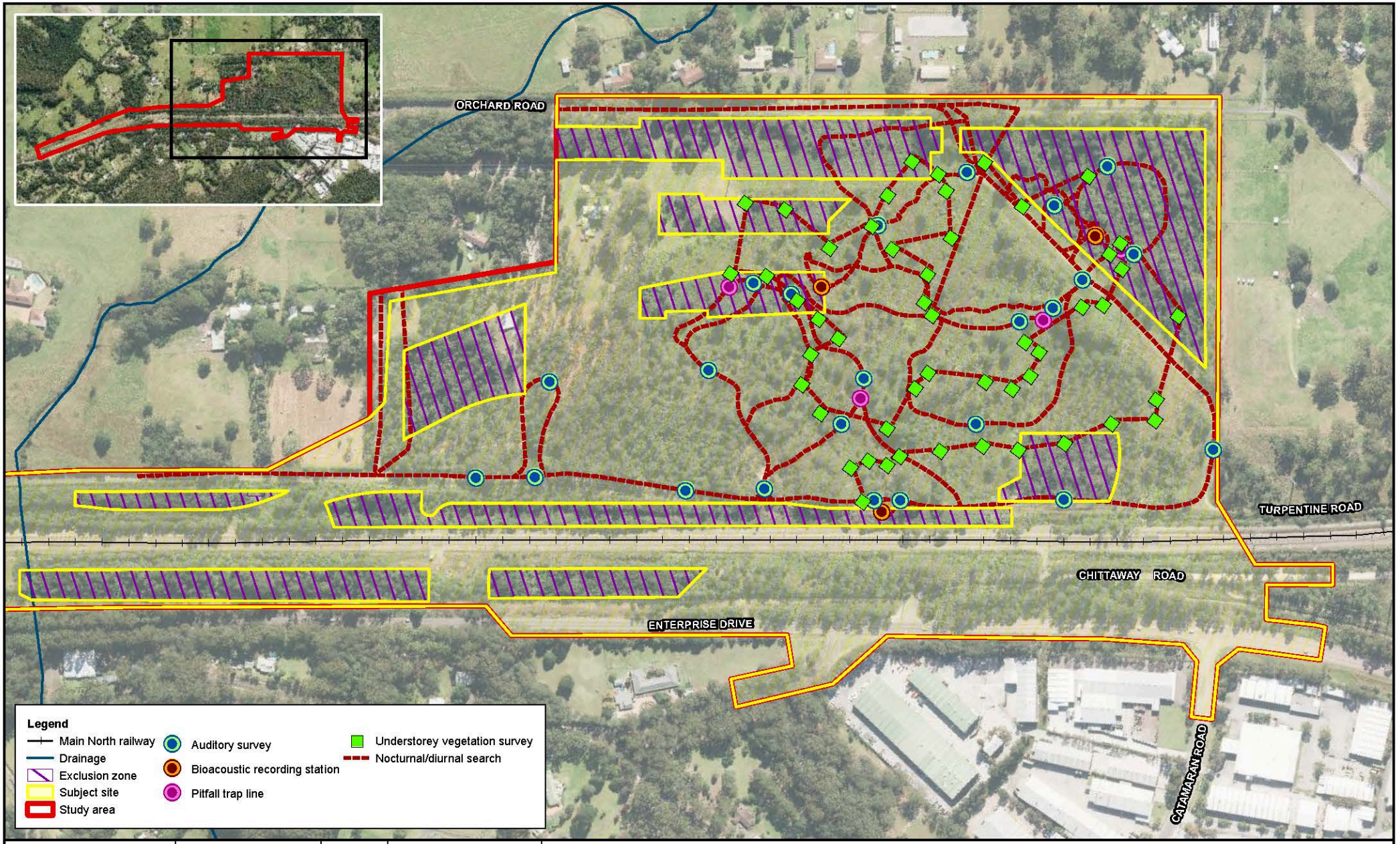
New Intercity Fleet Maintenance Facility Project
Figure 4.1
Geotechnical surficial sand mapping



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New Intercity Fleet Maintenance Facility Project
Figure 4.2
Mahony's Toadlet and Wallum Froglet survey effort in the study area

4.2.1.3 Local area surveys

Additional surveys for the Mahony's Toadlet were undertaken within the locality. These included an initial desk based assessment of potential habitat and limited targeted field surveys.

DESK-BASED ASSESSMENT

Characterising potential Mahony's Toadlet habitat

To determine the potential extent of Mahony's Toadlet in the locality a desk-based analysis was completed from localities where this species has been recorded using data presented in Clulow *et al.* (2016). Several characteristics of Mahony's Toadlet from published literature that aided the mapping of potential habitat include:

- Habitat specialist inhabiting coastal ephemeral and semi-permanent swamps and swales (occasionally man-made dams)
- Associated with heath or wallum habitats (commonly associated with acid paperbark swamps)
- Almost exclusively found on a substrate of white/ leached sand (i.e. restricted to quaternary sediments).
- Vegetation communities in which Mahony's Toadlet has been found include wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney Red Gum woodland.
- Terrestrial vegetation associations include tree species *Melaleuca quinquenervia*, *Eucalyptus robusta*, *Angophora costata*, *Acacia longifolia* and *Banksia* spp.

Based on the specialist habitat description described in published literature (Clulow *et al.*, 2016), core habitat for Mahony's Toadlet is defined as coastal ephemeral and semi-permanent swamps, swales and wetlands, in heath or wallum habitats and occurring on a substrate of white/ leached sand.

In addition to those characteristics nominated above, the observation of Mahony's Toadlet in the study area indicate additional habitat qualities that may identify potential habitat, including:

- The single Mahony's Toadlet individual located on site occurred in buried situation characterised by a dark grey silty-sand substrate.
- This location was in an area historically cleared for a power easement immediately adjacent to *Eucalyptus pilularis* (Blackbutt), with a ground cover dominated by *Imperata cylindrical* var. *major* (Blady Grass).
- The study area was identified as a terrace on an alluvial plain deposition, with a sediment type variously consisting of silt, clay, fluvial sand and gravel (in order of decreasing importance and frequency) (Troedson *et al*., 2015).
- The lowest areas (small channels and depressions) in the study area appear to be less than permanent in their retention of water, but likely retain water for long periods between rainfall events.
- From an ecological appraisal of substrate type and the distribution of water across the study area, it is considered that no one understorey habitat would be considered more important to Mahony's Toadlet in isolation. It is considered likely that variations in freshwater inputs across different climatic contexts would render different areas of the study area more important than others at different times. Areas of lowest elevation are likely to be important to the frog for breeding during dryer cycles and those that are of higher elevation, for breeding during wetter periods. Areas of higher elevation are also considered likely to be important during periods of torpor between breeding events.

Mapping of potential Mahony's Toadlet habitat

Based on the characteristics nominated above, mapping of potential Mahony's Toadlet habitat in the locality (five kilometre radius) is depicted in Figure 4.5. This map was compiled by successively refining areas potentially suitable for Mahony's Toadlet habitation. Apart from semi-permanent to permanent freshwater wetlands, areas subject to temporary inundation that may constitute breeding habitat, such as in the study area, can be difficult to determine in all but direct observation in high rainfall conditions. Therefore, vegetation with which Mahony's Toadlet has been associated in published literature and observable habitat attributes in the study area were used to define potential Mahony's Toadlet habitat in the locality.

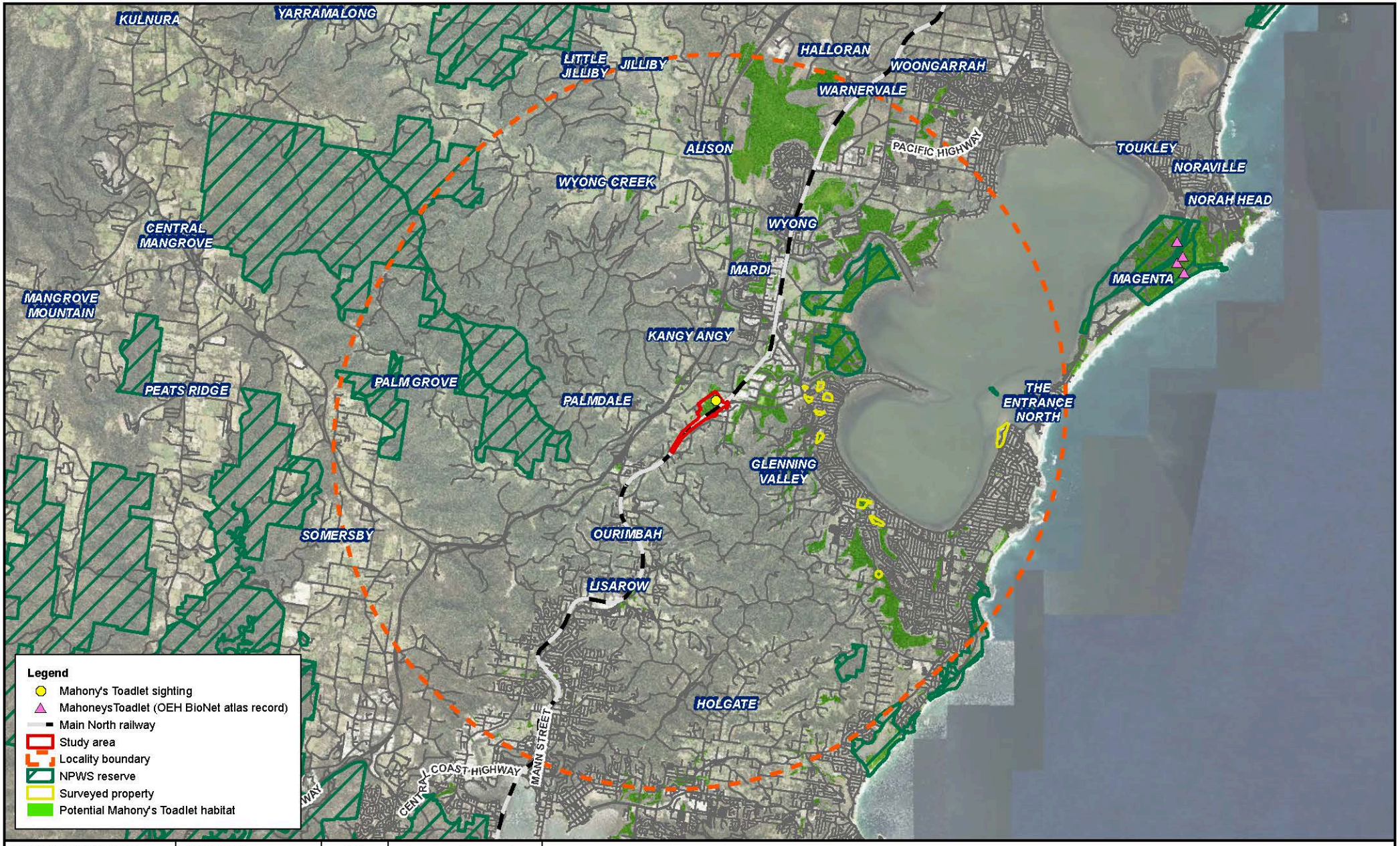
As Mahony's Toadlet is thought to be confined to Quaternary sediments, Coastal Quaternary Geology Mapping for NSW (Troedson *et al*., 2015) was used in the first instance to understand and identify those areas in the locality that retained Quaternary geology. Subsequently, vegetation mapping applicable to the locality (Bell, 2002, Bell, 2004) was confined to those areas identified as retaining Quaternary geology. Finally, those vegetation communities with which Mahony's Toadlet has been associated were selected as providing potential habitat.

Specifically, the following GIS map layers were employed:

- Coastal Quaternary Geology Mapping for NSW (Troedson *et al*., 2015)
  - Predominately including those units with a marine sand and/ or fluvial sand lithology.
- Vegetation mapping of the Wyong LGA (Bell, 2002), including the following 16 units that conform with habitat associations described above:
  - Coastal Sand Foredune Acacia Scrub
  - Coastal Sand Holocene Banksia Scrub
  - Coastal Sand Wallum Heath-Scrub
  - Coastal Sand Blackbutt-Apple Forest
  - Coastal Bangalay – Paperbark Forest
  - Coastal Sand Mahogany – Paperbark Swamp Forest
  - Freshwater Wetlands
  - Alluvial Redgum Footslopes Forest
  - Alluvial Bluegum – Paperbark Mesic Palm Forest
  - Alluvial Robusta – Paperbark Sedge – Palm Forest
  - Alluvial Floodplain Swamp Paperbark Thicket
  - Alluvial Woollybutt – Melaleuca Sedge Forest
  - Alluvial Floodplain Shrub Swamp Forest
  - Munmorah Impeded Sand Sedgeland
  - Narrabeen Impeded Wet Heath
  - Alluvial Riparian Blackbutt Forest.
- Vegetation mapping of the Gosford LGA (Bell, 2004), including the following 17 units that conform with habitat associations described above:
  - Alluvial Bluegum – Paperbark Forest
  - Umina Sands Coastal Woodland
  - Coastal Sand Wallum Heath
  - Swamp Mahogany – Paperbark Forest
  - Alluvial Paperbark Sedge Forest
  - Alluvial Floodplain Woollybutt Forest
  - Alluvial Floodplain *Blechnum* Forest
  - Alluvial Floodplain Redgum Forest
  - Coastal Sand Swamp Forest
  - Phragmites Rushland
  - Swamp Oak Sedge Forest
  - Narrabeen Alluvial Sedge Woodland
  - Umina *Lepironia* Sedgeland
  - Freshwater *Typha* Wetland
  - Coastal Sand Foredune Scrub
  - Coastal Sand Banksia Scrub
  - Swamp Paperbark Thicket.

TARGETED MAHONY'S TOADLET LOCALITY SURVEYS

Limited targeted surveys for Mahony's Toadlet in the locality were undertaken within publicly accessible sites, identified using criteria nominated in the desk-based assessment. Due to this species preference for acid paperbark swamp type habitats, preference was afforded to those locations that retain similar permanent, semi-permanent or ephemeral waterbodies. Nocturnal searches and auditory surveys as described in Section 4.2.1.2. were completed at 10 locations (Figure 4.3).



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Data source: - © Land and Property Information 2015, OEH 2017

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

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New Intercity Fleet Maintenance Facility Project
Figure 4.3
Mahony's Toadlet survey effort in the Project locality

4.2.2 Documenting survey effort

A total effort of 38 survey days targeting Mahony's Toadlet and Wallum Froglet, encompassing a variety of survey methodologies and climatic conditions, were undertaken to inform this SIS (Table 4.2). The survey effort significantly exceeded the suggested minimum industry standard survey for these species of 2 days/nights. Surveys were conducted in accordance with the CERs and in consideration of survey guidelines detailed in Section 4.1. In addition, the majority of surveys in the study area were completed during optimal conditions when amphibian activity was very high and coincided with a known breeding period of Mahony's Toadlet (March). A summary of the Mahony's Toadlet and Wallum Froglet survey effort is provided in Table 4.2.

Table 4.2 Summary of targeted fauna survey effort

	SURVEY TYPE	SURVEY EFFORT	DATES SURVEYED	HABITAT SEARCHED	SUGGESTED MINIMUM SURVEY EFFORT
Study area					
Frog surveys for BAR and SIS (WSP | Parsons Brinckerhoff, 2016b) (WSP | Parsons Brinckerhoff, 2016c)	Spotlight surveys Call playback Herpetofauna active searches	14 person hours 2 hours 3 person hours	17, 21–23 March 2016 17, 21–23 March 2016 17, 21–24 March 2016	Study area	Not applicable
Likelihood of occurrence of threatened frog species for SIS (Biosphere Environmental Consultants Pty Ltd, 2016a)	Call playback Spotlighting Auditory surveys Habitat assessment and mapping	14 person hours	12–13 May 2016	Study area	Not applicable
Targeted Mahony's Toadlet (and Wallum Froglet) surveys	Auditory surveys (including call playback) and nocturnal/diurnal search (including spotlighting)	6 person hours 6 person hours 6 person hours 12 person hours 3 person hours 15 hours 15 hours 8 hours 3 hours	23 November 2016 11–12 December 2016 17 December 2016 24–25 January 2017 27 January 2017 6–9 March 2017 14–16 March 2017 29–30 March 2017 25 April 2017	Mahony's Toadlet habitat area	Systematic day habitat search: → One hour per stratification unit Night habitat search (of damp and watery sites): → 30 minutes on two separate nights per stratification unit Nocturnal call playback: → At least one playback on each of two separate nights

	SURVEY TYPE	SURVEY EFFORT	DATES SURVEYED	HABITAT SEARCHED	SUGGESTED MINIMUM SURVEY EFFORT
	Habitat mapping (Biosphere Environmental Consultants Pty Ltd, 2016b) Habitat mapping (WSP | Parsons Brinckerhoff)	5 hours 7.5 hours	12 December 2016 March 2017		Not applicable
	Geotechnical assessment of sand extent	47 hand auger sample locations	8–9 February 2017		Not applicable
	Pitfall traps	112 trap nights	6–10 March 2017 14–18 March 2017		Method predominantly used for surveying reptiles (but useful for many species, including frogs): → 24 trap nights, preferably using six traps for four consecutive nights (per stratification unit up to 100 hectares)
	Song meter	2 x Song Meters, set for 15 full days of audio recording	2–31 March 2017		Not applicable

	SURVEY TYPE	SURVEY EFFORT	DATES SURVEYED	HABITAT SEARCHED	SUGGESTED MINIMUM SURVEY EFFORT
Opportunistic sightings		52 days	28–30 March 2017 14–17 March 2017 6–10 March 2017 1–2 March 2017 27 January 2017 24–25 January 2017 17 December 2016 11–12 December 2016 23 November 2016 19 August 2016 20 May 2016 12–13 May 2016 29 April 2016 14, 17, 21–24 March 2016 22, 23, 26 and 29 February 2016 7–17 December 2015 10, 16 and 17 September 2015	Study area	Not applicable
Local area surveys					
Local area surveys	Habitat assessment				Not applicable
	Auditory surveys (spotlighting/opportunistic survey)	8 hours 12 hours 12 hours	24–25 February 2017 29–30 March 2017 1–2 March 2017	Potentially suitable habitat identified in the locality (five kilometre radius)	Not applicable

Note: Suggested minimum survey effort as defined in *Threatened Species Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, 2004) and *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians* (Department of Environment and Climate Change, 2009).

4.3 Survey results

This section provides the results of Mahony's Toadlet and Wallum Froglet survey completed in the study area and locality.

For detailed information regarding plant community types, associated fauna habitat and description of general ecological surveys in the study area please refer to the previous SIS (WSP | Parsons Brinckerhoff, 2016c).

4.3.1 Subject species survey results

4.3.1.1 Mahony's Toadlet

STUDY AREA

In May 2016, one individual Mahony's Toadlet was located by call in the northern section of the study area. The species was found in a buried situation characterised by silty-sand substrates. The location was adjacent to a stand of *Eucalyptus pilularis* (Blackbutt) and the ground-layer was dominated by *Imperata cylindrical* var. *major* (Blady Grass). The location and habitat present at the Mahony's Toadlet record is shown in Figure 4.4, Photo 4.1 and Photo 4.2.

The dominant presence of Blady Grass, a dry forest species, in the understorey suggests the recorded location is not subject to medium or long-term inundation. Due to the buried situation and relatively dry nature of the record location, it is considered most likely that this is a site used by the frog for aestivation (dormancy) and if breeding occurs locally it would occur elsewhere in wet habitats.

A combination of targeted survey methodologies completed in the study area between November 2016 and March 2017, inclusive of nocturnal searches, auditory surveys, pit trapping and bioacoustics recording, did not observe additional records of this species. Consequently, determination of Mahony's Toadlet distribution is limited to the one individual record.

Photo 4.1 Habitat associated with Mahony's Toadlet record in the study area

Photo 4.2 Dark grey silt-sand substrate associated with Mahony's Toadlet record

Importance of quaternary sediment mapping for Mahony's Toadlet habitat

Due to Mahony's Toadlet almost exclusive preference for white/leached sandy substrate (Clulow *et al.*, 2016), a review of *Coastal Quaternary Geology Mapping for NSW* (Troedson *et al*., 2015) and a separate geotechnical investigation (WSP | Parsons Brinckerhoff, 2017) were completed to identify variations in substrate type to aid the process of determining where habitats preferred by Mahony's Toadlet might occur in the study area.

The study area is located on an alluvial plain in a broad open valley with sand deposited in the late quaternary having largely moved across the study area predominately by the prevailing action of surface water flow. A review of *Coastal Quaternary Geology Mapping for NSW* (Troedson *et al*., 2015) identified that the study area occurs as a terrace on an alluvial plain deposition, with a lithology (sediment type) variously consisting of silt, clay, fluvial sand and gravel (in order of decreasing importance and frequency).

The extent of surficial sand deposits within the study area was assessed from 47 hand auger locations, which predominately focused on the northern portion of the study area from which Mahony's Toadlet was recorded (WSP | Parsons Brinckerhoff, 2017). This assessment identified that the sediments were confined to two broad groups; those of a sandy nature and clay dominated forms. Results from the geotechnical investigation in the study area, where Mahony's Toadlet was recorded, found it to be dominated almost exclusively by sandy substrate with little variation (Figure 4.1). Substrates were very similar being variations between silty-sand and sandy-silt; with the sand being fine grained (WSP | Parsons Brinckerhoff, 2017). However, deposits of clean sand were not encountered at sample locations.

The presence of white/leached sands are largely the result of reworked Quaternary marine sediments (mostly of Pleistocene age) that are generally associated with soils of the Tuggerah soil landscape (Murphy 1993). Within the study area, sandy sediments are considered more closely associated with alluvial soils of the Wyong soil landscape type that forms part of deltaic floodplain and alluvial flats that often exhibit splays or lenses of sand around the foreshore of lakes (Murphy 1993).

From cursory comparisons between the Wyrrabalong National Park site (described in Clulow *et al* (2016)) and the study area, the dominance of sand content in substrates across the northern section of the study area are considered lower and more generally associated with the Wyong soil landscape, with substrates at Wyrrabalong National Park having a greater sand content and mapped as forming part of the Tuggerah soil landscape (Murphy 1993). It is not known whether the lower sand content of the study area substrates render onsite habitats less suitable for Mahony's Toadlet, but given that the Clulow *et al.* (2016) report that this species is mostly confined to habitats defined by white/leached sands, it may be inferred that onsite habitats are less preferred by this species rather than being of similar or greater preferability to the habitats described at the type localities.

