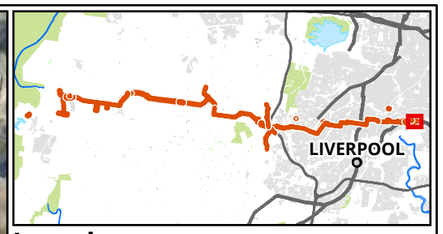


Legend

- Impact assessment area
- Impact area
- *Pimelea spicata* habitat

EPBC Act TEC

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Threatened flora records

- *Acacia pubescens* - Downy Wattle

Figure 12.1 MNES in the impact area and impact assessment area

0 25 50 75 100 125

Metres

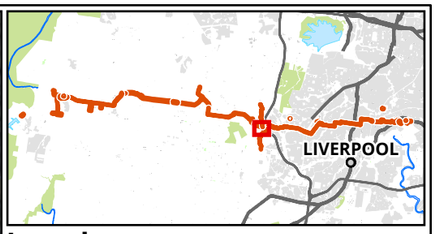
Scale: 1:3,500 @ A3

Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area

EPBC Act TEC

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Figure 12.2 MNES in the impact area and impact assessment area

0 30 60 90 120 150

Metres

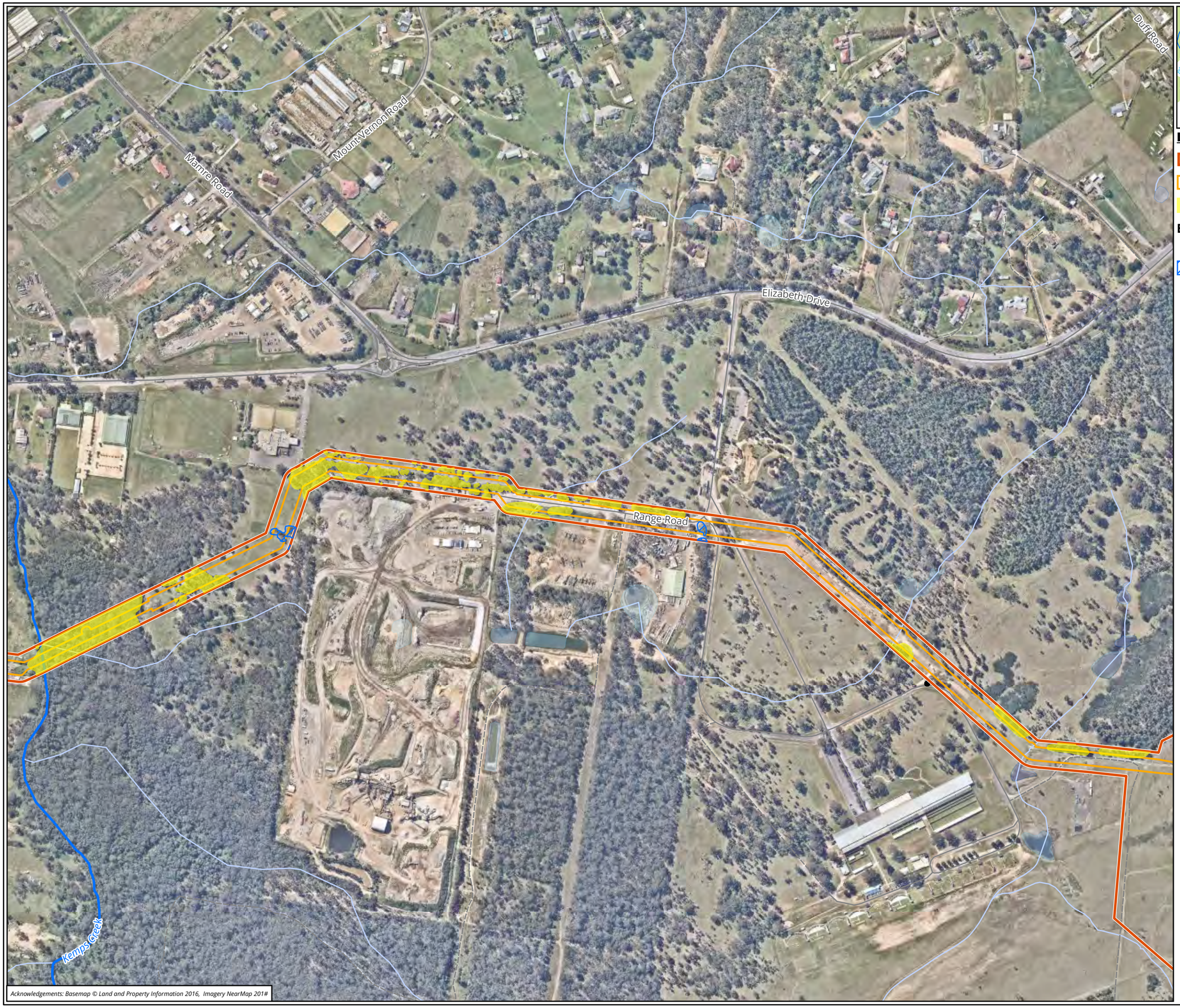
Scale: 1:4,000 @ A3

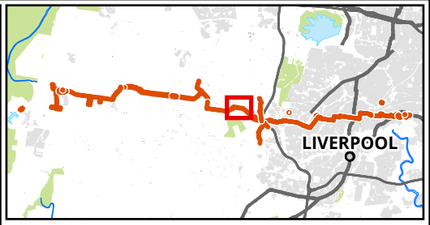
Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00





Legend

- Impact assessment area
- Impact area
- *Pimelea spicata* habitat

EPBC Act TEC

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Figure 12.3 MNES in the impact area and impact assessment area

0 50 100 150 200 250

Metres

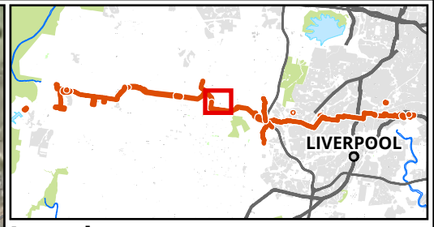
Scale: 1:6,500 @ A3

Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area

EPBC Act TEC

- Cooks River/Castlereagh Ironbark Forest (CEEC)
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Threatened flora records