As there was little variation in sandy substrate type within the north of the study area, it was concluded that the Mahony's Toadlet could potentially utilise a wide range of habitat in the northern portion the study area.

Vegetation communities described in the study area

The desktop analysis of existing vegetation mapping and field validation surveys identified that the vegetation within the subject site comprised four vegetation communities, the distribution of which are related to geological, topographical and geomorphological characteristics as well as previous and current land uses. The vegetation communities are mapped and described in detail in the previous SIS (WSP | Parsons Brinckerhoff, 2016c). For context regarding Mahony's Toadlet (and Wallum Froglet) habitat, the vegetation communities of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest and Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest are described below.

Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest

This was the dominant vegetation community within the subject site occurring predominantly in the northern portion of the subject site. The vegetation type was in Moderate to Good condition (High and Medium Quality) and in Low condition (dependent upon its location within the landscape and subsequently the level of disturbance the community is or has been subjected to) (Table 4.3). Some areas of this community, particularly along the railway line, roads and access tracks experienced sparse to dense weed infestations.

Table 4.3 Summary characteristics of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest within the subject site

STRATA	HEIGHT RANGE (m)	FOLIAGE COVER (%)	DOMINANT SPECIES
Canopy	5–20	0–40	*Eucalyptus robusta, Syncarpia glomulifera, Livistona australis, Glochidion ferdinandi* and the occasional *Eucalyptus pilularis* and *Archontophoenix cunninghamiana* in transitional areas.
Sub-canopy	3–8	0–30	*Acacia longifolia, Glochidion ferdinandi, Melaleuca biconvexa, Elaeocarpus reticulatus, Melaleuca linariifolia* and *Melaleuca ericifolia.* In some locations the sub-canopy was dominated by exotic species i.e. *Ligustrum sinense*.*
Shrub stratum	0.4–4	0–90	*Acacia longifolia, Persoonia linearis, Leptospermum polygalifolium, Elaeocarpus reticulatus, Melaleuca linariifolia* and *Melaleuca ericifolia.* In some locations the shrub stratum was dominated by exotic species i.e. *Lantana camara** as well as *Ligustrum sinense** and *Lantana camara** juveniles.
Groundcover	0.1–2	0–100	*Gahnia* spp., *Baloskion tetraphyllum, Baumea acuta, Pteridium esculentum, Gleichenia dicarpa, Calochlaena dubia, Cyperus* spp. and *Entolasia stricta.* In some locations the groundcover did experience high levels of weeds species including *Ehrharta erecta*, Ligustrum sinense** saplings and *Rubus fruticosus*.*
NSW PCT/BVT	PCT1723/HU937: Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast		
Conservational significance	High: This community forms part of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions threatened ecological community listed as Endangered under the TSC Act. This community provides habitat for a variety of threatened flora and fauna species including Melaleuca biconvexa which was recorded within this vegetation type.		
Condition	Moderate to Good (High Quality): Areas of good quality *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest predominantly within areas which retained a canopy and contained a high abundance and diversity of native species. These areas generally showed resilience to weed infestations as a result of an intact groundcover, shrub and canopy layers. These areas generally occurred in areas of lower disturbance and where vegetation was more intact i.e. few clearings, access tracks etc. Moderate to Good (Medium Quality): Areas of medium quality *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest predominantly occurred along the peripheries of the community or in areas where the canopy was absent. Within these areas the community lacked one or more strata and experienced low to moderate densities of exotic species, native species diversity did remain high. Low: Areas of low condition *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest occurred along the access track to the north of the subject site. Within this area the vegetation lacked one or more strata layers and was generally dominated by exotic groundcover species (native species <50 per cent).		
Extent and distribution within the site	This community covered the majority of the northern portion of the subject site covering an extant of 22.6 hectares. The community was situated on sandy alluvial soils with poor drainage with large stands of water observed in some locations. This community integrated with the Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest and Jackwood – Lilly Pilly – Sassafras Rainforest community preferring soils with lower drainage potential and at slightly lowered elevations.		

Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest

This community occurred as patches within the subject site; integrating with the *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation type. This community generally occurred on alluvial sandy soils which had higher drainage potential and were at slightly higher elevations that the surrounding vegetation. This community occurred in good condition with high native species diversity (Table 4.4).

Table 4.4 Summary characteristics of Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest within the subject site

STRATA	HEIGHT RANGE (m)	FOLIAGE COVER (%)	DOMINANT SPECIES
Canopy	10–26	0–40	*Eucalyptus pilularis, Syncarpia glomulifera* and *Corymbia gummifera* within the occasional *Eucalyptus robusta* and *Angophora floribunda.*
Sub-canopy	0–10	0–60	Immature *Syncarpia glomulifera* and *Melaleuca linariifolia.*
Shrub stratum	0.4–2.2	0–50	*Ozothamnus diosmifolius, Leptospermum polygalifolium, Leucopogon lanceolatus, Zieria smithii, Epacris pulchella, Cassinia uncata, Leucopogon margarodes, Acacia longissimi, Livistona australis* and *Polyscias sambucifolia.*
Groundcover	0.1–1.8	0–60	*Baloskion tetraphyllum, Entolasia stricta, Pteridium esculentum, Hibbertia dentata, Pomax umbellata, Gahnia* spp., *Xanthosia pilosa, Dianella caerulea, Microlaena stipoides* and the occasional exotic species such as *Hypochaeris radicata**.
NSW PCT/BVT	PCT1568/HU782: Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the central coast.		
Conservational significance	Moderate: This community does not form part of any listed threatened ecological community under the TSC Act or the EPBC Act. This community does however provide habitat for a variety of threatened flora and fauna species. The community also creates a narrow wildlife corridors in some areas of the subject site linking vegetation to remnants of vegetation within the locality.		
Condition	Moderate to Good (High Quality): Areas of good quality Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest retained an intact canopy and contained a high abundance and diversity of native species. These areas generally showed resilience to weed infestations as a result of an intact groundcover, shrub and canopy layers. Some areas of this community has been exposed to understorey clearing however retains a high diversity of native groundcover species which had good regeneration potential.		
Extent and distribution within the site	This community occurred as scattered patches within the north western portion of the subject site covering an extant of 3.3 hectares. This community integrated with *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest preferring slightly perched sandier alluvial soils which had higher drainage potential.		

Description of Mahony's Toadlet micro-habitat in the study area

Current observations indicate that this species is a habitat specialist, inhabiting coastal ephemeral and semi-permanent swamps and swales, in heath or wallum habitats almost exclusively on a substrate of white/ leached sand (Clulow *et al*., 2016) (NSW Scientific Committee, 2017).

Clulow *et al.* (2016) also suggests breeding would likely be similar to other *Uperoleia* species. That is, reliant on the presence of ephemeral and semi-permanent water. Therefore onsite wetland habitats should determine the distribution of potential breeding habitat for Mahony's Toadlet within the study area. The densely vegetated nature and relatively flat topography of the study area made it difficult to determine the exact distribution of semi-permanent and ephemeral water. However micro-elevational variations affecting the retention of water in the study area are expressed by different tolerances of understorey vegetation assemblages to inundation. Therefore the distribution of water during wet periods was mapped from a

combination of standing water noted during wet period surveys, vegetation surveys of understorey assemblages and the mapping of vegetation types from aerial photos (Figure 4.4).

The whole of the northern portion of the study area is characterised by a floodplain-type context, with underlying substrates subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less prone to waterlogging. Subterranean water tables are generally high; particularly during high rainfall events. Nevertheless, shallow-rooted species preferring dryer substrates, such as *Imperata cylindrical* var. *major* (Blady Grass) and *Pteridium esculentum* (Bracken Fern) are able to colonise areas of slightly higher elevation and remain perched above high water tables (Table 4.5, Photo 4.6). Such areas, including the record location, are considered to provide areas where the frog may persist above permanent inundation during aestivation periods with moisture still afforded from high water tables below.

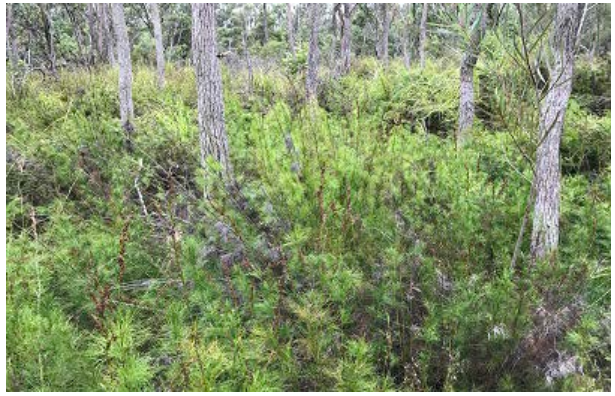
The lowest areas within the study area appear to be less than permanent in their retention of water, but still retain water for long periods between rainfall events. The semi-permanent nature of water retention is confirmed by the presence of true wetland occurring plants such as *Baumea teretifolia, Liparophyllum exaltatum* (Yellow Marsh-flower), and *Hemarthria uncinata* (Mat Grass) (Table 4.5, Photo 4.3). Such habitats may provide breeding opportunities for Mahony's Toadlet when local rainfall is relatively low.

In between the perched areas of dryer vegetation and the lowest semi-permanent areas of wetland habitat a range of water tolerant plants indicate those areas where water is retained on a more ephemeral basis (Table 4.5). *Baloskion tetraphyllum subsp. meiostachyum* (Tassel Cord Rush) (Photo 4.4) occurs on the lower areas above the semi-permanent waterbodies and *Gahnia clarkei* (Tall Saw-sedge) (Photo 4.5) higher again. These areas represent potential habitats where moisture is retained ephemerally after high rainfall events keeping water-tables relatively high.

In some areas *Baloskion tetraphyllum subsp. meiostachyum*, *Gahnia clarkei* and *Pteridium esculentum* all occur together where water-table levels are likely restricted to variances where the water tolerances of each are not exceeded or insufficient. These habitats, which occur widely across the study area may provide breeding opportunities for Mahony's Toadlet during periods of highest rainfall and represent the lowest extent of potential aestivation habitat.

Table 4.5 Understorey floristic descriptions for Mahony's Toadlet habitat in the study area

HABITAT	UNDERSTOREY FLORISTIC DESCRIPTION	EXAMPLES OF UNDERSTOREY VEGETATION REGARDING RETENTION OF WATER
Semi-permanent water habitat	Semi-permanent water habitat appear to be less than permanent in their retention of water, but appear to hold water for long periods between rainfall events. Semi-permanent water habitat was dominated by the sedge species *Baumea teretifolia* with a sub-dominance of *Baumea rubiginosa*. These sedges were observed to be frequently inter woven with the swamp grass species *Hemarthria uncinata* (Matgrass). Other species regularly observed within this assemblage were *Liparophyllum exaltatum* (Yellow Marsh-flower), *Goodenia paniculata* (Branched Goodenia), *Baloskion pallens*, *Melaleuca thymifolia* Thyme Honey-myrtle), *Gahnia clarkei* (Tall Saw-sedge), *Sacciolepis indica* (Indian Cupscale Grass), *Baloskion tetraphyllum subsp. meiostachyum* (Tassel Cord Rush), *Eurychorda complanata*, *Juncus continuus*, and *Juncus usitatus* (Common Rush). The exotic grass species *Paspalum urvillei** (Vasey Grass), *Axonopus fissifolius** (Narrow-leaved Carpet Grass) and *Andropogon virginicus** (Whiskey Grass) were also commonly observed within this assemblage along with the exotic rush species *Juncus cognatus**.	 **Photo 4.3 An example of sedge dominated understorey, indicative of semi-permanent water habitat within the study area**

HABITAT	UNDERSTOREY FLORISTIC DESCRIPTION	EXAMPLES OF UNDERSTOREY VEGETATION REGARDING RETENTION OF WATER
Ephemeral water habitat	Ephemeral water habitat extends over much of the Mahony's Toadlet habitat area and is dominated by the rush species *Baloskion tetraphyllum subsp. meiostachyum* (Tassel Cord Rush) with sub-dominance occurrences of *Gahnia clarkei* (Tall Saw-sedge) and fern species *Pteridium esculentum* (Bracken) and *Hypolepis muelleri*. Other commonly observed understorey species include *Entolasia stricta* (Wiry Grass), *Selaginella uliginosa* (Swamp Selaginella), *Parsonsia straminea* (Common Silkpod), *Cassytha glabella f. glabella* (Slender Devil's Twine), *Gleichenia dicarpa* (Pouched Coral-fern), *Baloskion pallens*, *Empodisma minus* (Spreading rope-rush), *Imperata cylindrica var. major* (Blady Grass), *Hemarthria uncinata* (Matgrass), *Eurychorda complanata*, *Juncus continuus*, *Schoenus brevifolius*, *Cyperus polystachyos*, *Gonocarpus micranthus* and *Sacciolepis indica* (Indian Cupscale Grass).	 **Photo 4.4 An example of *Baloskion tetraphyllum subsp. meiostachyum* (Tassle Cord Rush) dominant areas, indicative where water is retained on an ephemeral basis**  **Photo 4.5 An example of *Gahnia clarkei* (Tall Saw-sedge) with rush understorey, indicative of where water is retained on an ephemeral basis**

HABITAT	UNDERSTOREY FLORISTIC DESCRIPTION	EXAMPLES OF UNDERSTOREY VEGETATION REGARDING RETENTION OF WATER
Drier perched habitat	Drier perched habitat was varied in understorey floristics but includes areas exclusively dominated by *Pteridium esculentum* (Bracken). In areas subject to disturbance (electrical easements) and historical clearing and soil disturbance, assemblages comprise mono-specific to mixed native and exotic grass and herb assemblages, including commonly observed native species such as *Imperata cylindrica var. major* (Blady Grass). Dominant exotic species included *Paspalum quadrifarium** (Tussock Paspalum), *Paspalum urvillei** (Vasey Grass), *Axonopus fissifolius** (Narrow-leaved Carpet Grass) and *Andropogon virginicus** (Whiskey Grass), *Paspalum dilatatum** (Paspalum), *Setaria gracilis** (Slender Pigeon Grass) along with a large number of exotic weed species.	 **Photo 4.6 An example of dense closed understorey dominated by *Pteridium esculentum* (Bracken Fern), indicative of drier perched habitat less prone to waterlogging**

It is considered that breeding habitat would constitute the most important habitat for this species. If breeding habitat was not to occur in the study area, then a population of Mahony's Toadlet is not likely to be viable in the study area in the long term.

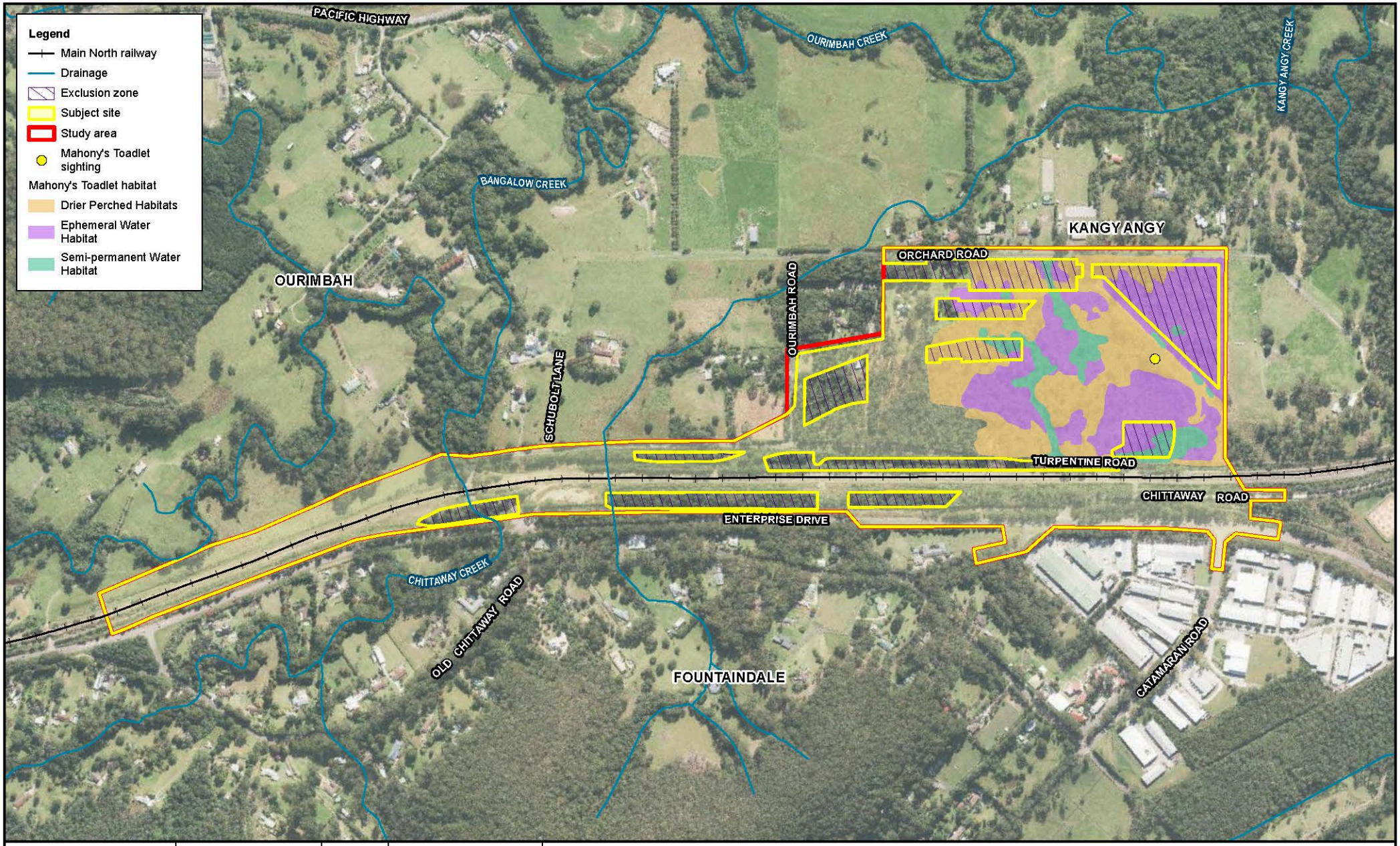
Water bodies at known breeding locations ranged from ca. 70 metres x 20 metres up to 300 metres x 500 metres in size (Clulow *et al*., 2016) and almost exclusively occurred on a substrate of leached white sand. As only one record of Mahony's Toadlet is currently known from the study area, potential breeding habitat is only inferred from the mapping of semi-permanent to ephemeral water habitats in the study area, which occur on a grey silty-sand to sandy-silt substrate. In total, approximately 11.1 hectares of potential breeding habitat has been mapped as occurring in the study area. However, in consideration of freshwater inputs across different climatic contexts, different areas of the study area are likely to be used at different times. The areas of lowest elevation (semi-permanent water habitat) are likely to constitute the most important breeding habitat for Mahony's Toadlet during dryer cycles, with approximately 2.3 hectares of semi-permanent water habitat mapped in the study area. During wetter periods an additional 8.8 hectares of potential breeding habitat may occur within areas of ephemeral water habitat (Figure 4.4).

These communities and their associated habitat type are detailed in Table 4.6.

Table 4.6 Mahony's Toadlet habitat in the study area

FAUNA HABITAT TYPE[1]	EXTENT IN STUDY AREA (ha)	EXTENT IN SUBJECT SITE (ha)
Semi-permanent water habitat	2.3	1.7
Ephemeral water habitat	8.8	5.6
Drier perched habitat	8.6	6.5
Total	**19.7**	**13.8**

(1) Fauna habitat type determined with relevance to Mahony's Toadlet likely use of habitat in the study area.



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Date: 11/05/2017	Approved by: -

Data source: - © Land and Property Information 2015

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
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New Intercity Fleet Maintenance Facility Project
Figure 4.4
Mahony's Toadlet habitat in the study area

LOCAL POPULATION SEARCH

To understand the significance of the Mahony's Toadlet record in the study area, consideration of a local population and the potential extent of habitat in the locality (five kilometre radius) was required. On the Central Coast, the two known locations for Mahony's Toadlet, being the study area and the Wyrrabalong National Park, are isolated from one another.

In a landscape context the study area falls within the hinterland strip between coastal estuarine lakes and adjacent foothills. This landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood plains and depressions in lower topographic areas, which provide landscape conditions suited to supporting floodplain Swamp Sclerophyll and Freshwater Wetland vegetation community types.

Such locations are relatively sparse in the regional landscape, due in part, to the small area of landscape context they occupy and the overlaying of urbanised developments, which are associated with the same near coastal locations. The development pressures that characterise coastal landscapes on the Central Coast and elsewhere in the bioregion, has resulted in the conservation listing of Swamp Sclerophyll Forests and Coastal Freshwater Wetlands as threatened, as are some species of animal that are dependent on the supported habitat (e.g. Wallum Froglet).