- *Pultenaea parviflora*

Threatened fauna record

- White-bellied Sea-Eagle

Figure 12.4 MNES in the impact area and impact assessment area

0 50 100 150 200 250

Metres

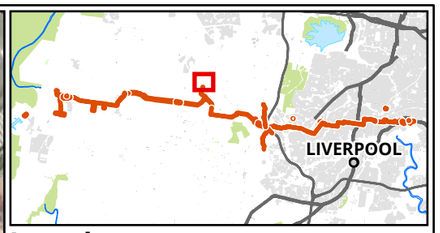
Scale: 1:7,000 @ A3

Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area

EPBC Act TEC

- Coastal Swamp Oak Forest (EEC)

Figure 12.5 MNES in the impact area and impact assessment area

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

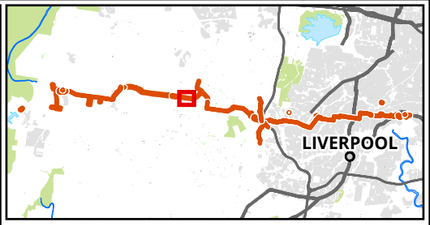
Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Acknowledgements: Basemap © Land and Property Information 2016, Imagery NearMap 201#

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area

EPBC Act TEC

- Cooks River/Castlereagh Ironbark Forest (CEEC)

Figure 12.6 MNES in the impact area and impact assessment area

0 30 60 90 120 150

Metres

Scale: 1:4,000 @ A3

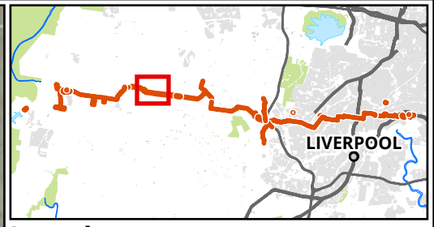
Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00

Acknowledgements: Basemap © Land and Property Information 2016, Imagery NearMap 201#



Legend

- Impact assessment area
- Impact area
- *Pimelea spicata* habitat

EPBC Act TEC

- Coastal Swamp Oak Forest (EEC)
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Threatened flora records