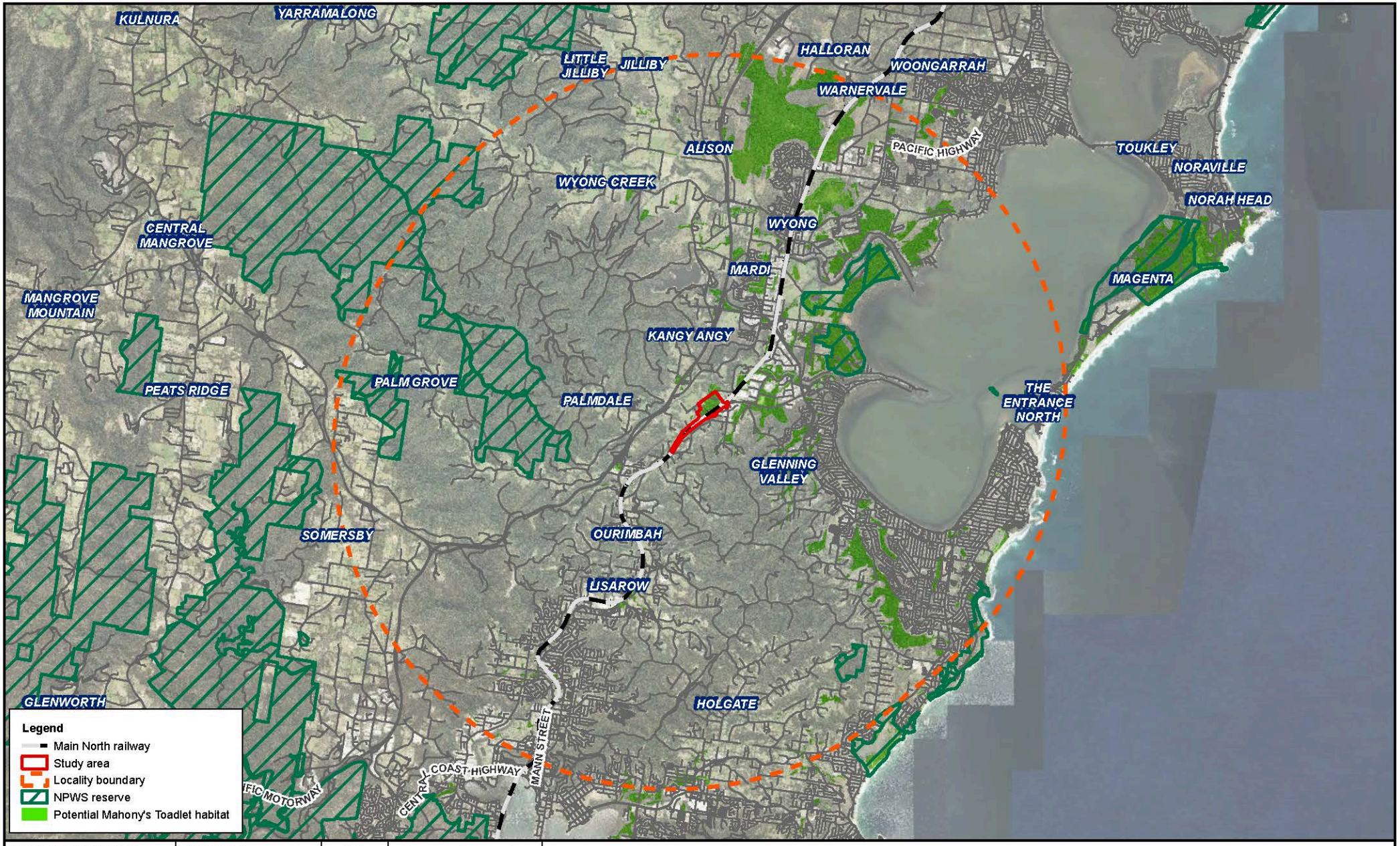
It follows that existing areas of potential Mahony's Toadlet habitat on the southern and western shores of Tuggerah Lake are somewhat small land parcels fragmented by an urbanised environment. One exception is the National Park Estate positioned on the western shore of Tuggerah Lake.

The desk-based assessment (see Section 4.2.1.3) sought to characterise and map potential Mahony's Toadlet habitat based firstly on Quaternary sediments and secondly potentially suitable vegetation associations. As substrate is a key consideration in the distribution of Mahony's Toadlet, Quaternary sediments in the greater Wyong area was used to refine areas of potential habitat (Troedson *et al*., 2015). Based on the refined quaternary sediment mapping and the addition of vegetation communities for which Mahony's Toadlet may be associated (see Section 4.2.1.3 and Figure 4.5), approximately 2,142 hectares of potential Mahony's Toadlet habitat has been identified in the locality (Figure 4.5). Of this, approximately 1,212.46 hectares occurs in reserves, inclusive of 247 hectares occurring in National Park Estate.

In addition to the desktop assessment, limited observations from a number of publicly accessible remnant patches of vegetation within the locality were surveyed for their potential to support Mahony's Toadlet habitat (Figure 4.3), including:

- Remnant vegetation at Burragah Road, Chittaway Bay
- Remnant vegetation at the western end of Platypus Road Chittaway Bay
- Remnant vegetation north-east of the corner of Thomas Walker Drive and Platypus Road Chittaway Bay
- Remnant vegetation bordering Tumbi Umbi Creek, cnr of Tumbi Creek Road and Gregory Street, Berkeley Vale
- Remnant vegetation northeast of the corner of Adelaide Street and Wyong Road, Killarney Vale
- Wetland habitat between the Avenue and Tumbi Road, Tumbi Umbi
- Picnic Point Reserve, The Entrance
- Wetland habitats to the east of Wyong Golf Club
- Remnant vegetation at the southern end of Myrtle Brush Park Berkeley Vale
- Remnant vegetation at the western end of Marlborough Place on Berkeley Creek, Berkeley Vale.

Auditory surveys and nocturnal searches completed at potential habitat locations in the locality (Figure 4.3) did not locate Mahony's Toadlet. Therefore understanding of the presence and extent of local populations of the species within the locality is restricted to mapping of the potential habitat. Based on the mapping of potential habitat for this species within the locality, the Mahony's Toadlet in the study area may be an indication of a once more widespread population in suitable sand substrate along the southern and western boundaries of Tuggerah Lake.



Map: 2202522A_GIS_F105_A3	Author: suansrir
Date: 11/05/2017	Approved by: -

Data source: - © Land and Property Information 2015

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
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New Intercity Fleet Maintenance Facility Project
Figure 4.5
Potential Mahony's Toadlet habitat
in the Project locality

4.3.1.2 Wallum Froglet

Survey effort for Wallum Froglet over a two year period (2015 and 2016), including targeted searches over different seasonal contexts that did not record Wallum Froglet in the study area; despite the presence of potential suitable habitat. In March 2017, following significant local rainfall (>185 millimetres in seven days), four individual Wallum Froglets were detected by call in two discrete locations of the study area (Figure 4.6). These locations are consistent with shallow depressions of semi-permanent to ephemeral water habitat (Photo 4.7, Photo 4.8) within *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community.

The local population of the Wallum Froglet appears to form a stronghold within the Porters Creek Wetland area and surrounds with smaller discrete sub-populations recorded from Berkley Creek Wetland and Tumbi Creek Wetland (Office of Environment & Heritage, 2017a). The study area is considered to form part of the southern Tuggerah Lake sub-population that appears to be associated to the broader Central Coast meta-population extending from approximately Redhead in the north to the Tuggerah Lake floodplain in the south.

Although the Wallum Froglet is a cryptic species, they have a distinct call and males are known to call throughout the year; especially after heavy rain (Department of Environment and Climate Change, 2009). Given the level of targeted survey effort within the study area, encompassing a range of seasonal contexts, over multiple years and through suitable conditions for detection, the very small numbers of Wallum Froglet recorded within the study suggest the habitat they are occupying are marginal. The study areas marginal habitat and sub-population is considered significantly less important to the large areas of habitat occurring within Porters Creek Wetland.

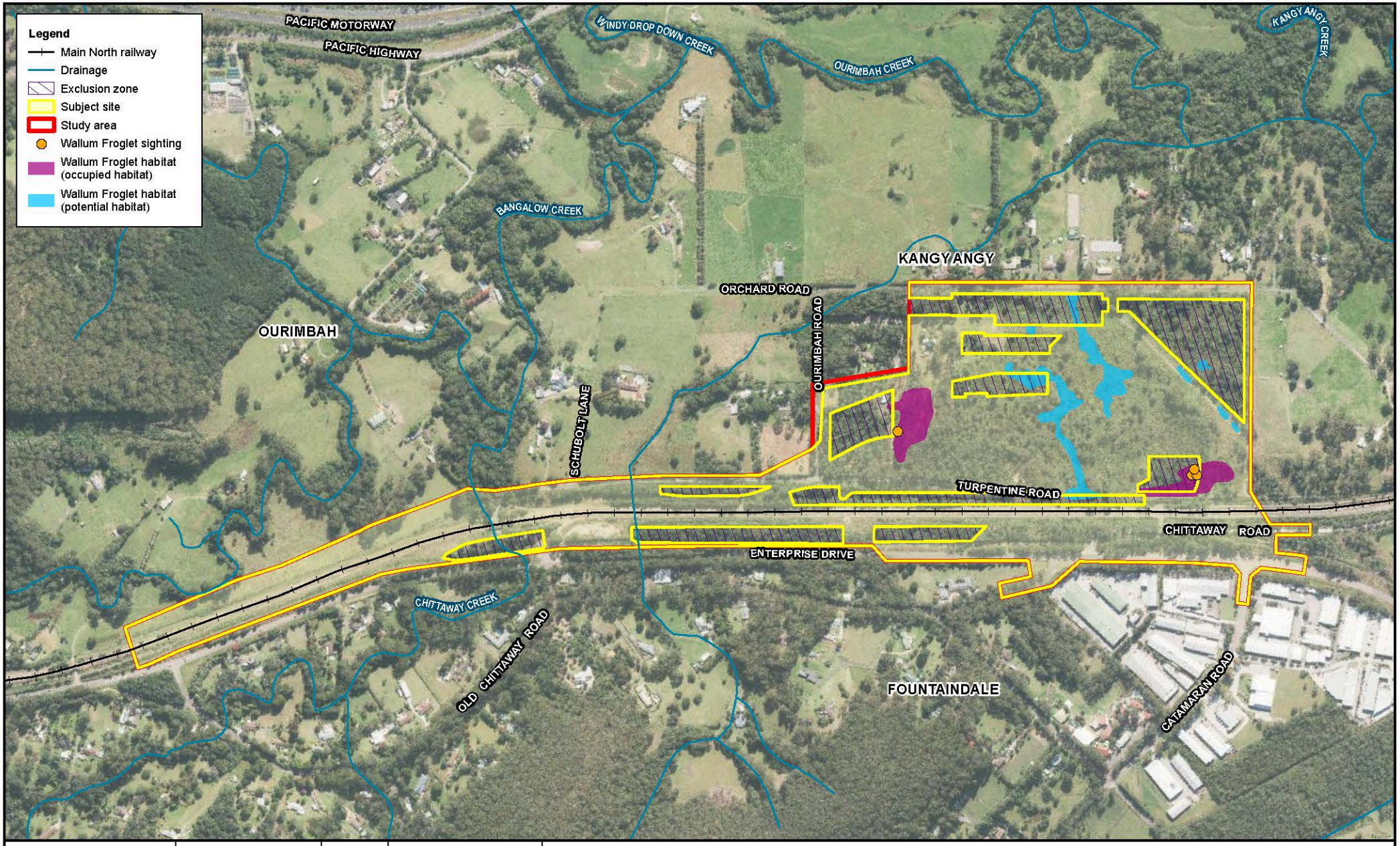
WALLUM FROGLET HABITAT IN THE STUDY AREA

Wallum Froglets are usually associated with paperbark wetlands and sedgelands on acid-rich water within coastal sandplains (Office of Environment & Heritage, 2017b, Biosphere Environmental Consultants Pty Ltd, 2016b). Within the study area, the whole of the northern portion of the study area is characterised by a floodplain-type context, with underlying substrates subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less prone to waterlogging. In this context, Wallum Froglet is considered to occupy semi-permanent to ephemeral shallow depressions (Figure 4.6, Photo 4.7, Photo 4.8) within a broader swamp forest type habitat (*Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community).

The species is known to occupy generally acidic soil water habitats (<6 pH) with two discrete areas of occupancy identified within the study area, totalling approximately 1.4 hectares. In addition, a further 1.6 hectares of potential habitat is considered to occur in association with semi-permanent water. These habitats may facilitate breeding opportunities for Wallum Froglet, but would be dependent on freshwater input during favourable seasonal conditions. Foraging and shelter habitat is likely to occur at the margins of these shallow depressions. In total, approximately 3.0 hectares of Wallum Froglet habitat has been mapped in the study area (Figure 4.6).

Photo 4.7 An example of sedge-dominated Wallum Froglet habitat in the study area

Photo 4.8 An example of sedge-dominated Wallum Froglet habitat in the study area



Map: 2202522A_GIS_F109_A3	Author: suansrir
Date: 11/05/2017	Approved by: -

Data source: - © Land and Property Information 2015

0 100 200 m

1:9,500

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A4

Note: Design is indicative only.
Subject to detailed design

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New Intercity Fleet Maintenance Facility Project
Figure 4.6
Wallum Froglet habitat in the study area

4.3.2 General species survey results

Rainfall was below average over the 2016 and part of the 2017 summer, with significant falls likely to promote activity in some amphibian species (particularly breeding cycle responses) not experienced until late January-early February 2017 and March 2017.

Although daytime temperatures were warm, local storm activity largely avoided the study area in late 2016, with a total of 134 millimetres of rain recorded in November and December 2016 (Bureau of Meteorology, 2016). Frog calling activity during this period (November to late January) was subdued and largely consisted of common species of frog, including Common Eastern Froglet (*Crinia signifera*), Brown-striped Frog (*Limnodynastes peronii*) and Eastern Dwarf Tree Frog (*Litoria fallax*).

Optimal survey conditions for amphibians were experienced from late January – March 2017 with warm evening temperatures and significant rainfall conducive for calling activity (Department of the Environment Water Heritage and the Arts, 2010). Approximately 339 millimetres of rain was experienced in the locality in March 2017, with 187 millimetres falling in a seven day period (Bureau of Meteorology, 2017). These rain events transformed the site with large areas of water along access tracks and lower areas of the northern section of the study area.

The majority of surveys in the study area were completed during this period, when amphibian activity was very high. Notably, Dainty Green Tree Frog and Bleating Tree Frog were calling in high numbers. While other more common species were also calling in high numbers through the same period, the large numbers of these two species calling is a strong indication that very good amphibian survey conditions prevailed during these survey evenings. It was during these conditions that four individual Wallum Froglets were recorded from discrete patches of the study area (Figure 4.6). Furthermore, on at least one evening high numbers of *Uperoleia* spp. were encountered and checked (40 plus individuals) for identification, however none exhibited the characteristic underside marbling of Mahony's Toadlet.

A species list for all frogs recorded from the study area is provided in the Table 4.7. To date, only one individual Mahony's Toadlet has been recorded in the study area. Two species of skink are included in Table 4.7 due to their capture during targeted pit trapping.

Table 4.7 Amphibian species recorded in the study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	TSC ACT[2]	OBSERVATION TYPE[3]
Amphibians				
Crinia signifera	Common Eastern Froglet	–	–	T
Crinia tinnula	Wallum Froglet	–	V	W
Limnodynastes peronii	Brown-striped Frog	–	–	T
Litoria dentata	Bleating Tree Frog	–	–	W
Litoria fallax	Eastern Dwarf Tree Frog	–	–	O
Litoria gracilenta	Dainty Green Tree Frog	–	–	T
Litoria revelata	Whirring Tree Frog	–	–	W
Litoria tyleri	Southern Laughing Tree Frog	–	–	W
Uperoleia fusca	Dusky Gungan	–	–	T
Uperoleia mahonyi	Mahony's Toadlet	–	E	T
Reptiles				
Eulamprus quoyii	Eastern Water Skink	–	–	T
Lampropholis delicata	Garden Skink	–	–	T

(1) Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
(2) Listed as Vulnerable (V) or Endangered (E) under the NSW *Threatened Species Conservation Act 1995*.
(3) Observation type: W = heard, O = observed, T= trapped.

4.3.3 Field survey limitations

Even when field surveys are undertaken, no sampling technique can totally eliminate the possibility that a species is present on a site. The conclusions in this report are based upon data acquired for the site and the environmental field surveys are, therefore, merely indicative of the environmental conditions of the site at the time field surveys are undertaken, including the presence or absence of species. It should be recognised that site conditions, including the presence of threatened species, can change with time.

Access to some locations were restricted as a result of private ownership or as a result of dense undergrowth commonly associated with *Melaleuca* swamp forest type habitats in the locality. Furthermore, rainfall through much of NSW was below average over the 2016 and early 2017 summer, with significant falls likely to promote activity in some amphibian species (particularly breeding cycle responses) not experienced until late January, early February and March 2017. The majority of surveys in the study area were completed during this period under ideal conditions, when amphibian activity was very high. Surveys coincided with warm evening temperatures and significant rainfall conducive for calling activity. Approximately 339 millimetres of rain was experienced in the locality in March 2017, with 187 millimetres falling in a seven day period (Bureau of Meteorology, 2017).

5 ASSESSMENT OF IMPACTS ON THREATENED SPECIES

5.1 Potential impacts associated with the Project

Potential direct and indirect impacts to Mahony's Toadlet and Wallum Froglet habitat are likely to result from the construction and operational phases of the Project. The key impacts associated with the Project of particular relevance to Mahony's Toadlet and Wallum Froglet include:

- Clearing of approximately 13.8 hectares of Mahony's Toadlet habitat, including:
  - 1.7 hectares of semi-permanent water habitat
  - 5.6 hectares of ephemeral water habitat
  - 6.5 hectares of drier perched habitat.
- Clearing of 2.4 hectares of Wallum Froglet habitat, including:
  - 1.1 hectares of occupied habitat
  - 1.3 hectares of potential habitat.

A summary of impacts likely to occur as a result of the Project area provided below in Table 5.1.

Table 5.1 Potential impacts associated with the Project

POTENTIAL IMPACT	PHASE OF THE PROJECT	
	CONSTRUCTION	OPERATION
Direct impacts		
Removal of native vegetation (including Swamp Sclerophyll Forest EEC)	Yes	
Removal of threatened plant species (*Melaleuca biconvexa*)	Yes	
Removal of threatened fauna species habitat	Yes	
Indirect impacts		
Alteration of natural hydrology regimes	Yes	Yes
Sediment, pollutant or nutrient runoff into adjacent vegetation	Yes	Yes
Wildlife connectivity and fragmentation (including edge effects)	Yes	Yes
Potential environmental impact of increased noise, light and vibration on wildlife	Yes	Yes
Increase in fauna injury and/or mortality	Yes	Yes
Weed invasion and feral animal incursion	Yes	Yes
Introduction and spread of pathogens and disease	Yes	Yes

5.2 Assessment of subject species likely to be affected

In accordance with the CERs, subject species likely to be affected was limited to Mahony's Toadlet for the purposes of this SIS. However, in the course of completing targeted field surveys for Mahony's Toadlet, and following significant rainfall, several individual Wallum Froglets were detected in the study area. As the Wallum Froglet was not considered an affected species in the previous SIS (June 2016) (WSP | Parsons Brinckerhoff, 2016c), it has been recognised and included in this SIS as an affected species.

5.2.1 Mahony's Toadlet (*Uperoleia mahonyi)*

5.2.1.1 Distribution

Mahony's Toadlet appears to have a highly restricted distribution, endemic to the mid-north coast of NSW, and to date has been found between Kangy Angy and Seal Rocks (Office of Environment and Heritage, 2017b). The study area is located in the southern extent of the species known distribution, which infers that the study area occurs at what is currently understood to be the southern extremity of the species known range.

5.2.1.2 Habitat

Current observations of Mahony's Toadlet indicate the species is a habitat specialist, inhabiting coastal ephemeral and semi-permanent swamps and swales, and occasionally man made dams, in heath or wallum habitats almost exclusively on a substrate of white/leached sand. It is thought to be totally confined to Quaternary sediments (Office of Environment and Heritage, 2017b, Clulow et al., 2016).

The species is commonly associated with acid paperbark swamps (NSW Scientific Committee, 2017, Office of Environment and Heritage, 2017b). The study area contains ephemeral ponds associated with paperbarks, which are likely to support viable foraging and potential breeding habitat for the species.

Vegetation communities in which Mahony's Toadlet has been recorded include wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland (NSW Scientific Committee, 2017, Office of Environment and Heritage, 2017b). Terrestrial vegetation associations include the tree species *Melaleuca quinquenervia*, *Eucalyptus robusta*, *Angophora costata*, *Acacia longifolia* and *Banksia* spp. (including *B. serrata* and *B. aemula*) (Clulow *et al.*, 2016).

5.2.1.3 Ecology

Aside from recent research undertaken by Clulow *et al*. (2016), very little is currently known about the ecology of Mahony's Toadlet.

This species is distinguished from all other *Uperoleia* species by a combination of ventral (or underside) pigment (the ventral surface is completely covered with black and white marbling), presence of maxillary (upper jaw) teeth, toes unwebbed, lack of colour patch below the knee and a "squelch" as a call (Clulow *et al*., 2016).

Mahony's Toadlet breeding occurs in March (autumn) and October-November (spring) (NSW Scientific Committee, 2017). Water bodies which contained calling males ranged from 70 metres x 20 metres up to 300 metres x 500 metres in size, with depths of 10–50 centimetres (Clulow *et al*., 2016). All water bodies occupied by Mahony's Toadlet were observed to occur on a substrate of leached and often white sand (Clulow *et al*., 2016).

Importantly, breeding habitat for females is taken to be dependent on standing water in which females attach their eggs to submerged vegetation or leaf debris (Clulow *et al*., 2016) as do other closely related *Uperoleia* spp.. Females have been recorded some 400 metres from water bodies, suggesting moderate dispersal distances and uses of multiple habitat types (Office of Environment and Heritage, 2017b).

The type locality (geographical location where the holotype specimen (single specimen designated in the original description) was originally found) for Mahony's Toadlet was an ephemeral coastal sandplain swale at Oyster Cove, NSW. Another example of Mahony's Toadlet habitat occurs in the Wyrrabalong National Park, Norah Head, NSW (Clulow *et al*., 2016).

5.2.1.4 Recovery plan

As Mahony's Toadlet is primarily associated with wallum habitats, it could be considered as an addition to the list of wallum dependant frog species (Clulow *et al*., 2016). Therefore, until more species specific information is available, the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent Frog Species (Meyer et al., 2006)* is considered the most relevant recovery plan for the species.

To date, the OEH has not identified any priority actions to help recover the Mahony's Toadlet in NSW. However, the OEH has listed activities to assist this species (Office of Environment and Heritage, 2017b) including:

- Retain wetland protection buffers in new coastal developments
- Fence off water bodies to prevent stock from grazing in these areas
- Protect coastal wetland areas
- Determine response of species to Chytrid Fungus which is currently unknown
- Refine the distribution of the species through targeted surveys
- Control incursion of weeds into coastal wetland habitat
- Rehabilitate or recreate former and existing habitat degraded or destroyed by grazing, sandmining and other activities
- Manage and control pest species, including Plague Minnow in accordance with approved Threat Abatement Plans
- Apply fire regime appropriate for vegetation type (frequency varying between 6–35 year intervals) and ensure standing water is present if undertaking prescribed burns.

5.2.1.5 Threats and key threatening processes

Key threats to Mahony's Toadlet that have been identified by the OEH include (Office of Environment and Heritage, 2017b):

- Destruction and degradation of coastal wetlands as a result of roadworks, coastal developments and sandmining
- Reduction of water quality and modification to acidity in coastal wetlands
- Changes to hydrology of coastal wetlands as a result of a changing climate and/or sea level rise
- Lack of distributional knowledge due to potential misidentification (particularly calls) during past surveys
- The impact of Chytrid Fungus on this species is currently unknown
- Limited information exists on ecological information such as fecundity, survival rates, specific habitat attributes, and response to disturbance
- Nutrient enrichment and chemical run off from urban and agricultural areas and as a result of mosquito control
- Predation of tadpoles and eggs by Eastern Gambusia
- Habitat disturbance by feral pigs.

Several other frogs that are similarly dependent on wallum habitat in coastal south-east Queensland and eastern NSW are currently listed as threatened, all of which face the same threatening processes of habitat loss and sand mining (Meyer *et al*., 2006).

The following list of threats has been compiled from the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent Frog Species (Meyer et al., 2006)* and discussed in terms of Mahony's Toadlet habitat requirements and site specific information relating to the habitats supported by the study area.

HABITAT LOSS (URBAN DEVELOPMENT AND SAND MINING)

The habitat utilised by Mahony's Toadlet has been extensively cleared for agriculture, sand mining and residential developments , (Clulow *et al*., 2016) (Meyer *et al*., 2006). In the relation to the locality, anthropogenic activities have further modified remaining sand deposits resulting in the loss of remnant sand strands. These sand residues have been levelled out and used to even the land surface for subsequent land uses either as rural or residential land.

HABITAT DEGRADATION

The degradation of wallum habitat at sites impacted by urban and industrial developments (and other human activities) could impact negatively on Mahony's Toadlet via changes in hydrology, altered water chemistry and increases in soil and water nutrient levels.

HABITAT FRAGMENTATION AS A RESULT OF LAND CLEARING

There are few areas of wallum habitat remaining in coastal NSW, all of which are generally heavily fragmented due to coastal developments (Clulow *et al*., 2016). Increased fragmentation may reduce opportunities for dispersal or movement of frogs between wetland catchments and between sub-populations within catchments. Potentially this may increase the risk of extinction for those populations whose viability is dependent on immigration of individuals from other populations. It may also reduce the likelihood of recolonisation following severe habitat disturbance (Meyer *et al*., 2006).

EXOTIC DISEASE

Exotic disease has emerged as a significant threat to amphibian populations internationally. Chytridiomycosis is an infectious disease caused by the chytrid fungus (*Batrachochytrium dendrobatidis*), a fungus capable of causing sporadic deaths in some amphibian populations and 100 per cent mortality in others (Department of Sustainability, 2013). The disease has been implicated in the mass die-offs and species extinctions of frogs since the 1990s.

OTHER RECOGNISED THREATS

- Predation by introduced Eastern Gambusia.
- Use of biocides in weed and mosquito control.
- Pig damage.
- Vehicular traffic.

5.2.1.6 Discussion of conservation status

On 10 March 2017, the NSW Scientific Committee made a determination for the provisional listing, on an emergency basis, of the frog Mahony's Toadlet as an Endangered Species in part 1 of Schedule 1 of the TSC Act (NSW Scientific Committee, 2017).

5.2.1.7 Discussion of local and regional abundance

As outlined above, Mahony's Toadlet appears to have a highly restricted distribution, found to date only throughout the Port Stephens, Myall Lakes and northern Central Coast sand beds in a relatively small area of eastern coastal New South Wales (Office of Environment and Heritage, 2017b, Clulow *et al*., 2016). At the time when Mahony's Toadlet was described in scientific literature (Clulow *et al*., 2016), the species distribution was restricted to sandy substrates of coastal and or marine origin. However this distribution and habitat preference has been subsequently extended by the record in the study area at Kangy Angy. It is likely that with targeted surveys the extent of occurrence and area of occupancy of Mahony's Toadlet is likely to increase in the future.

5.2.1.8 Discussion of other known local populations

DISCUSSION OF LOCAL POPULATIONS

The one individual Mahony's Toadlet recorded in the study area is the only known record in the locality (i.e. a five kilometre radius of the study area). In context of the locality, the study area forms part of low-lying swamp vegetation associated with Ourimbah Creek and the broader western and southern Tuggerah Lake floodplain. This area forms a mosaic of coastal swamp vegetation that extends in the north from the Porters Creek Wetland to the south east that includes the Tuggerah Nature Reserve, Tuggerah State Conservation Area along with a number of smaller Council reserve areas and private land holdings. All of which may support populations of Mahony's Toadlet. The presence or absence of Mahony's Toadlet populations in these protected areas and private properties has not yet been confirmed.

Within the locality approximately 2,125 hectares of potential Mahony's Toadlet habitat has been mapped in the Project locality. Of this, approximately 1,212.46 hectares (or 57 per cent) occur within protected reserves. The swampy wallum habitats within the locality to the north-east of the study area, such as Tuggerah State Conservation Area (approximately 3.8 kilometres) and Tuggerah Nature Reserve (approximately 4.9 kilometres) are potentially suitable for the species and more contiguous than those of the subject site. These areas of National Park Estate account for approximately 247 hectares (or 12 per cent) of potential Mahony's Toadlet habitat in the locality.

During the 2016 and 2017 summer period the study area remained very dry in late 2016 and early 2017 despite occasional storm activity. However, during February–March 2017 very heavy rains transformed the site with large areas of water along tracks and lower areas of the northern section of the study area. Surveys were conducted during this period when amphibian activity was very high, with a number of species, notably Dainty Green Tree Frog and Bleating Tree Frog calling in high numbers. While other more common species were also calling in high numbers through the same period, the large numbers of these two species calling is a strong indication that very good amphibian survey conditions prevailed during these survey evenings. On at least one evening high numbers of *Uperoleia* species were encountered and checked (40 plus individuals) for identity, however none exhibited the characteristic underside marbling of Mahony's Toadlet.

While it is possible that Mahony's Toadlet breeding cycles may not be in strict synchrony with other amphibian species active during the survey periods it is likely that conditions suiting other *Uperoleia* species, which were abundantly active during some nights, would be of suitability to elicit activity of a portion of the Mahony's Toadlet population if it were abundant within the study area. In addition to those survey periods exhibiting high amphibian activity, a number of surveys were conducted later in March while an abundance of water continued to exist on site and very warm and humid conditions prevailed. Surveys of the type locality at Oyster Cove, NSW, confirmed Mahony's Toadlet calling in late April 2017.

The results of these surveys indicate Mahony's Toadlet numbers within the study are limited. Due to a lack of records in the locality it is impossible to determine conclusively if Mahony's Toadlet exists outside the currently known location within the study area.

DISCUSSION OF REGIONAL POPULATIONS

Studies conducted by Clulow *et al*. (2016) and Clulow *in litt* (8 November 2016) report this species occurring in eight locations on sands beds in the Port Stephens, Myall Lakes and Central Coast areas of NSW (NSW Scientific Committee, 2017). These sightings identify two populations of Mahony's Toadlet in the region. The first population was identified initially at Oyster Cove, approximately 83 kilometres north north-east of the study area, with the second population identified in the Wyrrabalong National Park at Norah Head, approximately 14.5 kilometres north-east of the study area. The northern population includes sites at Tomago, Nelson Bay and sites north of Port Stephens. Both populations are found on swampy wallum habitats on bleached coastal sands with permanent standing water. Both populations have been identified as core breeding populations (Clulow *et al.*, 2016). Population size is unknown, however, at waterbodies where they are recorded the estimated abundance is in the hundreds (S. Clulow in litt. 8 November 2016) (NSW Scientific Committee, 2017).

As Mahony's Toadlet has been recorded almost exclusively on a substrate of leached (highly nutrient impoverished) white sand and is commonly associated with acid paperbark swamps (NSW Scientific Committee, 2017), the majority of core breeding and thus largest populations of Mahony's Toadlet appear to be associated with the northern population. Due to the amount of urbanised development separating the northern population and the Wyrrabalong National Park population from the study area, individuals in the study area may no longer be continuous with other populations to the north.

Three of the eight known Mahony's Toadlet sites occur in reserves, including the Wyrrabalong National Park, Tilligerry State Conservation Area and Worimi State Conservation Area. Other locations include Oyster Cove, Nelson Bay, Fingal Bay, Hawks Nest and Seal Rocks (NSW Scientific Committee, 2017). Due to the large extent National Park Estate surrounding Seals Rocks (Myall Lakes National Park) (and potentially Hawks Nest), it is likely that additional records for Mahony's Toadlet in this area would also occur in secure reserves.

ASSESSMENT OF SPECIES REGIONAL SIGNIFICANCE

The regional significance of Mahony's Toadlet in the study area is limited by the relatively recent description of the species and a lack of records for this species.

In a regional context Mahony's Toadlet is essentially restricted to two discrete populations within its currently understood range. These comprise of a northern population centred on Port Stephens and a second southern population in association with Tuggerah Lake, including sub-populations at the Wyrrabalong National Park and the study area. Due to the recent discovery of Mahony's Toadlet, the extent of occurrence and area of occupancy is likely to increase with further targeted surveys.

The regional significance of coastal ephemeral and semi-permanent swamps and wallum habitats on Quaternary sediments, particularly those with sandy substrates, is likely to be important for the promoting of viable breeding populations and the species' overall abundance. Mahony's Toadlet has almost exclusively been recorded on a substrate of leached white sand, and is commonly associated with acid paperbark swamps (Clulow *et al.*, 2016). Such areas, which occur relatively abundantly with the northern population, could be considered to represent core habitat with known breeding populations.

In the study area, Mahony's Toadlet is known from a mosaic of low semi-permanent to ephemeral depressions within a broader swamp sclerophyll type habitat on a grey silty-sand to sandy-silt substrate. Currently, the Mahony's Toadlet record in the study area is an isolated record to the south-west of Tuggerah Lake; although this may be an artefact of a general lack of targeted survey effort in areas of suitable habitat on the Central Coast. Nevertheless, Mahony's Toadlet habitat described in the study area is not characteristic of other regional populations that are known to retain breeding populations.

From cursory comparisons between the known southern population records of the Wyrrabalong National Park site (described in Clulow *et al* (2016)) and the study area, the dominance of sand content in substrates across the northern section of the study area are lower, with substrates at Wyrrabalong National Park having a greater sand content. It is not known whether the lower sand content of the study area substrates render onsite habitats less suitable for Mahony's Toadlet, but given Clulow *et al.* (2016) identifies the species as mostly confined to habitats defined by leached sands, it may be inferred that onsite habitats are marginal compared to the habitats described at the type localities.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

Habitat suitable for Mahony's Toadlet, consisting of trees and shrubs on suitable sandy soil is of naturally limited extent (NSW Scientific Committee, 2017). Remaining suitable habitat in coastal areas between the Hawkesbury River and Port Macquarie is well reserved with approximately 54 per cent (or 19,280 hectares) of suitable vegetated salicaceous sands occurring in the reserve system (NSW Scientific Committee, 2017). However, this estimate is based on a larger area than the current known range. Within the known range of this species, 62 per cent (of a total of approximately 18,000 hectares) of potentially suitable habitat occurs in reserves.

Three of the eight known Mahony's Toadlet sites occur in reserves, including the Wyrrabalong National Park, Tilligerry State Conservation Area and Worimi State Conservation Area. Other locations include Oyster Cove, Nelson Bay, Fingal Bay, Hawks Nest and Seal Rocks (NSW Scientific Committee, 2017). Due to the large extent National Park Estate surrounding Seals Rocks (Myall Lakes National Park) (and potentially Hawks Nest), it is likely that additional records for Mahony's Toadlet in this area would also occur in reserves.

In the locality the study area falls within the lakeside hinterland strip between coastal estuarine lakes and adjacent foothills in a somewhat similar topographic context to those areas where populations of Mahony's Toadlet are known to occur (i.e. Port Stephens and Wyrrabalong National Park).

Due primarily to the development pressures that characterise coastal landscapes on the Central Coast, and elsewhere in the bioregion, the presence and availability of viable habitats for Mahony's Toadlet are limited, spatially distributed and primarily restricted to protected areas. Based on the desk-based assessment, approximately 2,125 hectares of potential Mahony's Toadlet habitat occurs in the Project locality. Of this, approximately 1,212.46 hectares (or 57 per cent) occur within protected reserves (247 hectares are within

National Park Estate and the remaining 965.46 hectares occurs within reserves outside National Parks (i.e. council reserves)).

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

One Mahony's Toadlet individual was recorded on the subject site in May 2016. Since this time a significant survey effort has been applied during ideal weather conditions. Despite the species cryptic nature, the lack of additional records from the extensive survey effort under suitable conditions indicate that the habitat supported by the subject site is of lower significance to other potential more intact habitats that occur in the locality and of even lower significance than the regional habitats where breeding populations occur within the southern population centred at the Wyrrabalong National Park.

Approximately 2,125 hectares of potential Mahony's Toadlet habitat has been mapped in the Project locality. Of this, approximately 1,212.46 hectares (or 57 per cent) occur within protected reserves. The swampy wallum habitats within the locality to the north-east of the study area, such as Tuggerah State Conservation Area (approximately 3.8 kilometres) and Tuggerah Nature Reserve (approximately 4.9 kilometres) are potentially suitable for the species and more contiguous than those of the subject site. These areas of National Park Estate account for approximately 247 hectares (or 12 per cent) of potential Mahony's Toadlet habitat in the locality.

In any regard, the one record within the locality places a level of significance on the study area in the local context. Therefore, until Mahony's Toadlet or a population of the species is confirmed in other locations, the subject site is the default location of significance for the species in the locality.

5.2.1.9 Habitat utilisation

In reference to the significant targeted survey effort that has been applied to the study area, the one individual record of Mahony's Toadlet within the study area indicates limited habitat utilisation. A greater level of habitat utilisation would be indicated by more than one record and/or a breeding population.

The study area does however support semi-permanent (2.3 hectares) and more ephemeral (8.8 hectares) water bodies associated with sedges and adjacent degraded wallum habitats. Such habitats could be utilised by the species for sheltering and foraging, and possibly breeding. In addition, 8.6 hectares of drier perched habitat has been mapped in the study area, which may be important during periods of aestivation (dormancy).

5.2.1.10 Description of vegetation as habitat

Vegetation communities in the study area were described in the previous SIS (June 2016) (WSP | Parsons Brinckerhoff, 2016c). Within the Mahony's Toadlet habitat area, vegetation communities consisted of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm forest, which occurs in three conditions classes (high, medium and low quality) and Blackbutt – Turpentine – Sydney Blue Gum tall open forest. As the whole of the northern portion of the study area is characterised by a floodplain-type context, underlying substrates are subject to variations in elevation, forming a mosaic of low areas holding water, as well as more elevated substrates less prone to waterlogging.

Blackbutt – Turpentine – Sydney Blue Gum tall open forest generally occurred at a slightly higher elevation and consequently is largely consistent with drier perched habitat for Mahony's Toadlet. *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm forest occupies the majority of the Mahony's Toadlet and encompasses semi-permanent and ephemeral water habitat as well as drier perched habitat areas. Both vegetation communities occur on silty-sand soils and provide foraging, shelter and aestivation habitat, whilst lower water holding areas occur as potential breeding habitat.

Understory floristics were used as one apparatus to differentiate tolerance of understory vegetation assemblages to inundation (Table 4.5). In combination with standing water noted during wet period surveys, understorey vegetation was defined in three categories; semi-permanent water habitat, ephemeral water habitat and drier perched habitat. These habitat types are described in habitat utilisation (above), assessment of habitat (below), and Section 4.3.1.1.

5.2.1.11 Assessment of habitat in the study area

Generally the preferences of fauna habitat for specific species can be determined by their presence in that habitat. However, the determination of the distribution of utilised habitat in the study area for Mahony's Toadlet has been limited by the single individual record of this species in May 2016.

Due to its preference for sandy substrates, geotechnical investigations were undertaken to identify variations in substrate type, to aid in the process of determining where habitats preferred by Mahony's Toadlet may occur in the study area. The results from geotechnical investigations in the northern section of the study area found it to be dominated almost exclusively by sandy substrates with little variation in sandy substrate type. Substrates were very similar being variations between silty-sand or sandy-silt, with the sand being fine grained (WSP | Parsons Brinckerhoff, 2017). As there was little variation in sandy substrate type within the northern study area, it was concluded that the potential distribution of Mahony's Toadlet in the northern portion the study area could be widespread.

From cursory comparisons between the Wyrrabalong National Park site and the study area, dominance of sand content in substrates across the northern section of the study area are lower, with sandy substrates at the Wyrrabalong National Park having a greater sand content. It is not known whether the lower sand content of study area substrates render onsite habitats less suitable for Mahony's Toadlet, but given Clulow *et al* (2016) identifies this species as mostly confined to habitats defined by leached sands, it may be inferred that onsite habitats are less preferable than the habitats described at the type localities.

Clulow *et al.* (2016) note that breeding would likely be similar to other *Uperoleia* species that is, reliant on the presence of ephemeral and semi-permanent water. Therefore onsite wetland habitats should determine the distribution of potential breeding habitat for Mahony's Toadlet within the site. The whole of the northern portion of the study area is characterised by a flood-plain-type context, supporting Swamp-Sclerophyll vegetation communities, so subterranean water tables are generally high particularly during high rainfall events. Nevertheless, shallow-rooted species preferring dryer substrates, such as *Imperata cylindrical* var. *major* (Blady Grass) and *Pteridium esculentum* (Bracken Fern) are able to colonise areas of slightly higher elevation and remain perched above high water tables. Such areas, including the record location, are considered to provide areas where the frog may persist above permanent inundation during aestivation periods with moisture still afforded from high water tables below.

The lowest areas within the study area appear to be less than permanent in their retention of water, but still retain water for long periods between rainfall events. The semi-permanent nature of water retention is confirmed by the presence of true wetland occurring plants such as *Baumea teretifolia, Liparophyllum exaltatum* (Yellow Marsh-flower) and *Hemarthria uncinata* (Mat Grass). Such habitats may provide breeding opportunities for Mahony's Toadlet when local rainfall is relatively low.

In between the perched areas of dryer vegetation and the lowest semi-permanent areas of wetland habitat a range of water tolerant plants indicate those areas where water is retained on a more ephemeral basis. *Baloskion tetraphyllum subsp. meiostachyum* (Tassel Cord Rush) occurs on the lower areas above the semi-permanent waterbodies and *Gahnia clarkei* (Tall Saw-sedge) higher again. These areas represent potential habitats where moisture is retained ephemerally after high rainfall events keeping water-tables relatively high.

In some areas *Baloskion tetraphyllum subsp. meiostachyum* (Tassel Cord Rush), *Gahnia clarkei* (Tall Saw-sedge) and *Pteridium esculentum* (Bracken Fern) all occur together where water-table levels are likely restricted to variances where the water tolerances of each are not exceeded or insufficient. These habitats, which occur widely across the study area may provide breeding opportunities for Mahony's Toadlet during periods of highest rainfall and represent the lowest extent of potential aestivation habitat.

In terms of an ecological appraisal of habitats available to Mahony's Toadlet in the study area, it is considered that breeding habitat would constitute the most important habitat for this species. If breeding habitat was not to occur in the study area, then a population of Mahony's Toadlet is not likely to be viable in the study area in the long term.

Water bodies at known breeding locations ranged from ca. 70 metres x 20 metres up to 300 metres x 500 metres in size (Clulow *et al*., 2016) and almost exclusively occurred on a substrate of leached white

sand. As only one record of Mahony's Toadlet is currently known form the study area, potential breeding habitat is only inferred from the mapping of semi-permanent to ephemeral water habitats in the study area, which occur on a grey silty-sand to sandy-silt substrate.

In total, approximately 11.1 hectares of potential breeding habitat has been mapped as occurring in the study area. However, in consideration of freshwater inputs across different climatic contexts, different areas of the study area are likely to be used at different times. The areas of lowest elevation (semi-permanent water habitat) are likely to constitute the most important breeding habitat for Mahony's Toadlet during dryer cycles, with approximately 2.3 hectares of semi-permanent water habitat mapped in the study area. During wetter periods an additional 8.8 hectares of potential breeding habitat may occur within areas of ephemeral water habitat (Figure 4.4).

5.2.1.12 Extent of habitat removal

Within the subject site the Project is likely to affect approximately 13.8 hectares of Mahony's Toadlet habitat (Table 5.2). In terms of potential breeding habitat, the Project is likely to affect 1.7 hectares of semi-permanent water habitat, which likely constitutes breeding habitat during dry cycles. During wetter periods an additional 5.6 hectares of potential breeding habitat, in association with ephemeral water habitat is likely to be affected by the Project.

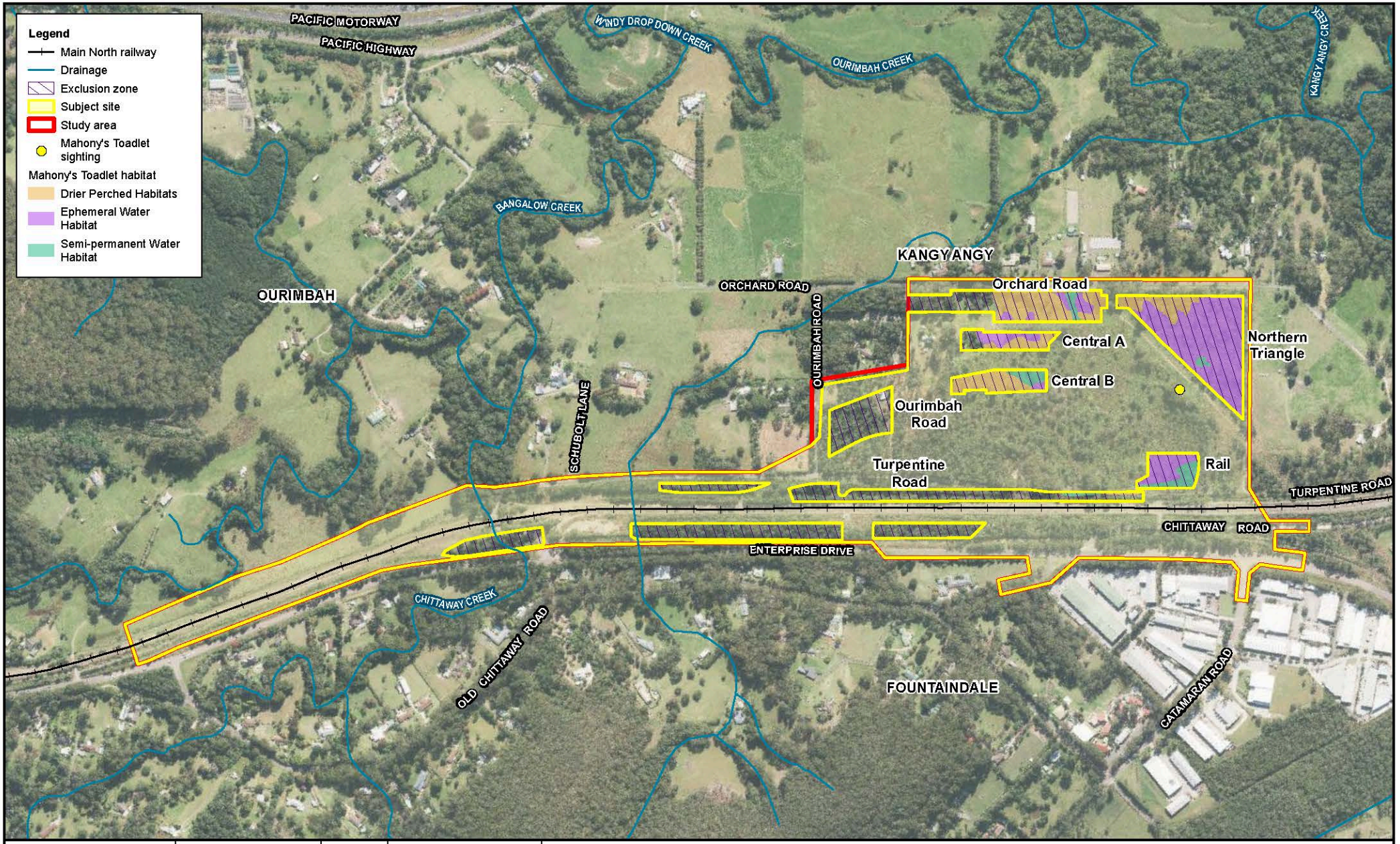
Table 5.2 Extent of Mahony's Toadlet habitat removal

MAHONY'S TOADLET HABITAT TYPE	EXTENT AVAILABLE WITHIN STUDY AREA (ha)	EXTENT WITHIN SUBJECT SITE TO BE REMOVED (ha)	PERCENTAGE OF HABITAT REMOVED (%)
Semi-permanent water habitat	2.3	1.7	74
Ephemeral water habitat	8.8	5.6	64
Drier perched habitat	8.6	6.5	76
Total	**19.7**	**13.8**	**70**

A Conservation Management Plan being developed for the Project has identified exclusion zones in the study area, which include Mahony's Toadlet breeding habitat (semi-permanent water), potential breeding habitat (ephemeral water) and drier perched habitat (Table 5.3, Table 6.6).

Table 5.3 Extent of Mahony's Toadlet habitat retained for conservation

MAHONY'S TOADLET HABITAT TYPE	EXTENT AVAILABLE WITHIN STUDY AREA (ha)	HABITAT RETAINED FOR CONSERVATION IN STUDY AREA (ha)	PERCENTAGE OF HABITAT RETANED FOR CONSERVATION (%)
Semi-permanent water habitat	2.3	0.6	26
Ephemeral water habitat	8.8	3.2	36
Drier perched habitat	8.6	2.1	24
Total	**19.7**	**5.9**	**30**



Map: 2202522A_GIS_F110_A2	Author: suansrir
Date: 11/05/2017	Approved by: -

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Figure 5.1
Mahony's Toadlet habitat retained in the study area

5.2.1.13 Corridor connectivity and fragmentation

As much of the study area and associated lands is characterised by floodplain topography perched above Bangalow Creek, Chittaway Creek and Ourimbah Creek, land immediately adjacent is fragmented due to historical clearing for rural residential land holdings. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient but important riparian habitat that allows for connectivity for less mobile species in an otherwise managed landscape.

Although the study area is surrounded by cleared and managed rural residential tenures, construction and operation of the Project would add incrementally to existing fragmentation of habitat to be retained, in an approximate north–south alignment from the coastal range south of the existing rail corridor to riparian habitat associated with Ourimbah Creek in the north.

To reduce the level of potential fragmentation, specific exclusion zones are proposed in strategic locations within the study area. The intention of the exclusion zones is to maintain a level of connectivity and movement opportunities for Mahony's Toadlet within and around the proposed infrastructure, as shown on Figure 5.1.

5.2.1.14 Impacts on threatened species and/or populations in OEH estate

Three of the eight known Mahony's Toadlet sites occur in reserves, including Wyrrabalong National Park, Tilligerry State Conservation Area and Worimi State Conservation Area. Other locations include Oyster Cove, Nelson Bay, Fingal Bay, Hawks Nest and Seal Rocks (NSW Scientific Committee, 2017). Due to the large extent National Park Estate surrounding Seals Rocks (Myall Lakes National Park) (and potentially Hawks Nest), it is likely that records for Mahony's Toadlet in this area would also occur in reserves. Within the known range of this species, 62 per cent (of a total of approximately 18,000 hectares) of potentially suitable habitat occurs in reserves (NSW Scientific Committee, 2017).

Several conservation estates occur in the locality, including Tuggerah Nature Reserve and Tuggerah State Conservation Area. These two areas of National Park Estate have been mapped as retaining approximately 247 hectares of potential Mahony's Toadlet habitat with an additional 965.46 hectares mapped within reserves outside National Park Estate (i.e. council reserves). With regard to the Tuggerah Lake population of Mahony's Toadlet, the only other known record (apart from the study area) is from a secure reserve in the Wyrrabalong National Park. The Project is not likely to directly or indirectly impact Mahony's Toadlets in these reserves, if they were found to occur in these locations.

5.2.1.15 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of the *Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy* (WSP | Parsons Brinckerhoff, 2016a). The subject site was selected as the preferred location giving consideration to environmental, heritage and ecological values, and engineering requirements.

Opportunities to reduce the clearing of native vegetation have been investigated as part of design development. The consideration of ecological constraints resulted in the reduction in impacts to the *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation within the subject site by 20 per cent. Further details regarding the reductions in vegetation impacts for applicable communities as a result of design development is provided in Table 5.4.

Table 5.4 The reduction of impacts to vegetation communities by amending the subject site during design development

VEGETATION COMMUNITY	FAUNA HABITAT	PREVIOUS EXTANT WITHIN SUBJECT SITE (ha)	REVISED EXTANT WITHIN SUBJECT SITE (ha)	ADDITIONAL VEGETATION RETAINED BY AMENDING THE SUBJECT SITE (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest	Swamp Forest	31.8	22.6	9.2
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.2	0.3
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.3	0.6
Cleared and disturbed land	Cleared land	13.4	9.6	3.8

Following the formal description of Mahony's Toadlet (Clulow *et al*., 2016), TfNSW undertook a further review of the siting of work compounds and drainage detention basins, which resulted in the additional retention of Mahony's Toadlet habitat and establishment of project exclusion zones to ensure the long-term viability and connectivity of Mahony's Toadlet habitats in the study area (Figure 5.1).

In addition, in 2017 TfNSW commissioned a further review of concept options to rearrange the design of the Project and reroute access roads to minimise ecological impacts to Mahony's Toadlet habitat and other ecologically sensitive areas (AECOM, 2017). These options are considered in detail in Section 6.1 and the *Provisional Desktop Options Assessment Report* (AECOM, 2017).

The principle of ecological sustainable development have been an integral consideration for the Project through its development, and included the integration of economic, social and environmental considerations in the decision-making process. Details of how the relevant principles of ecologically sustainable development have been incorporated into the Project are provided in Table 5.5.

Table 5.5 Incorporation of ecologically sustainable development principles into the Project

ESD PRINCIPLE	COMMENT
Precautionary principle	A precautionary approach has been applied throughout the Project's development. A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of the *Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy* (WSP | Parsons Brinckerhoff, 2016a). The subject site was selected as the preferred location giving consideration to environmental, heritage and ecological values, and engineering requirements. The REF process (inclusive of the BAR and previous SIS) and this SIS has reduced the environmental impact of the Project. Notwithstanding this, the Project will impact on the only currently known habitat for Mahony's Toadlet in the locality. As little is known about this relatively new frog species and its dependence on the potential habitats within the locality and study area, a precautionary approach has been applied and the Project is considered likely to have a significant impact upon Mahony's Toadlet. A referral under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) has been submitted to the Australian Government. The Project is considered a 'controlled action' based on the potential for significant impacts to Regent Honeyeater and Swift Parrot foraging habitat.

ESD PRINCIPLE	COMMENT
Inter-generational equity	Issues that have potential long-term implications, such as consumption of non-renewable resources, waste disposal, greenhouse gas emissions, removal of vegetation, land use changes and impacts on amenity, have been considered in the *Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy* (REF) (WSP | Parsons Brinckerhoff, 2016a), the previous SIS (WSP | Parsons Brinckerhoff, 2016c) and this SIS. Impacts have been reduced through design considerations and identification of various mitigation and management measures. When the Project begins operation, it would deliver inter-generational equity by: → ensuring sufficient capacity and reliability is available to meet forecast demand for rail passenger movement → enhancing environmental quality by enabling the achievement of a number of environmental benefits, including reduced road congestion, air quality, greenhouse gas emissions and improved energy efficiency over comparable transport modes. It is acknowledged that the Project may have some adverse impacts on the current generation, generally through the proposed environmental impacts, and land acquisition requirements, in addition to temporary impacts during the construction period. However, these are not considered to be of a nature or extent such that they should warrant disadvantage to future generations.
Conservation of biological diversity and ecological integrity	Extensive efforts have been made to reduce impacts on biodiversity and, specifically, the amount of clearing of native vegetation for the Project. Opportunities to reduce the extent of native vegetation clearing have been investigated as part of design development. The consideration of ecological constraints resulted in the reduction in impacts to the Threatened Ecological Community *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation within the subject site by 20 per cent. The Project would result in the removal of up to 27 hectares of vegetation and a biodiversity offset strategy has been developed to compensate for the residual biodiversity impacts of the Project. Following the formal description and threatened species listing of the Mahony's Toadlet as Endangered under the TSC Act (NSW Scientific Committee, 2017) and in consideration of the OEH conditions of consent for the former SIS concurrence, TfNSW undertook a further comprehensive design review of the Project's proposed layout of work compounds and drainage detention basins. This review specifically investigated the potential for minimising impacts to Mahony's Toadlet and Wallum Froglet habitat within the study area and resulted in the additional identification, avoidance and retention of site specific Mahony's Toadlet and Wallum Froglet habitat areas to ensure the long-term viability and connectivity of habitats in the study area (Figure 5.1, Figure 5.2). The Project will result in the removal of up to 13.8 hectares of Mahony's Toadlet habitat. To compensate for residual impacts to Mahony's Toadlet (and Wallum Froglet) a comprehensive Conservation Management Plan is proposed for the Project, inclusive of appropriate biodiversity offsets.
Improved valuation and pricing of environmental resources	Environmental and social issues were considered in the strategic planning and establishment of the need for the Project and in consideration of the various site location options. The value placed on environmental resources was considered throughout the planning, environmental investigations and design for the Project management and mitigation measures summarised in Chapter 8 of the REF (WSP | Parsons Brinckerhoff, 2016a).

5.2.2 Wallum Froglet (*Crinia tinnula)*

5.2.2.1 Distribution

The Wallum Froglet only occurs in lowland coastal habitats in south-east Queensland from Litabella National Park to Kurnell in Sydney (Meyer *et al*., 2006).

5.2.2.2 Habitat

Wallum Froglets are found in a wide range of habitats, usually associated with paperbark wetlands and sedgelands on acid-rich groundwater within coastal sandplains. Wallum Froglets can also be found along drainage lines within other vegetation communities, and occasionally in swamp sclerophyll forests (Office of Environment & Heritage, 2017b). Specific habitat requirements for this species are moist microhabitats in swamps, or wet or dry heaths, or sedge grasslands or swamps. They are best detected in autumn (March to May) but also in summer and winter after heavy rainfall (Anstis, 2002, Barker *et al*., 1995, Meyer *et al*., 2006).

5.2.2.3 Ecology

The Wallum Froglet breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches where the soil water pH is <6. Breeding is thought to peak in the colder months, but can occur throughout the year following rain. Wallum Froglets shelter under leaf litter, vegetation, other debris or in burrows of other species. Shelter sites are wet or damp and often located near the edge of water. Males call throughout the year and anytime of the day, peaking following rain (Office of Environment & Heritage, 2017b, Biosphere Environmental Consultants Pty Ltd, 2016b).

5.2.2.4 Recovery plan

The TSC Act provides for the preparation of recovery plans. At the current time, no such plan has been prepared for the Wallum Froglet. The NSW OEH has assigned the Wallum Froglet to the keep-watch species management stream under the *Saving Our Species* Program (Office of Environment & Heritage, 2017b). Species listed under the keep-watch management steam require no immediate action to protect them. The Wallum Froglet is of a low priority as it is likely to be secure in NSW for the long term without targeted management (Office of Environment & Heritage, 2017b).

Despite recovery efforts in NSW, the Wallum Froglet is listed under the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent frog species (Meyer et al., 2006)*. The core recovery actions identified for Wallum –dependent frog species include:

- → Identify and assess essential habitat
- → Protect wallum frog populations and manage habitat
- → Acquire additional information on threats to inform management
- → Engage stakeholders and the broader community in recovery of wallum frog species
- → Rehabilitate degraded wallum habitat
- → Monitor frog numbers and distribution.

5.2.2.5 Threats and key threatening processes

Wallum Froglets are usually associated with paperbark wetlands and sedgelands on acid-rich groundwater within coastal sandplains. The Wallum Froglet and several other frogs that are similarly dependent on wallum habitat in coastal south-east Queensland and eastern NSW are listed under the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent frog species (Meyer et al., 2006)*. The following list of threats has been compiled from the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent Frog Species (Meyer et al., 2006)*.

HABITAT LOSS (URBAN DEVELOPMENT AND SAND MINING)

The habitat utilised by Wallum Froglet has been extensively cleared for agriculture, sand mining and residential developments (Meyer *et al*., 2006). In relation to the locality, anthropogenic activities have further modified remaining wallum sedge swamps resulting in the loss and fragmentation of habitats. These wallum sedge swamps have been cleared, drained and filled for subsequent land uses either as rural, industrial or residential land.

HABITAT DEGRADATION

The degradation of wallum habitat at sites impacted by urban and industrial developments (and other human activities) could impact negatively on Wallum Froglet via changes in hydrology, altered water chemistry and increases in soil and water nutrient levels.

HABITAT FRAGMENTATION AS A RESULT OF LAND CLEARING

There are few areas of wallum habitat remaining in coastal NSW, all of which are generally heavily fragmented due to coastal developments (Clulow et al., 2016). Increased fragmentation may reduce opportunities for dispersal or movement of frogs between wetland catchments and between sub-populations within catchments. Potentially this may increase the risk of extinction for those populations whose viability is dependent on immigration of individuals from other populations. It may also reduce the likelihood of recolonisation following severe habitat disturbance (Meyer *et al*., 2006).

EXOTIC DISEASE

Exotic disease has emerged as a significant threat to amphibian populations internationally. Chytridiomycosis is an infectious disease caused by the chytrid fungus (*Batrachochytrium dendrobatidis*), a fungus capable of causing sporadic deaths in some amphibian populations and 100 per cent mortality in others (Department of Sustainability, 2013). The disease has been implicated in the mass die-offs and species extinctions of frogs since the 1990s.

OTHER RECOGNISED THREATS

- Predation by introduced Eastern Gambusia.
- Use of biocides in weed and mosquito control.
- Pig damage.
- Vehicular traffic.

5.2.2.6 Discussion of conservation status

The Wallum Froglet is listed as Vulnerable under the NSW TSC Act.

5.2.2.7 Discussion of local and regional abundance

DISCUSSION OF OTHER KNOWN LOCAL POPULATIONS

In March 2017, following significant local rainfall (greater than 185 millimetres in seven days), four individual Wallum Froglets were detected by call in two discrete locations of the study area.

In context of the local population, the study area forms part of low-lying swamp vegetation associated with Ourimbah Creek and the broader western and southern Tuggerah Lake floodplain. This area forms a mosaic of coastal swamp vegetation that extends in the north from the Porters Creek Wetland to the south east that includes the Tuggerah Nature Reserve, Tuggerah State Conservation Area along with a number of smaller Council reserve areas including Berkeley Creek and Tumbi Creek Wetlands.

The local population of the Wallum Froglet appears to form a stronghold within the Porters Creek Wetland area and surrounds with smaller discrete sub-populations recorded from Berkley Creek Wetland and Tumbi Creek Wetland (Office of Environment & Heritage, 2017a). The study area is considered to form part of the southern Tuggerah Lake sub-population that appears to be associated to the broader Central Coast meta-

population that extents from approximately Redhead in the north to the Tuggerah Lake floodplain in the south.

Other known populations with recent records demonstrate the Wallarah Creek, Munmorah wetland and Norah Head are supporting breeding populations (Office of Environment & Heritage, 2017a, Atlas of living Australia, 2017).

ASSESSMENT OF THEIR REGIONAL SIGNIFICANCE

In a regional context the Wallum Froglet is essentially restricted to two discrete meta-populations within the Sydney Basin Bioregion. These comprise of a population at Kurnell in southern Sydney and a Central Coast population that extends from approximately Redhead in the north to the Tuggerah Lake floodplain in the south. The Central Coast population occurs in association with the coastal floodplains of the Tuggerah Lake, Munmorah Lake and Lake Macquarie.

Given the marginal status of onsite habitat, the retention of suitable habitat in the study area, and the distribution of larger areas of similar or better quality habitat for this species within the broader meta-population, the loss of habitat within the subject site occurs on the southern extremity of the broader Central Coast meta-population and is unlikely to adversely affect the long-term survival of the Wallum Froglet at a regional level.

LONG-TERM SECURITY OF OTHER HABITATS SHALL BE EXAMINED

The landscape context is characterised by broad relatively low-lying areas where runoff from western hills flood plains and coastal depressions and swales, which provide landscape features and conditions able to support ephemeral waterbodies in association with swamp sclerophyll forest and wallum vegetation communities. However, such habitats are relatively sparse in the regional landscape due in part to the relatively small area of landscape context they occupy and the overlaying of urbanised developments, which are favoured on the same near coastal locations.

Due primarily to the development pressures that characterise coastal landscapes on the Central Coast, and elsewhere in the bioregion, the presence and availability of viable habitats for Wallum Froglet are limited. However, Porters Creek wetland, which occurs approximately seven kilometres to the north of the study area, appears to from a stronghold for Wallum Froglet (Office of Environment and Heritage, 2017a). Porters Creek Wetland is a local government conservation secure site. In addition, the OEH has established a conservation management site at Porters Creek wetland under the Saving Our Species Program for *Melaleuca biconvexa*, which will aid the long-term security of Wallum Froglet. The Wallum Froglet is also currently known from National Park Estates, including Colongra Swamp Nature Reserve and Munmorah State Conservation Area.

RELATIVE SIGNIFICANCE OF THE SUBJECT SITE IN THE LOCALITY

The small sub-population of Wallum Froglet recorded in the study area is suspected to be part of a larger area of occupancy associated with wallum habitats on parts of the western and southern Tuggerah Lake floodplain. Although the Wallum Froglet is a cryptic species, they have a distinct call and males are known to call throughout the year; especially after heavy rain (Department of Environment and Climate Change, 2009). The level of survey effort encompassing a range of seasonal contexts, over multiple years and through suitable conditions for detection suggests that habitat in the study area is potentially of lower significance to habitat supporting the larger population north of the study area in the vicinity of Porters Creek Wetland.

The local population of the Wallum Froglet appears to form a stronghold within the Porters Creek Wetland area and surrounds with smaller discrete sub-populations recorded from the study area, Berkley Creek Wetland and Tumbi Creek Wetland (Office of Environment & Heritage, 2017a). The study area is considered to form part of the southern Tuggerah Lake sub-population that appears to be associated to the broader Central Coast meta-population that extends from approximately Redhead in the north to the Tuggerah Lake floodplain in the south.

Habitat for the Wallum Froglet within the study area, whilst considered marginal, may facilitate breeding opportunities for Wallum Froglet, dependent on freshwater input during favourable seasonal conditions.

Foraging and shelter habitat is likely to occur at the margins of these shallow depressions. Exclusion zones have been proposed for the Project, which would retain occupied and potential Wallum Froglet habitat in the study area. Together with other small discrete sub-populations recorded from Berkley Creek and Wetland and Tumbi Umbi Wetland (Office of Environment & Heritage, 2017a), suitable habitats for Wallum Froglet would remain in the locality.

HABITAT UTILISATION

In reference to the significant targeted survey effort that has been applied to the study area, the few individual records for Wallum Froglet in the study area indicates habitat utilisation, but is at the lower end of the habitat utilisation scale. The species is known to occupy generally acidic water habitats (<6 pH) and in the study area the Wallum Froglet was recorded from two discrete areas of occupancy, totalling 1.4 hectares. The relatively small area of occupied habitat and recording of only several individuals suggests that the study area retains marginally suitable wallum habitat in the context of habitats associated with the broader metapopulation.

In total, approximately 3.0 hectares of occupied and potential Wallum Froglet habitat has been mapped as occurring in the study area. These habitats may facilitate breeding opportunities for Wallum Froglet, but would be dependent on freshwater input during favourable seasonal conditions. Foraging and shelter habitat is likely to occur at the margins of these shallow depressions.

DESCRIPTION OF VEGETATION AS HABITAT

Vegetation within the study area varies in its suitability for Wallum Froglet. Wallum Froglets are usually associated with paperbark wetlands and sedgelands on acid-rich water within coastal sandplains (Office of Environment & Heritage, 2017b). Within the study area, the whole of the northern portion of the study area is characterised by a floodplain-type context, with underlying substrates subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less prone to waterlogging. The two locations where Wallum Froglet was recorded within the study area are consistent with shallow depressions of semi-permanent water habitat within *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community.

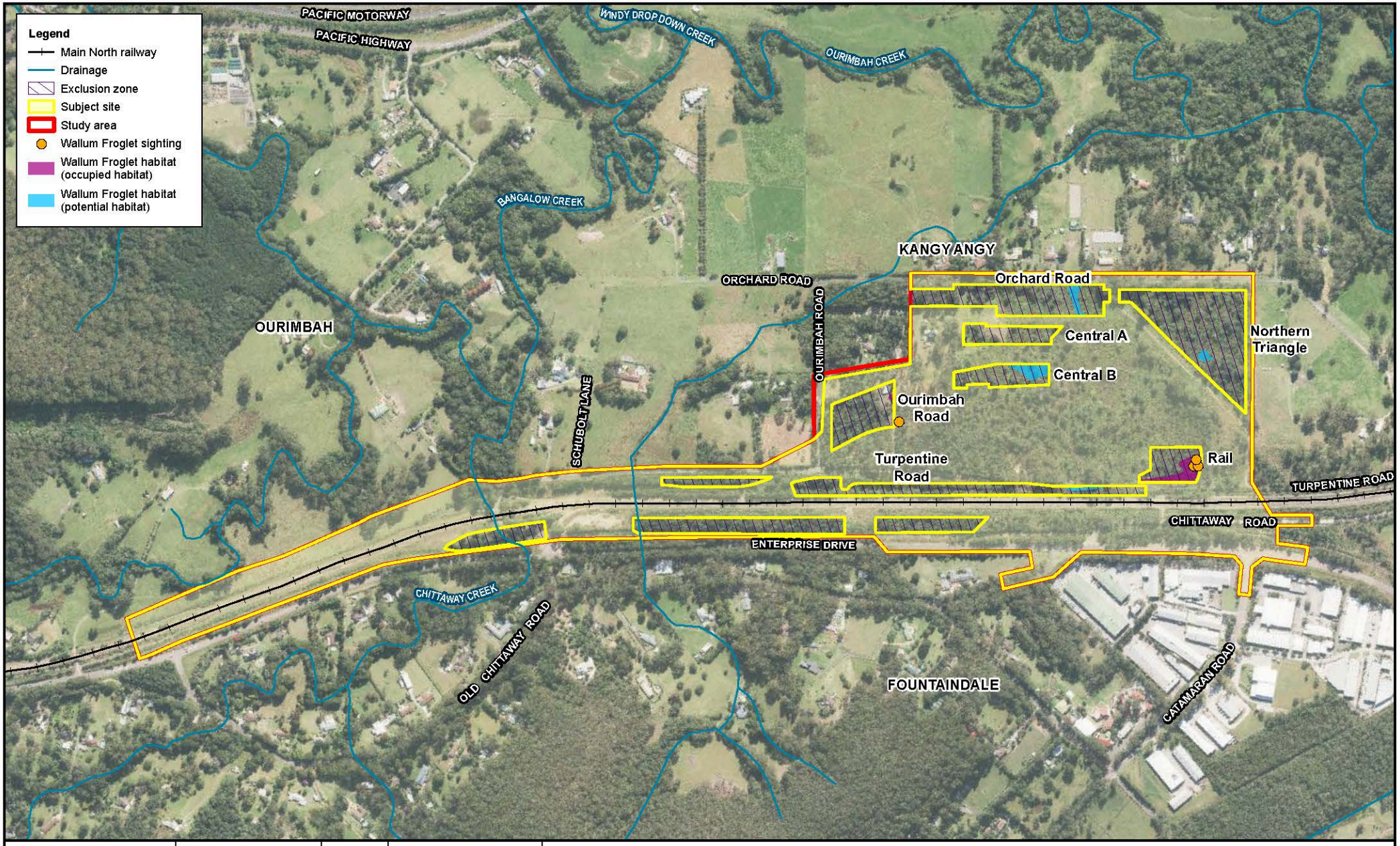
Understory floristics were used as one apparatus to differentiate tolerance of understory vegetation assemblages to inundation (Table 4.5). In combination with standing water noted during wet period surveys, Wallum Froglet habitat was defined as semi-permanent water habitat.

5.2.2.8 Assessment of habitat in the study area

Wallum Froglets are usually associated with paperbark wetlands and sedgelands on acid-rich water within coastal sandplains (Office of Environment & Heritage, 2017b, Biosphere Environmental Consultants Pty Ltd, 2016b). Within the study area, the whole of the northern portion of the study area is characterised by a floodplain-type context, with underlying substrates subject to variations in elevation, which form a mosaic of low areas holding water, as well as more elevated substrates less prone to waterlogging. In this context, Wallum Froglet is considered to occupy semi-permanent shallow depressions (Figure 4.6, Photo 4.7, Photo 4.8) within a broader swamp forest type habitat (*Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest vegetation community).

The species is known to occupy generally acidic soil water habitats (<6 pH) with two discrete areas of occupancy identified within the study area, totalling approximately 1.4 hectares. In addition, a further 1.6 hectares of potential habitat is considered to occur in association with semi-permanent water. These habitats may facilitate breeding opportunities for Wallum Froglet, but would be dependent on freshwater input during favourable seasonal conditions. Foraging and shelter habitat is likely to occur at the margins of these shallow depressions. In total, approximately 3.0 hectares of Wallum Froglet habitat has been mapped in the study area (Figure 4.6).

Given the small number of records from the study area, despite extensive surveys conducted during suitable conditions, the habitat is considered marginal in the context of habitats associated with the broader Central Coast meta-population that extends from approximately Redhead in the north to the Tuggerah Lake floodplain in the south.



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Date: 11/05/2017	Approved by: -

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Figure 5.2
Wallum Froglet habitat retained in the study area

EXTENT OF HABITAT REMOVAL

Approximately 3.0 hectares of Wallum Froglet habitat has been mapped as occurring in the study area, inclusive of 1.4 hectares of occupied habitat and 1.6 hectares of potential habitat. Of this approximately 2.4 hectares would likely be affected by the Project, including 1.1 hectares of occupied habitat and 1.3 hectares of potential habitat.

CORRIDOR CONNECTIVITY AND FRAGMENTATION

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor, road network and managed rural residential lands. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. The Project would add incrementally to existing fragmentation of habitat within the study area and broader Central Coast meta-population area of occupancy.

In reference to Figure 5.2, the proposed layout of the Project has considered the retention of habitat and the provision of connectivity of these habitats within the study area. In effect this layout maintains connectivity and prevents the isolation of retained conservation habitats within the study area and provides opportunities for further connectivity to additional areas of potential habitats outside of the study area. In the immediate vicinity of the Project, Chittaway Creek, Bangalow Creek and Ourimbah Creek retain sufficient, but important, riparian habitat that provide connectivity for less mobile species, such as Wallum Froglet, in an otherwise managed landscape.

IMPACTS ON THREATENED SPECIES AND/OR POPULATIONS IN OEH ESTATE

Several OEH conservation estates occur within the locality, including Tuggerah Nature Reserve, Tuggerah State Conservation Area, Wambina Nature Reserve and the Wyrrabalong National Park. The Project is not likely to directly or indirectly impact Wallum Froglet in these reserves.

5.2.2.9 Description of feasible alternatives

A comprehensive and detailed assessment of feasible alternatives including the 'do nothing option' are provided in section 3.1 of the Review of Environmental Factors for the New Intercity Fleet Maintenance Facility at Kangy Angy (WSP | Parsons Brinckerhoff, 2016a). The subject site was selected as the preferred location giving consideration to environmental, heritage and ecological values, and engineering requirements.

Opportunities to reduce the clearing of native vegetation were investigated during design. The consideration of ecological constraints resulted in the reduction of *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest EEC within the subject site by 20 per cent. See reductions across all vegetation communities after ecological input at the design phase in Table 5.6.

Table 5.6 The reduction of impacts to vegetation communities by amending the subject site during design development

VEGETATION COMMUNITY	FAUNA HABITAT	PREVIOUS EXTANT WITHIN SUBJECT SITE (ha)	REVISED EXTANT WITHIN SUBJECT SITE (ha)	ADDITIONAL VEGETATION RETAINED BY AMENDING THE SUBJECT SITE (ha)
Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm Forest[1]	Swamp Forest	31.8	22.6	9.2
Jackwood – Lilly Pilly – Sassafras Rainforest	Rainforest	1.5	1.2	0.3
Blackbutt – Turpentine – Sydney Blue Gum Mesic Tall Open Forest	Wet Open Forest	3.9	3.3	0.6
Cleared and disturbed land	Cleared land	13.4	9.6	3.8

TfNSW undertook a review of suitable siting of work compounds and drainage detention basins, which have minimised impacts to Wallum Froglet habitat. Further refinement was applied through the identification and establishment of project exclusion zones to ensure the long-term viability and connectivity of habitats in the study area (Figure 5.2).

In addition, in 2017 TfNSW commissioned further concept options and a review of the potential to rearrange the Project and reroute access roads to minimise impacts to ecological sensitive areas (AECOM, 2017). These options are considered in detail in Section 6.1 and the *Provisional Desktop Options Assessment Report* (AECOM, 2017).

6 AMELIORATIVE MEASURES

The general principle to minimise impacts to biodiversity, should in order of consideration, endeavour to:

- Avoid impacts on habitat, through the planning process
- Minimise impacts on habitat, through the planning process
- Mitigate impacts on habitat, though the use of a range of mitigation measures
- Offset residual impacts.

This hierarchy of ameliorative measures is discussion in the following Sections 6.1–6.4.

6.1 Avoid and minimise

The avoidance of impacts can be achieved through the planning process. This process involves a preliminary examination of a number of possible site options and their potential impacts on the environment and other factors (for example, economic and social considerations). Those potential sites that best fit the environmental, social and economic criteria are then short-listed. This was completed as part of the site selection process for the Project. The results of this selection process is provided in the *Central Coast Train Stabling and Maintenance Facility Comparative Site* Analysis (GHD, 2015).

Minimising impacts involves reducing the loss of habitat or significant species as far as practicable. Through detailed surveys, it is usually possible to fine-tune the subject site (alignment and width of Project footprint) to minimise loss of important vegetation communities or habitats and avoid significant plant species or habitat features. The final subject site is also subject to engineering constraints and safety standards.

A reference design was prepared for the Project from options assessments and value engineering exercises undertaken in pre-concept and concept development stages. The reference design was also developed using input from the REF (WSP | Parsons Brinckerhoff, 2016a) and previous SIS (WSP | Parsons Brinckerhoff, 2016c). The reference design considered five road access routes in 2015 and 2016 against a range of parameters, including; flood immunity, design speed, road section, utilisation of existing declared corridors, impacts on rail corridor and areas of significant biodiversity value. Wider impacts for road access routes were also considered including, construction, impacts upon local amenity, environment, functionality of the facility, property acquisition, flooding, utilities and traffic. This assessment identified the preferred access road option selected for the reference design as AR3C (AECOM, 2017).

Following the formal description and threatened species listing of the Mahony's Toadlet as Endangered under the TSC Act (NSW Scientific Committee, 2017) and in consideration of the OEH conditions of consent for the former SIS concurrence, TfNSW undertook a further comprehensive design review of the Project's proposed layout of work compounds and drainage detention basins. This review specifically investigated the potential for minimising impacts to Mahony's Toadlet and Wallum Froglet habitat within the study area and resulted in the additional identification, avoidance and retention of site specific Mahony's Toadlet and Wallum Froglet habitat areas to ensure the long-term viability and connectivity of habitats in the study area (Figure 5.1, Figure 5.2).

In addition to the design review of temporary construction and drainage works, TfNSW also commissioned a review of potential options for alterative concept designs, including alternative access routes and maintenance facility site layouts with reduced impacts on Mahony's Toadlet habitat and other ecologically sensitive areas (AECOM, 2017). This review considered the same selection criteria and parameters described above in assessing these additional options. A summary of the access route and maintenance facility options potential impacts on Mahony's Toadlet and biodiversity values is provided in the following sections.

6.1.1 Access roads options

In total, a further seven access road routes were considered in 2017 in the options assessment. These options were primarily designed to provide alternative access routes to the adopted reference design access road 3C (AR3C) with reduced impacts on Mahony's Toadlet habitat (AECOM, 2017). The assessment concluded that while the adopted reference design AR3C had the greatest impact on Mahony's Toadlet habitat, it remained the most viable option when the combined impacts across the multiple criteria were considered. Table 6.1 provides an analysis of all road access options considered and their potential impact Mahony's Toadlet habitat.

Table 6.1 Extent of Mahony's Toadlet habitat affected by different access road options (2017)

ACCESS ROAD OPTION	EXTENT OF MAHONY'S TOADLET HABITAT AFFECTED (ha)	PERCENTAGE OF TOTAL HABITAT IN SUBJECT SITE
AR3C	1.45	8.6%
AR3D	0.39	2.3%
AR5A	0.39	2.3%
AR5B	0.39	2.3%
AR5C	0.39	2.3%
AR5D	0.39	2.3%
AR5E	0.39	2.3%
AR5F	0.39	2.3%

Note: all area estimates are approximate and require confirmation based on detailed design and set out of roads, facilities and construction areas. The area estimates are provided as a guide only to consider impacts on Mahony's Toadlet habitat.

6.1.2 Maintenance facility options

To further minimise the impact to Mahony's Toadlet habitat, a number of concept layouts were considered in 2017. Due to the length of the proposed trains (205 metres) and allowance for safety space, a minimum length requirement of 238 metres is required to accommodate trains at the maintenance shed, standing roads and train wash facility. Accordingly, it was not considered feasible to move all infrastructure associated with the Project south to avoid Mahony's Toadlet habitat without severely impacting the functional viability of the Project. In addition to affecting the functional viability, options for relocating standing roads and train wash facility elsewhere in the site were constrained by the requirements to substantially avoid flood affected land, increased property impacts on neighbouring residents and increased impacts on the Threatened Ecological Community (TEC) and areas of threatened species of plant *Melaleuca biconvexa*.

Considering the Projects limitations on the wholesale relocation of infrastructure, TfNSW investigated alternative layouts of some individual design elements to further reduce impact on Mahony's Toadlet habitat. Three potential alternative maintenance facility layouts were considered, including:

- Reference design: the design prepared in 2016.
- Option A: this option sought to move the entry roads and some of the ancillary elements of the facility such as security buildings, water treatment facilities, fire treatment plant and transformers to the south of the study area in avoid additional Mahony's Toadlet habitat.
- Option B: this option was developed on the same basis as Option A, though omits standing road 5 in order to further reduce impacts on Mahony's Toadlet habitat.

Table 6.2 Extent of biodiversity values affected by different maintenance facility layout options

MAINTENANCE FACILITY OPTION	BIODIVERSITY VALUE			
	MAHONY'S TOADLET HABITAT AFFECTED (HA)	PERCENTAGE OF TOTAL MAHONY'S TOADLET HABITAT IN SUBJECT SITE	*MELALEUCA BICONVEXA* HABITAT AFFECTED (HA)	MELALEUCA BICONVEXA – SWAMP MAHGANY – CABBAGE PALM FOREST (EEC)
Reference design	7.93	46.8%	2.1	20.91
Option A	6.98	41.2%	2.1	21.06
Option B	6.80	40.1%	2.1	21.31

6.1.3 Summary

The options assessment determined the preferred access road option as AR3C when all criteria were considered (AECOM, 2017). While a number of other options (including AR1, AR2 and AR5) resulted in reduced impacts on the Mahony's Toadlet habitat, these options were found unlikely to be viable due to substantial major impacts on one or more other criteria. Furthermore when consideration of each of the options impacts on combined biodiversity values were investigated, no one option resulted in substantially reduced impacts. While the preferred option, AR3C is shown to have a greater impact on Mahony's Toadlet habitat, this is generally a small proportion of the overall habitat area within the study area.

The results of the options assessment of maintenance facility layout was also mixed. Options A and B are marginally preferred in terms of a reduced impact on Mahony's Toadlet habitat, however both of these options provide slightly greater impacts on the TEC *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest. One advantage of option A and B is that they move facilities out of the northern portion of the study area, thus allowing larger continuous areas of Mahony's Toadlet habitat and *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm Forest (AECOM, 2017).

It should be noted that both options A and B are conceptual only. That is, these options were prepared for the purposes of documenting potential changes to the layout to avoid more ecologically sensitive areas only. These options have not been fully verified by detailed design to ensure actual operational functionality and/or constructability (AECOM, 2017).

The area of direct impact will continue to be reviewed throughout the detailed design stage and where practicable further reductions may be achievable.

6.2 Mitigation measures

Residual impacts that cannot be avoided or minimised are mitigated wherever practicable. In order to address the impacts of the Project on Mahony's Toadlet, Wallum Froglet and other biodiversity, the following mitigation measures are recommended (refer Table 6.3) along with a number of long-term strategies including Conservation Management Plan (CMP) to be prepared for Mahony's Toadlet and Wallum Froglet (refer Section 6.2.1).

Table 6.3 Proposed mitigation measures

IMPACT	MITIGATION MEASURE
Removal of native vegetation and fauna habitats	→ Clearing of vegetation should be minimised, to only vegetation that is absolutely required to be removed in order to undertake work. → Implement clearing protocols, including: ▪ Environmental manager or ecologist to undertake a pre-clearance survey to identify any habitat that may be present on limbs or in tree to be removed such as bird nests or fauna roosting. ▪ Removal of any hollow bearing trees or limbs to be supervised by an ecologist in order to facilitate the relocation of any injured or displaced native fauna. ▪ Check trees for the presence of bird nests and potentially arboreal mammals, prior to felling. ▪ As far as practicable, animals found to be occupying trees would be allowed to leave before clearing. ▪ Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling. ▪ Establish exclusion zones to protect vegetation and fauna habitat outside of the assessed and approved clearing limits, including the threatened ecological communities recorded within the study area (including Swamp Sclerophyll Forest, Lowland Rainforest and *Melaleuca Biconvexa*). ▪ The limits of clearing would be clearly demarcated on-site prior to construction to avoid unnecessary vegetation and habitat removal. → Restrict equipment placement, storage and stockpiling of removed branches and trees to designated areas in cleared land.
Aquatic impacts	→ Minimise the clearing of aquatic habitats (ephemeral ponds) to that which is absolutely necessary for the safe construction and operation of the proposed Project. → Incorporate existing drainage channels into design of proposed Project drainage channels where practicable. → Protect aquatic habitats and riparian zones where works are not required with exclusion zones. → Control and manage potential contaminants (fuels, oils, lubricants) from construction activities. → Install high visibility signs at freshwater aquatic sites occurring outside the proposal area, to inform workers of no go areas and that these areas are environmentally sensitive. This is particularly important during spring and summer when migratory shorebirds and waders use such habitats. → Design and construct waterway crossings in accordance with the DPI's fish passage requirements (Fairfull et al., 2003). → Riparian and fringing aquatic vegetation would be replanted in disturbed areas immediately after construction to stabilise creek banks.
Direct mortality	→ Implementation of clearing protocols as per removal of native vegetation and fauna habitats. → Where practicable and feasible, one wall of proposed drainage detention basins could be graded or trimmed to provide a gradient that is amenable for fauna to escape on their own accord.
Impacts to groundwater dependent ecosystems (swamp forest)	→ A groundwater management plan and monitoring program would be developed and implemented to address potential impacts to groundwater, if encountered. → Revegetate disturbed areas with native vegetation where appropriate.
Erosion and sedimentation	→ Erosion and sediment controls should be implemented in accordance with the Blue Book (Department of Environment and Climate Change, 2008). → Revegetate disturbed areas with native vegetation groundcover where appropriate. → Avoid excessive soil disturbance. → When accessing construction sites, contractors should only use designated access tracks.

IMPACT	MITIGATION MEASURE
Weed invasion	→ Noxious weeds within the study area will be managed in accordance with the *Noxious Weeds Act 1993.* → Management techniques may include immediate weed removal and disposal without stockpiling, disposal of weed-contaminated soils at appropriate weed disposal facilities and to ensure that all equipment is cleaned prior to and on completion of works to ensure weeds are not introduced or spread to other locations.
Invasion and spread of pathogens and disease	→ Protocols to prevent the introduction and/or spread of Chytrid fungus would be implemented. These protocols would be based on OEH Hygiene Protocol for the Control of Disease in Frogs. → Protocols and site hygiene to prevent the introduction and/or spread Myrtle rust would be implemented (i.e. vehicle and equipment wash down facilities).
General	→ Ensure all workers are provided an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches. → Prepare a flora and fauna management plan as part of the Construction Environmental Management Plan.
Residual impacts	→ Develop an offset strategy to mitigate the impact of clearing native vegetation. This will fulfil the need to improve or maintain as required in the *Principles for the use of biodiversity offsets in NSW.*

6.2.1 Long-term management strategies

6.2.1.1 Conservation management plan

A Conservation Management Plan (CMP) will be prepared for Mahony's Toadlet and the Wallum Froglet. The aim of this CMP is to address the conservation significance of Mahony's Toadlet and Wallum Froglet in the study area and to specify effective management and mitigation of potential impacts to Mahony's Toadlet and Wallum Froglet during the construction and operational phases of the Project. This CMP will also address the potential requirement for compensatory offset strategies. This CMP should be included in the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) for the Project.

The following management measures outlined within the CMP would be implemented to minimise potential impacts on Mahony's Toadlet and Wallum Froglet within the study area:

- → Environmental induction training
- → Site hygiene management
- → Temporary frog exclusion fencing
- → Permanent frog exclusion fencing
- → Pre-clearing surveys (nocturnal and diurnal)
- → Relocation procedures
- → Construction works procedures
- → Reporting procedures
- → Retention of onsite habitat (refer to section 6.3.4.1)
- → Creation of habitat enhancement areas
- → Monitoring procedures for onsite conservation areas, inclusive of retained habitat and created habitat.

6.2.1.2 Monitoring

To ensure that onsite retained habitat areas are maintained or improved as a result of ameliorative measures implemented, routine monitoring of physical and ecological parameters of Mahony's Toadlet and Wallum Froglet habitat would be required. A monitoring program would be developed in accordance with the Project's Conditions of Approval and in consideration of the Project BAR, the previous SIS and this SIS.

Monitoring time frames would be dependent on the variable being measured, however this monitoring should consider the following time frames:

- Pre-construction
- During construction
- Post construction, annually for a period up to five years.

6.2.1.3 Revegetation of temporarily disturbed ground

Depending on vegetation and project type, mitigation measures generally employed during temporary construction would include the following:

- Landscaping and revegetation
- Site rehabilitation.

It is proposed that all areas of temporarily disturbed ground, such as construction compound or stockpile areas, would be revegetated in accordance with a site specific Vegetation Management Plan (VMP). The VMP would:

- Identify specific areas in the study area for rehabilitation
- Detail revegetation plan for identified areas
- Specify use of locally occurring native species with reference to designated vegetation community type
- Identify appropriate timing for rehabilitation works
- Detail relevant inspections during rehabilitation works
- Corrective actions and adaptive management.

6.2.1.4 Monitoring under the construction environmental management plan

Ongoing monitoring for the effectiveness of mitigation measures would be detailed in the Project CEMP, OEMP and/or CMP. The purpose of this document is to outline key actions for environmental (and ecological) management and to monitor the effectiveness of the biodiversity mitigation measures that were recommended in the BAR (as appended to the Project REF). The monitoring relates to the general impacts of construction activities on ecological characteristics, such as native vegetation (including EECs), fauna habitats, aquatic habitats and general ecological values in the immediate vicinity of the Project.

The CEMP/CMP or similar document would detail the following proposed mitigation measures, including timing, monitoring procedure, responsibilities and performance measures:

- Environmental induction for site personnel
- Delineation of no-go zones
- Weed monitoring and treatment:
  - heavy machinery inspections
  - hygiene protocols
  - chemical and physical control methods
- Vegetation clearing:
  - demarcation of vegetation in the construction footprint (subject site)
  - pre-clearing surveys and inspections
  - pre-clearing surveys for amphibians
  - removal of vegetation
  - fauna handling and relocation
- Pathogens and disease:
  - protocols to prevent the introduction or spread of Chytrid Fungus
- Aquatic disturbance:
  - control and management of potential contaminants (i.e. fuels and lubricants)
  - water sampling of Chittaway Creek (chemical/physical analysis)
- Implementation of environmental controls:
  - erosion and sediment control
  - minimising incidence of fauna being trapped in drainage detention basins
  - revegetation of temporarily disturbed grounds (referencing site specific VMP).

6.3 Compensatory offset strategies

6.3.1 Is an offset required?

The need for biodiversity offsets is founded in the theory of 'avoid, minimise and mitigate' the impacts of projects. The accepted approach to environmental assessment requires that, in the first instance, environmental impacts are avoided or minimised as far as practicable and subsequently reduced to acceptable levels through appropriate mitigation techniques. Where measures to avoid and mitigate impacts are not feasible or cost effective than offset strategies can be used to compensate the residual impacts of the development on biodiversity.

Transport for NSW has followed the 'avoid, minimise and mitigate' theory by firstly avoiding impacts to approximately 5.9 hectares of Mahony's Toadlet habitat and approximately 0.6 hectares of Wallum Froglet habitat within the study area via modifications in design. Further avoidance of habitat clearing has the potential to occur during the detailed design phase of the Project.

Although the Project will avoid and minimise impacts, it is likely that up to 27 hectares of native vegetation would be removed, which provides habitat for threatened fauna. This includes 13.8 hectares which is considered to provide potential habitat for Mahony's Toadlet, and 2.4 hectares is considered potential habitat for Wallum Froglet. Subsequently, it would be necessary to provide biodiversity offsets to fulfil the CERs and OEHs requirements for the SIS.

Offset requirements for other biodiversity have been identified and approved under the previous SIS (WSP | Parsons Brinckerhoff, 2016c).

6.3.2 Biodiversity offset policy and guidelines

In order to address the SIS CERs for the Project, this biodiversity offset strategy has been developed with reference to:

- The OEH Principles for the use of biodiversity offsets in NSW (Office of Environment & Heritage, 2016b).
- The BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage, 2014).

The relevant NSW and Commonwealth biodiversity offsetting principles and guidelines are summarised below. It is however noted that at the time of preparing this SIS changes to the NSW biodiversity offset policy and guidelines are imminent. Transport for NSW will consider these changes and the potential implications to the Projects offset requirements in consultation with DP&I and OEH.

6.3.2.1 Principles for the use of biodiversity offsets in NSW

The OEH have provided guidelines for developing biodiversity offsets to achieve conservation outcomes, particularly for projects where there will be an unavoidable loss of biodiversity (Office of Environment & Heritage, 2016b). Although not a defined requirement under legislation, these guidelines provide a list of 13 principles to be followed when developing biodiversity offsets:

- Impacts must be avoided first by using prevention and mitigation measures
- All regulatory requirements must be met
- Offsets must never reward ongoing poor performance
- Offsets will complement other government programs
- Offsets must be underpinned by sound ecological principles
- Offsets should aim to result in a net improvement in biodiversity over time
- Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs
- Offsets should be agreed prior to the impact occurring
- Offsets must be quantifiable (the impacts and benefits must be reliably estimated)
- Offsets must be targeted
- Offsets must be located appropriately

- Offsets must be supplementary
- Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contracts.

6.3.2.2 BioBanking scheme

The NSW government has developed the Biodiversity Banking and Offsets Scheme (BioBanking) to help address the loss of biodiversity values, including threatened species. This scheme was established under Part 7A of the TSC Act and uses offsets (where appropriate) to assist in addressing the cumulative effects of development in NSW and in particular, to help meet the goal of maintaining or improving biodiversity. This approach is intended to allow development to occur in a sustainable way without placing extra stress on the environment (Department of Environment and Climate Change, 2007a).

BioBanking consists of the following main components:

- Establishment of BioBank sites on private land through 'BioBanking agreements' with the Minister for the Environment. A BioBanking agreement is similar to a covenant and is attached to the land title. It stays with the land, and lasts in perpetuity to ensure that the BioBank site is managed for biodiversity conservation.
- Calculation of biodiversity credits through either:
  - creation of biodiversity credits for the gain in biodiversity values from taking management actions on a BioBank site
  - measuring the biodiversity credits required to offset the loss of biodiversity values due to the impacts of a development.
- The trading of biodiversity credits between development sites and BioBank sites to offset the impact of development on biodiversity.

The BBAM establishes two classes of biodiversity credits that may be created:

- Ecosystem credits – these are created or required for all impacts on biodiversity values (including threatened species that can be reliably predicted by habitat surrogates), except the threatened species or populations that require species credits.
- Species credits – these are created or required for impacts on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Species Profile Database.

The OEH maintains the BioBanking public register which lists biodiversity credits generated at BioBank sites for sale, BioBank site expressions of interest (EOI) register and lists of biodiversity credits which are required to offset development impacts.

While the BBAM represents an alternative pathway to that of the SIS for Part 4 matters, it also provides a currently recognised methodology to quantify the offset requirements for a project's residual impacts. OEH has requested that biodiversity offset requirements for the Project are quantified using the BioBanking Assessment Methodology 2014.

6.3.3 Estimating the Projects offset requirements

To estimate the biodiversity offset requirements for the Project, an assessment using the BioBanking credit calculator (tool version 4.1) has been completed.

6.3.3.1 Estimate of Mahony's Toadlet offset requirements

Due to the very recent scientific description of Mahony's Toadlet (Clulow et al., 2016), together with the recent determination for listing as a threatened species under the TSC Act (NSW Scientific Committee, 2017), there is no formal method under BioBanking to quantify the Projects impacts and corresponding offset requirements for Mahony's Toadlet.

It is proposed that offsets for Mahony's Toadlet are restricted to ecosystem credits directly associated with the areas of potential Mahony's Toadlet habitat in the locality (Figure 4.5) and/or ecosystem credits for PCT matching those described in the literature (Clulow *et al.*, 2016) (NSW Scientific Committee, 2017) and the associated geomorphological characteristics (Clulow et al., 2016).

The BioBanking credit calculator estimated that approximately 793 ecosystem credits would be required to offset the Project impacts on 13.8 hectares of Mahony's Toadlet habitat (as identified in section 4.3.1.1 and Figure 4.4). An overview of the ecosystems required is provided in Table 6.4.

Table 6.4 Summary of Mahony's Toadlet habitat to be impacted and ecosystem credits required to offset impacts

BIOMETRIC VEGETATION TYPE	PLANT COMMUNITY TYPE	THREATENED ECOLOGICAL COMMUNITY	AREA TO BE IMPACTED (ha)	RED FLAG	ESTIMATED CREDIT REQUIRED
HU937	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Moderate to Good – High Quality)	Yes	8.8	Yes	744
	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Moderate to Good – Medium Quality)	Yes	2.7	Yes	
	Melaleuca biconvexa – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Low Condition)	Yes	0.9	No	
HU782	Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (Moderate to Good – High Quality)	No	1.02	No	49
Total			**13.8**		**793**

Note: With respect to Table 6.4, Red Flag refers to an area of land that contains an Endangered Ecological Community that is not in low condition.

6.3.3.2 Estimate of Wallum Froglet offset requirements

The BioBanking credit calculator estimated that the Project will also be required to offset the removal of 2.4 hectares of Wallum Froglet habitat from within the subject site with 31 Wallum Froglet species credits (Table 6.5).

Table 6.5 Species credit required for the Project

SCIENTIFIC NAME	COMMON NAME	NUMBER OF INDIVIDUALS OR AREA (ha) TO BE REMOVED	NUMBER OF CREDITS REQUIRED
Crinia tinnula	Wallum Froglet	2.4	31

6.3.4 Potential offset options

A biodiversity offset strategy (BOS) for the Project is currently being developed in accordance with the previous SIS conditions of approval provided by OEH. Subject to the approval of this SIS the BOS would be further updated to incorporate offsets requirements identified in 6.3.3 above and developed with reference to the principles for the use of biodiversity offsets in NSW (refer to section 7.1.2.2). In accordance with these principles, the feasibility of potential offset options will be assessed using the following criteria:

- → Duration – measures must offset the impact of the development for the period that the impact occurs
- → Accuracy – the impacts and benefits must be reliably estimated

- Suitability – measures must offset the impact in the same region
- Effort – measures must be undertaken beyond existing requirements and not already be funded by another scheme
- Enforcement – measures must be enforceable through development consent conditions, license conditions, convents or a contract.

Offset strategies may include both on and offsite or local area proposals that contribute to the long term conservation of threatened species and ecological communities. The offset strategies which are considered for the Project will include a combination of the following in order of preference:

- Onsite offsets – securely conserve and improve the condition of existing habitat or providing a buffer to an area of existing habitat within the study area
- Purchase of biodiversity credits under the NSW BioBanking Scheme
- Offsite offsets – securing and improving the condition of existing habitats at another site.

Given that similar habitats will be retained within the study area the preferred option would be to securely conserve and improve these areas as onsite offset areas (Figure 5.1, Figure 5.2). In addition the participation in BioBanking, involving the purchase of biodiversity credit from a BioBank, would aid in fulfilling the remaining offset requirements.

Transport for NSW is committed to delivering an offset package that will appropriately offset the impacts of the Project in consultation with DoEE, DP&I and OEH. It is acknowledged that the biodiversity offset package may incorporate one or more of the options above to deliver an offset package for the Project that satisfies the CERs and agency conditions.

6.3.4.1 Onsite exclusion zones (offset areas)

Through recent design workshops specifically targeted at the retention of Mahony's Toadlet and Wallum Froglet habitat within the study area, TfNSW has nominated six exclusion zones (or onsite offsets) within the subject site (Figure 5.1, Figure 5.2).

The exclusion zones include 8.98 hectares of native vegetation, incorporating 5.9 hectares of Mahony's Toadlet habitat and 0.6 hectares of Wallum Froglet habitat that would be managed appropriately through a CMP to be developed for the Project. The CMP plan would clearly document areas of retained vegetation and/or habitat features to ensure their long-term conservation and viability of both species. Refer to section 6.2.1.1 for more details.

A summary of the onsite offset areas as shown in Figure 5.1, Figure 5.2 and detailed Table 6.6.

Table 6.6 Retention of Mahony's Toadlet and Wallum Froglet habitat

EXCLUSION ZONE	TOTAL AREA (HA)	MAHONY'S TOADLET HABITAT (ha)	WALLUM FROGLET HABITAT (ha)
Orchard Road	1.8	1.2	0.1
Central A	0.6	0.46	–
Central B	0.67	0.67	0.14
Rail	0.66	0.66	0.27
Turpentine Road	1.45	0.07	0.04
Triangle	2.83	2.83	0.04
Ourimbah Road	0.97	–	0.01
Total	**8.98**	**5.9**	**0.6**

6.3.4.2 Purchase of credits

BioBanking enables a proponent to offset the biodiversity impacts of a proposed development by buying and retiring biodiversity credits. Often, the BBAM requires offsets to include the same vegetation type or formation and to occur within the same Interim Biogeographical Regionalisation for Australia Subregion. For the purposes of BioBanking, the characteristics of the study area are summarised in Table 6.7.

Table 6.7 Criteria of the study area relevant to BioBanking

CRITERIA	LOCATION
Council	The former Wyong Shire Council, now known as the Central Coast Council
Bioregion	Sydney Basin
Catchment Management Area	Hunter–Central Rivers CMA Wyong sub-catchment
Species credit requirements	Wallum Froglet
Vegetation community type to be cleared	HU937 – *Melaleuca biconvexa* – Swamp Mahogany – Cabbage Palm swamp forest of the Central Coast (Swamp Sclerophyll Forest)
	HU782 – Blackbutt – Turpentine – Sydney Blue Gum mesic tall open forest on ranges of the Central Coast

6.3.4.3 Consideration of other offset options

CONTRIBUTIONS TO LAND MANAGEMENT FOR CONSERVATION

The Project is located within the Central Coast Council Local Government Area (LGA) and the development of the offset package should consider local requirements. This could include financial (or other) contributions to the *Saving our Species* sites for Mahony's Toadlet and or Wallum Froglet, including potentially the Porters Creek Management site and/or the Wyrrabalong National Park.

As part of the development of the offset package for the Project, TfNSW are investigating the possibility of contributions that can be used to facilitate restoration of Mahony's Toadlet and/or Wallum Froglet habitats. In particular, contributions would be targeted at known habitats sites for these species.

Any contributions would be seen as discounting the quantum of the offset requirements for the Project determined using the BBAM.

6.3.4.4 Security of offset sites

Transport for NSW is committed to delivering an offset that will provide ongoing conservation of suitable habitats in perpetuity for the benefit of future generations. Offset sites must be enduring and must offset the impact of the development for at least the period that the impact occurs. The security of land tenure and ongoing management of offset site(s) is critical to the long-term viability of offsets and must be carefully considered.

To ensure the conservation of lands in-perpetuity, the offset strategy will require the dedication of the identified offset sites under a secure conservation arrangement. There are a number of options available to secure land under permanent conservation agreements. Transport for NSW is committed to exploring and identifying the most suitable conservation arrangement for land in consultation with the relevant stakeholders. Potential options in order of preference may include:

- Obtaining a BioBanking agreement
- Voluntary Conservation Agreements under the NPW Act
- Trust Agreements under the *Nature Conservation Trust Act 2001* (NCT Act)
- Transfer of lands to National Park Estate.

6.3.4.5 Compensatory offsets summary

The Project would require the removal of 13.8 hectares of Mahony's Toadlet habitat and 2.4 hectares of Wallum Froglet habitat, or approximately 793 ecosystem credits and 45 species credits using the BioBanking credit calculator (BBAM tool Version 4.1). It is proposed that these offset requirements will be incorporated into the BOS currently being developed in accordance with the previous SIS conditions of approval provided by OEH.

The Projects preferred options for offsetting include onsite offsets and purchase of biodiversity credits under the NSW BioBanking Scheme.

Transport for NSW are currently identifying a range of potential offset sites for inclusion within the BOS. These sites will contain large areas of the wetland communities, or similar wetland communities that are required to be offset. The Project will offset its impacts in accordance with the OEH principles for the use of biodiversity offsets in NSW (Office of Environment & Heritage, 2016b) and/or in consultation with DoEE, DP&I and OEH.

7 ASSESSMENT OF SIGNIFICANCE OF LIKELY EFFECT OF PROPOSED ACTION

The Project will be assessed under Part 5 of the EP&A Act. Section 5A of the EP&A Act requires that a seven part test is undertaken to assess the likelihood of significant impact upon threatened species, populations or ecological communities listed under the TSC Act (Department of Environment and Climate Change, 2007c).

An assessment of significance (7 part test) was completed in accordance with the TSC Act for Mahony's Toadlet and Wallum Froglet as presented below.

7.1 Mahony's Toadlet (*Uperoleia mahonyi)*

IN THE CASE OF A THREATENED SPECIES, WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON THE LIFE CYCLE OF THE SPECIES SUCH THAT A VIABLE LOCAL POPULATION OF THE SPECIES IS LIKELY TO BE PLACED AT RISK OF EXTINCTION

One Mahony's Toadlet and approximately 19.7 hectares of habitat were recorded within the study area (Figure 4.4, Table 4.6). Of this, approximately 13.8 hectares is likely to be impacted by the Project.

In examining the life cycle of Mahony's Toadlet, the semi-permanent and ephemeral depressions on sandy substrates in the study area could potentially support breeding habitat for the species. In total, approximately 11.1 hectares (comprising 2.3 hectares of semi-permanent water habitat and 8.8 hectares of ephemeral water habitat) has been mapped as occurring in the study area. However, in consideration of freshwater inputs across different climatic contexts, different areas of the study area are likely to be used at different times. The areas of lowest elevation (semi-permanent water habitat) are likely to constitute the most important potential breeding habitat for Mahony's Toadlet during dryer cycles. During wetter periods ephemeral water habitat may also provide potential breeding habitats. It is yet to be concluded through extensive field survey effort that a breeding population occurs in the study area.

The habitat in the study area is unlike those where confirmed breeding populations have been recorded (Clulow *et al*., 2016). The swampy wallum habitats on bleached coastal sands with permanent standing water, where breeding populations of the species are known to occur (i.e. Oyster Cove and the Wyrrabalong National Park) (Clulow *et al*., 2016), are in contrast to the study area's grey silty sand substrates with ephemeral depressions. Given this species is mostly confined to habitats defined by leached sands and breeding habitats within permanent freshwater wetlands (Clulow *et al*., 2016), it may be inferred that onsite habitats are marginal in comparison to the habitats described at the type localities.

The importance of the habitat within the study area is limited by only one individual being recorded following significant targeted surveys during optimal conditions and seasons. Despite this species known to be vocal and congregate in large numbers at other sites within its distribution (Clulow *et al*., 2016). The results of these surveys suggest the Mahony's Toadlet numbers in the study area are of limited abundance. The absence of additional records may also indicate the habitat within the subject is of lower significance to other potential more intact habitats that occur in the locality and of even lower significance than regional habitats where breeding populations are known to occur.

There are currently no other records of Mahony's Toadlet within the locality, however approximately 2,125 hectares of potential Mahony's Toadlet habitat has been mapped therein. Of this, approximately 1,212.46 hectares (or 57 per cent) occurs within protected reserves. The swampy wallum habitats within the locality to the north-east of the study area, such as Tuggerah State Conservation Area (approximately 3.8 kilometres) and Tuggerah Nature Reserve (approximately 4.9 kilometres) are potentially suitable for the species and more contiguous than those of the subject site. These areas of National Park Estate account for approximately 247 hectares (or 12 per cent) of potential Mahony's Toadlet habitat in the locality. Given the

species relatively recent discovery and taxonomic description it is highly likely further observations of this species within areas of potential habitat and within the species distribution will be recorded.

The Project has identified exclusion zones that will retain approximately 5.9 hectares of Mahony's Toadlet habitat within the study area and will continue to facilitate the species ongoing dispersion around the study area.

Therefore given the relatively limited occurrence of this species within the study area, marginal habitat types compared to the species known type localities in the region, distribution of larger areas of similar and/or better quality potential habitats for this species within the locality and retention of habitat within the study area, the Project is unlikely to result in adverse effect on the lifecycle of the species such that a viable local population of the species will be placed at risk of extinction.

IN THE CASE OF AN ENDANGERED POPULATION, WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON THE LIFE CYCLE OF THE SPECIES THAT CONSTITUTES THE ENDANGERED POPULATION SUCH THAT A VIABLE LOCAL POPULATION OF THE SPECIES IS LIKELY TO BE PLACED AT RISK OF EXTINCTION

This criteria is not applicable, as Mahony's Toadlet is not an endangered population.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

This criteria is not applicable, as Mahony's Toadlet is not an ecological community.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

The extent to which habitat is likely to be removed or modified as a result of the action proposed

The project will require the removal of approximately 13.8 hectares of Mahony's Toadlet habitat, including 1.7 hectares of semi-permanent water habitat, which potentially constitutes breeding habitat during dry cycles and an additional 5.6 hectares of ephemeral water habitat providing potential breeding habitat during wetter periods.

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor, road network and managed rural residential lands. The Project would add incrementally to existing fragmentation of habitat within the study area.

In reference to Figure 5.1, the proposed layout of the Project has considered the retention of habitat and the provision of connectivity of these habitats within the study area. In effect this layout maintains connectivity and prevents the isolation of retained exclusion zones within the study area and provides opportunities for further connectivity.

The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality

The project will require the removal of approximately 13.8 hectares of Mahony's Toadlet habitat**.**

The importance of the habitat within the study area is limited by only one individual being recorded following significant targeted surveys during optimal conditions and seasons. The results of these surveys suggest the Mahony's Toadlet numbers in the study area are of limited abundance. The absence of additional records may also indicate the habitat within the subject is of lower significance to other potential more intact habitats that occur in the locality and of even lower significance than regional habitats where breeding populations are known to occur.

Given the limited information currently available on the species and the study area containing the only currently known habitat for this species within the locality, a precautionary approach has been applied and the study area is considered important to the long term survival of the species in the locality.

The Project has therefore identified exclusion zones, which retain approximately 5.9 hectares of Mahony's Toadlet habitat in the study area. The habitat to be retained is in addition to large areas of similar and/or better quality potential habitats for this species remaining within the locality, including areas within the secure conservation reserve estate.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

No recovery plan currently exists for this species. However as Mahony's Toadlet is primarily associated with wallum habitats, it could be considered that existing recovery plans for wallum dependant frog species are likely to be relevant to this species. The actions needed for recovery of wallum-dependent frog species include:

- Identify and assess essential habitat
- Protect wallum frog populations and manage habitat
- Acquire information on threats to inform management
- Engage stakeholders and the broader community in recovery of wallum frog species
- Rehabilitate degraded wallum frog habitat
- Monitor frog numbers and distribution.

The Project is likely to result in actions that are not consistent with the objectives above, in particular clearing of this species habitat. However the Project has identified exclusion zones that will retain approximately 5.9 hectares of Mahony's Toadlet habitat within the study area and will continue to facilitate the species ongoing dispersion around the study area. The Project also includes provision for the retention and management of habitat through a Conservation Management Plan for Mahony's Toadlet (and Wallum Froglet) that is commensurate with most of the actions listed above.

WHETHER THE ACTION PROPOSED CONSTITUTES OR IS PART OF A KEY THREATENING PROCESS OR IS LIKELY TO RESULT IN THE OPERATION OF, OR INCREASE THE IMPACT OF, A KEY THREATENING PROCESS

As Mahony's Toadlet is primarily associated with wallum habitats, it could be considered that identified key threatening processes for other wallum dependant frog species are likely to be relevant to this species. The following list of threats has been compiled from the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent Frog Species*:

- Habitat loss (urban development and sand mining)
- Habitat degradation
- Habitat fragmentation as a result of land clearing
- Exotic disease
- Predation by introduced Eastern Gambusia

- Use of biocides in weed and mosquito control
- Pig damage
- Vehicular traffic.

With respect to Mahony's Toadlet, the Project is will result in 13.8 hectares of habitat loss and habitat fragmentation. The Project will add incrementally to these threatening processes, however the implementation of conservation strategies to be outlined in the Conservation Management Plan, will assist in mitigating or reducing the effect of these threatening processes.

CONCLUSION

To date one individual Mahony's Toadlet has been recorded in the study area associated with 19.7 hectares of habitat. Despite extensive targeted surveys under optimal conditions no further records of this species have been recorded.

The study area does not contain permanent freshwater habitat associated with known breeding sites for this species, however semi-permanent and ephemeral depressions appear to support water for long periods between local rainfall events and may potentially provide breeding habitat for the species.

The Project will impact on approximately 13.8 hectares of this species habitat while retaining approximately 5.9 hectares of habitat within the study area, including the potential breeding habitat in the form of semi-permanent and ephemeral depressions. It will also continue to facilitate the species ongoing dispersion around the Project.

The assessment presented above has evaluated the Project and its possible adverse impacts on the local population of Mahony's Toadlet. The Project will impact on the only currently known habitat for this species within the locality.

Little is known about this relatively new frog species and its dependence on the potential habitats within the locality and study area. In this regard a precautionary approach has been applied and the Project is considered likely to have a significant impact upon Mahony's Toadlet.

7.2 Wallum Froglet (*Crinia tinnula)*

IN THE CASE OF A THREATENED SPECIES, WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON THE LIFE CYCLE OF THE SPECIES SUCH THAT A VIABLE LOCAL POPULATION OF THE SPECIES IS LIKELY TO BE PLACED AT RISK OF EXTINCTION

Four individual Wallum Froglets were detected in two discrete locations of the study area during targeted seasonal surveys. In the context of the local population, the study area forms part of low-lying swamp vegetation associated with Ourimbah Creek and the broader western and southern Tuggerah Lake floodplain. This area forms a mosaic of coastal swamp vegetation that extends in the north from the Porters Creek Wetland to the south east that includes the Tuggerah Nature Reserve along with a number of smaller Council reserve areas including Berkeley Creek and Tumbi Creek Wetlands.

The local population of the Wallum Froglet appears to form a stronghold within the Porters Creek Wetland area and surrounds with smaller discrete sub-populations recorded from Berkley Creek Wetland and Tumbi Creek Wetland (Office of Environment & Heritage, 2017a). The study area is considered to form part of the southern Tuggerah Lake sub-population that appears to be associated to the broader Central Coast meta-population that extends from approximately Redhead in the north to the Tuggerah Lake floodplain in the south.

Within the study area, the Wallum Froglet is considered to occupy semi-permanent to ephemeral shallow depressions within a broader swamp forest type habitat. The species is known to occupy generally acidic soil water habitats (<6 pH) with two discrete areas of occupancy identified within the study area, totalling approximately 1.4 hectares. In addition, a further 1.6 hectares of potential habitat is considered to occur in association with semi-permanent water. These habitats may facilitate breeding opportunities for Wallum

Froglet, but would be dependent on freshwater input during favourable seasonal conditions. Foraging and shelter habitat is likely to occur at the margins of these shallow depressions.

Given the small number of records from the study area, despite extensive surveys conducted during suitable conditions, the habitat is considered marginal in the context of habitats associated with the broader meta-population. In total, approximately 3.0 hectares of occupied and potential Wallum Froglet habitat has been mapped as occurring in the study area. Of this, approximately 2.4 hectares will likely be impacted by the Project, including 1.1 hectares of occupied habitat and 1.3 hectares of potential habitat.

A CMP would be developed for Wallum Froglet in the study area, central of which, is the retention of exclusion zones. The nominated exclusion zones would retain semi-permanent and ephemeral depression habitat whilst also providing connectivity, so as to avoid any isolation of habitats in the study area. In total, the Project would retain approximately 0.6 hectares of Wallum Froglet habitat, inclusive of 0.3 hectares of occupied habitat and 0.3 hectares of potential habitat.

Therefore, given the marginal status of onsite habitat, the retention of suitable habitat in the study area, and the distribution of larger areas of similar or better quality habitat for this species in the within broader meta-population, the Project is not likely to result in a viable local population of the species be placed at risk of extinction.

IN THE CASE OF AN ENDANGERED POPULATION, WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON THE LIFE CYCLE OF THE SPECIES THAT CONSTITUTES THE ENDANGERED POPULATION SUCH THAT A VIABLE LOCAL POPULATION OF THE SPECIES IS LIKELY TO BE PLACED AT RISK OF EXTINCTION

This criteria is not applicable, as Wallum Froglet is not an endangered population.

IN THE CASE OF AN ENDANGERED ECOLOGICAL COMMUNITY OR CRITICALLY ENDANGERED ECOLOGICAL COMMUNITY, WHETHER THE ACTION PROPOSED:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

This criteria is not applicable, as Wallum Froglet is not an ecological community.

IN RELATION TO THE HABITAT OF A THREATENED SPECIES, POPULATION OR ECOLOGICAL COMMUNITY:

The extent to which habitat is likely to be removed or modified as a result of the action proposed.

The Project will require the removal of approximately 2.4 hectares of Wallum Froglet habitat, including 1.1 hectares of occupied habitat and 1.3 hectares of potential habitat, which constitute marginal wallum habitat.

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action.

Habitat within and immediately surrounding the study area is already fragmented by the existing rail corridor, road network and managed rural residential lands. This has created a mosaic of smaller and somewhat fragmented patches of habitat on flat alluvial valleys leading to forested foothills and ranges. The Project would add incrementally to existing fragmentation of habitat within the study area and broader Central Coast meta-population area of occupancy.

In reference to Figure 5.2, the proposed layout of the Project has considered the retention of habitat and the provision of connectivity of these habitats within the study area. In effect this layout maintains connectivity

and prevents the isolation of retained conservation habitats within the study area and provides opportunities for further connectivity to additional areas of potential habitats outside of the study area.

In short, whilst the proposed action will result in the loss of habitat for the Wallum Froglet within the subject site, this impact is considered unlikely to result in an area of habitat becoming fragmented or isolated from other areas of habitat that would adversely affect the long-term survival of the species in the locality.

The importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality.

The small sub-population of Wallum Froglet recorded in the study area is suspected to be part of a larger area of occupancy associated with wallum habitats on parts of the western and southern Tuggerah Lake floodplain. Although the Wallum Froglet is a cryptic species, they have a distinct call and in suitable habitat, often occur in numbers. The level of survey effort encompassing a range of seasonal contexts, over multiple years and through suitable conditions for detection suggests that habitat in the study area is potentially of lower significance to habitat supporting the larger population north of the study area in the vicinity of Porters Creek Wetland.

Habitat for the Wallum Froglet within the study area, whilst considered marginal, may facilitate breeding opportunities for Wallum Froglet, but would be dependent on freshwater input during favourable seasonal conditions. Foraging and shelter habitat is likely to occur at the margins of these shallow depressions.

The Project will retain habitat for Wallum Froglet within the study area and large areas of similar and/or better quality potential habitats for this species will remain within the locality. Given the marginal nature of the habitat to be removed, modified, fragmented or isolated it is considered the proposed action is unlikely to adversely affect the long-term survival of Wallum Froglet in the locality.

WHETHER THE ACTION PROPOSED IS LIKELY TO HAVE AN ADVERSE EFFECT ON CRITICAL HABITAT (EITHER DIRECTLY OR INDIRECTLY)

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities. Under the TSC Act, the Chief Executive maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

WHETHER THE ACTION PROPOSED IS CONSISTENT WITH THE OBJECTIVES OR ACTIONS OF A RECOVERY PLAN OR THREAT ABATEMENT PLAN

Wallum Froglet is listed under the *National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent frog species (Meyer et al., 2006*). The actions needed for recovery of wallum-dependent frog species include:

- → Identify and assess essential habitat
- → Protect wallum frog populations and manage habitat
- → Acquire information on threats to inform management
- → Engage stakeholders and the broader community in recovery of wallum frog species
- → Rehabilitate degraded wallum frog habitat
- → Monitor frog numbers and distribution.

The Project is likely to result in actions that are not consistent with the objectives above, in particular clearing of this species habitat. However the Project also includes provision for the retention and management of habitat through a conservation management plan for Wallum Froglet that is commensurate with the majority of the actions listed above.

WHETHER THE ACTION PROPOSED CONSTITUTES OR IS PART OF A KEY THREATENING PROCESS OR IS LIKELY TO RESULT IN THE OPERATION OF, OR INCREASE THE IMPACT OF, A KEY THREATENING PROCESS

Wallum Froglet is listed under the National Recovery Plan for the Wallum Sedgefrog and other Wallum-dependent frog species, which identifies the following as key threatening processes for wallum dependant frog species:

- Habitat loss (urban development and sand mining)
- Habitat degradation
- Habitat fragmentation as a result of land clearing
- Exotic disease
- Predation by introduced Eastern Gambusia
- Use of biocides in weed and mosquito control
- Pig damage
- Vehicular traffic.

With respect to Wallum Froglet, the Project would result in 2.4 hectares of habitat loss and habitat fragmentation. The proposed action will add incrementally to these threatening processes, however the implementation of conservation strategies to be outlined in the Conservation Management Plan, will assist in mitigating or reducing the effect of these threatening processes.

CONCLUSION

The Wallum Froglet has a distinct call and in suitable habitat, usually occurs in numbers. In March 2017, following significant local rainfall, four individual Wallum Froglets were detected in two discrete locations of the Project study area. Even though the species is cryptic, the level of survey effort encompassing a range of seasonal contexts, over multiple years and through suitable conditions for detection suggests that habitat in the study area is considered marginal in comparison to the habitat supporting larger populations north of the Project. The presence of Wallum Froglet recorded in the study area is likely to be a sub-population to a larger meta-population of Wallum Froglet associated with wallum type habitats surrounding the southern and western shores of Tuggerah Lake, with a core concentration located in the Porters Creek Wetland.

In total, approximately 3.0 hectares of occupied and potential Wallum Froglet habitat has been mapped as occurring in the study area. Of this, approximately 2.4 hectares will likely be impacted by the Project, including 1.1 hectares of occupied habitat and 1.3 hectares of potential habitat. The Project will retain approximately 0.6 hectares of Wallum Froglet habitat, inclusive of 0.3 hectares of occupied habitat and 0.3 hectares of potential habitat.

Whilst the proposed action would add incrementally to the threatening processes of habitat loss and habitat fragmentation in the region, the implementation of conservation strategies, including the retention of semi-permanent and ephemeral depressions outlined in the Conservation Management Pan for Wallum Froglet, will assist in mitigating or reducing the effect of these threatening processes.

It is therefore considered the Project is unlikely to have a significant impact on Wallum Froglet or its habitat.

8 ADDITIONAL INFORMATION

8.1 Qualification and experience

The contributors to the preparation of this report; their qualifications and their role is provided in Table 8.1.

Table 8.1 Contributors and their qualifications

NAME	QUALIFICATION	ROLE
Alex Cockerill	BSc (Hons)	Lead Ecologist – Project manager, field survey and technical review
Allan Richardson	BEnvSc (Hons)	Senior Ecologist – Field survey and reporting
Nathan Cooper	BEnvSc, Grad Dip Ornith	Senior Ecologist – Field survey and reporting
Clementine Watson	BEnvSc	Graduate Ecologist – Field survey and reporting
Rob Harrison	MEnvMgt, BEcoAg	Principal Ecologist – Reporting
Mark Stables	BSc (Hons)	Senior Ecologist – Field survey and technical review
Rob Suansri	BSc, BEc	Mapping and data management – GIS operator
Emily Mitchell	BDevStud	Mapping and data management – GIS operator
Arthur White	PhD	Expert Amphibian Report

8.2 Other approvals required for the development activity

Other approvals may be required under NSW legislation for the Project. Additional approvals may include Part 5 determination under the NSW EP&A Act. Before the Project can proceed, this SIS will require concurrence from OEH.

In addition to the preparation of an SIS, an EPBC referral has been made due to the likely significant impacts on the vulnerable listed species *Melaleuca biconvexa. Melaleuca biconvexa* is confirmed as not forming part of the controlled action, however impacts to Regent Honeyeater and Swift Parrot have been determined to be a controlled action by DOEE.

Additional approval requirements for the proposed works are provided in the relevant sections of the Project's REF.

8.3 Licensing matters relating to the survey

All work was carried out under the appropriate licences which included:

- Scientific Licence: SL100630 issued by OEH as required under Clause 22 of the *National Parks and Wildlife Regulations 2002* and Section 132C of the *National Parks and Wildlife Act 1974.*
- Animal Research Authority: Trim 15/74 issued by the Department of Industries and Investment NSW (Agriculture) as required under the *Animal Research Act 1985*.

9 BIBLIOGRAPHY

- AECOM 2017. New InterCity Fleet Maintenance Facility Provisional Desktop Options Assessment Report. Prepared for Transport for New South Wales.
- ANSTIS, M. 2002. *Tadpoles of South-eastern Australia: a Guide with Keys,* Sydney, New Holland Publishers.
- ATLAS OF LIVING AUSTRALIA. 2017. *Atlas of living Australia* [Online]. Available: www.ala.org.au/ [Accessed January 2017].
- BARKER, J., GRIGG, G. & TYLER, M. 1995. *A field guide to Australian Frogs,* Sydney, Surrey Beatty and Sons.
- BELL, S. 2002. The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales. Parts 1 and 2. Report to Wyong Shire Council. Wyong: Wyong Shire Council.
- BELL, S. 2004. The natural vegetation of the Gosford Local Government Area, Central Coast, New South Wales. Gosford: Unpublished report to Gosford City Council, East Coast Flora Survey.
- BIOSPHERE ENVIRONMENTAL CONSULTANTS PTY LTD 2016a. Expert Report - Likelihood of Occurrence of Threatened Frog Species - New Intercity Fleet Maintenance Facility Project (TfNSW). Kangy Angy, Central Coast, NSW. Biosphere Environmental Consultants Pty Ltd.
- BIOSPHERE ENVIRONMENTAL CONSULTANTS PTY LTD 2016b. Wallum froglet and Mahony's Toadlet Surveys, Kangy Angy, December 2016.: Biosphere Environmental Consultants Pty Ltd.
- BUREAU OF METEOROLOGY. 2016. *Climate Data Online* [Online]. Commonwealth of Australia. Available: http://www.bom.gov.au/climate/data/index.shtml?bookmark=136 [Accessed 3 June 2016].
- BUREAU OF METEOROLOGY. 2017. *Weather and climate data* [Online]. Available: http://www.bom.gov.au/climate/data/.
- CLULOW, S., ANSTUS, M., KEOGH, J. S. & CATULLO, R. 2016. A new species of Australian frog (Myobatrachidae: *Uperoleia*) from the New South Wales mid-north coast sandplains. *Zootaxa,* 4184**,** 285-315.
- DEBUS, S. J. S. 1995. Surveys of large forest owls in Northern New South Wales: methodology, calling behaviour and owls responses. *Corella,* 19**,** 38-50.
- DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2007a. Biodiversity Banking and Offsets Scheme - Scheme Overview. Sydney South.
- DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2007b. Introducing the NSW threatened species priorities action statement (PAS). Sydney South NSW: Department of Environment and Climate Change,.
- DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2007c. Threatened species assessment guidelines. The assessment of significance. Hurstville: Department of Environment and Climate Change.
- DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE. 2008. *Controlling Erosion and Sediment* [Online]. Hurstville: Department of Environment and Climate Change. Available: http://www.environment.nsw.gov.au/sustainbus/landscapeErosionSediment.htm [Accessed 12 November 2008].
- DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE 2009. Threatened species survey and assessment guidelines: field survey methods for fauna - Amphibians. Department of Environment and Climate Change.
- DEPARTMENT OF ENVIRONMENT AND CONSERVATION 2004. Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft). Hurstville: Department of Environment and Conservation.

- DEPARTMENT OF SUSTAINABILITY, E., WATER, POPULATION AND COMMUNITIES, 2013. Chytridiomycosis (Amphibian chytrid fungus disease) - Fact sheet. *In:* DEPARTMENT OF SUSTAINABILITY, E., WATER, POPULATION AND COMMUNITIES (ed.). Canberra.
- DEPARTMENT OF THE ENVIRONMENT. 2016. *Fauna databases and online resources* [Online].
- DEPARTMENT OF THE ENVIRONMENT WATER HERITAGE AND THE ARTS 2010. Survey guidelines for Australia's threatened frogs - guidelines for detecting frogs listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. *In:* DEPARTMENT OF THE ENVIRONMENT, W., HERITAGE AND THE ARTS (ed.). Department of the Environment, Water, Heritage and the Arts.
- EMM 2015a. Preliminary Ecological Assessment - New Intercity Maintenance Facility. St Leonards: Prepared for Transport for NSW.
- EMM 2015b. Preliminary Ecological Assessment: New Intercity Maintenance Facility St Leonards: prepared for Transport for NSW.
- EMM 2016. New Intercity Maintenance Facility - Threatened Species Observations Memorandum. St Leonards.
- FAIRFULL, S., WITHERIDGE, G. & FISHERIES, N. 2003. *Why Do Fish Need to Cross the Road: Fish Passage Requirements for Waterway Crossings*, NSW Fisheries.
- GHD 2015. Central Coast Train Stabling and Maintenance Facility Comparative Site Analysis
- HARDEN, G. 1992. *Flora of New South Wales Volume 3,* Kensington, University of New South Wales Press Ltd.
- HARDEN, G. 1993. *Flora of New South Wales Volume 4,* Kensington, University of New South Wales Press Ltd.
- HARDEN, G. 2000. *Flora of New South Wales Volume 1 (Revised Edition),* Kensington, University of New South Wales Press Ltd.
- HARDEN, G. 2002. *Flora of New South Wales Volume 2 (Revised Edition),* Kensington, University of New South Wales Press Ltd.
- KAVANAGH, R. P. & DEBUS, S. J. S. 1994. The Powerful Owl *Ninox strenua* in New South Wales. *Australian Birds* 28, supplement 21-38.
- MATTESON, K. C. & LANGELLOTTO, G. A. 2010. Determinates of inner city butterfly and bee species richness. *Urban Ecosyst***,** 1-15.
- MEYER, E., HERO, J.-M., SHOO, L. & LEWIS, B. 2006. National Recovery Plan for the wallum sedgefrog and other wallum-dependent frog species. A report prepared for the Department of the Environment and Water Resources, Canberra and Queensland Parks and Wildlife Service, Brisbane.
- NSW SCIENTIFIC COMMITTEE 2017. Determination for provisional listing of an endangered species on an emergency basis - Mahony's Toadlet (*Uperoleia mahonyi*). Hurstville: Office of Environment and Heritage.
- NSW SCIENTIFIC COMMITTTEE 2017. Determination for provisional listing of an endangered species on an emergency basis, of the frog Mahony's Toadlet *Uperoleia mahonyi*. *In:* NSW OFFICE OF ENVIRONMENT AND HERITAGE (ed.). Hurstville, NSW.
- OFFICE OF ENVIRONMENT & HERITAGE. 2016a. *BioNet Atlas of NSW Wildlife - Ecological Data for Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* [Online]. Available: http://www.environment.nsw.gov.au/AtlasApp/UI_Modules/TSM_/ProfileEdit.aspx?pId=10786&pType=Other&a=1 [Accessed 3 March 2016].
- OFFICE OF ENVIRONMENT & HERITAGE. 2016b. *OEH principles for the use of biodiversity offsets in NSW* [Online]. Available: http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.htm [Accessed 11 May 2016].

- OFFICE OF ENVIRONMENT & HERITAGE. 2017a. *Bionet Atlas of NSW Wildlife* [Online]. Available: http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx [Accessed 18 January 2017].
- OFFICE OF ENVIRONMENT & HERITAGE. 2017b. *Wallum Froglet profile* [Online]. Available: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10183 [Accessed 2017.
- OFFICE OF ENVIRONMENT AND HERITAGE 2014. BioBanking Assessment Methodology 2014. Sydney.
- OFFICE OF ENVIRONMENT AND HERITAGE. 2017a. *BioNet the Atlas of NSW Wildlife Database Search* [Online]. Available: http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx.
- OFFICE OF ENVIRONMENT AND HERITAGE. 2017b. *Mahony's Toadlet - profile* [Online]. [Accessed 20 April 2017.
- ROYAL BOTANIC GARDENS. 2016. *Plant Information Network System of The Royal Botanic Gardens and Domain Trust Version 2.0* [Online]. Available: http://plantnet.rbgsyd.nsw.gov.au/.
- STRALBERG, D., JONGSOMJIT, D., HOWELL, C., SNYDER, M., ALEXANDER, J., WIENS, J. & ROOT, T. 2009. Re-Shuffling of Species with Climate Disruption: A No-Analog Future for California Birds? *PLoS ONE,* 4**,** e6825.
- THACKWAY, R. & CRESSWELL, I. D. 1995. *An Interim Biogeographic Regionalisation of Australia,* Canberra, Australian Nature Conservation Agency.
- TROEDSON, A. L., HASHIMOTO, T. R., COLQUHOUN, G. P. & BALLARD, J. C. 2015. Coastal Quaternary Geology Data Package for NSW (Digital Dataset). Geological Survey of New South Wales, Maitland.
- WSP | PARSONS BRINCKERHOFF 2016a. New Intercity Fleet - Maintenance Facility Review of Environmental Factors
- WSP | PARSONS BRINCKERHOFF 2016b. New Intercity Fleet Maintenance Facility Biodiversity Assessment Report. An unpublished report prepared on behalf of Transport for NSW.
- WSP | PARSONS BRINCKERHOFF 2016c. New Intercity Fleet Maintenance Facility Project - Species Impact Statement. An unpublished report prepared on behalf of Transport for NSW.
- WSP | PARSONS BRINCKERHOFF 2017. Geotechnical Assessment of Sand Extent, Proposed Stabling and Maintenance Facility, Kangy Angy.