- *Pultenaea parviflora*

Threatened fauna record

- White-bellied Sea-Eagle

Figure 12.7 MNES in the impact area and impact assessment area

0 70 140 210 280 350

Metres

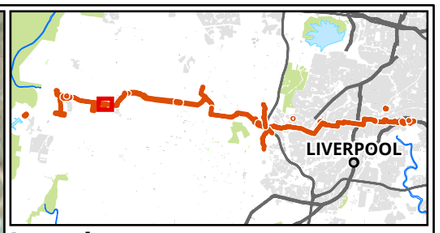
Scale: 1:8,500 @ A3

Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

Impact assessment area

Impact area

EPBC Act TEC

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Figure 12.8 MNES in the impact area and impact assessment area

0 25 50 75 100 125

Metres

Scale: 1:3,500 @ A3

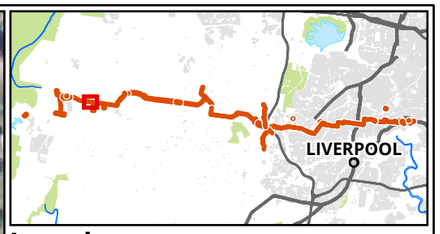
Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Acknowledgements: Basemap © Land and Property Information 2016, Imagery NearMap 201#

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area
- *Pimelea spicata* habitat

Figure 12.9 MNES in the impact area and impact assessment area

0 25 50 75 100 125

Metres

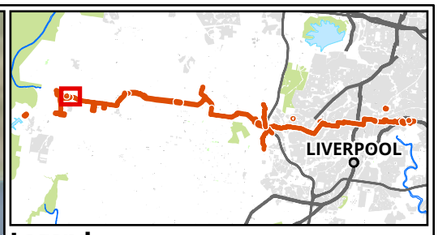
Scale: 1:3,500 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00



Legend

- Impact assessment area
- Impact area

EPBC Act TEC

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)

Threatened flora records

- *Eucalyptus benthamii* - Camden White Gum

Threatened fauna record

- Grey-headed Flying-fox

Figure 12.10 MNES in the impact area and impact assessment area

0 40 80 120 160 200

Metres

Scale: 1:5,000 @ A3

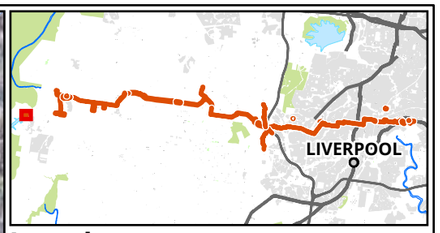
Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00

Acknowledgements: Basemap © Land and Property Information 2016, Imagery NearMap 201#



Legend

- Impact assessment area
- Impact area

Threatened fauna record

- Large-eared Pied Bat
- White-bellied Sea-Eagle

Figure 12.11 MNES in the impact area and impact assessment area

0 20 40 60 80 100

Metres

Scale: 1:2,500 @ A3

Coordinate System:
GDA 1994 MGA Zone 56

N

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LW, Last edited by: lwilson
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020_LW 00

9.5 Summary of relevant impacts to MNES

This section provides a summary of relevant impacts to the MNES listed in Table 40 as likely to be impacted by the project, species subject to targeted survey and not recorded have been excluded on the basis on impacts to potential habitat only. Detailed assessments of potential impacts that are considered to be potentially significant are provided in the assessments of Significant Impact Criteria provided in Appendix 6. Further assessment of the project's impact, including to MNES, are provided in Section 11.

MNES potentially subject to the impacts detailed below include:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community
- Camden White Gum
- Downy Wattle
- Spiked Rice-flower
- Sydney Bush-pea
- Dural Land Snail
- Grey-headed Flying-fox
- Koala
- Large-eared Pied Bat
- Regent Honeyeater
- Swift Parrot

Relevant impacts to MNES from the project have been identified as:

- Direct loss of up to 13.77 ha of potential habitat for EPBC listed biota.
- Direct removal of 1.88 ha of one EPBC Act listed CEEC, and 0.22 ha of one EPB Act listed EEC.
- Loss of connectivity
- Modification of habitat
- Introduction of disease/pathogens
- Altered hydrology
- General disturbance from construction.

These impacts are discussed in greater detail in the sections below.

Direct loss of habitat

The project will remove 13.77 hectares of native vegetation providing habitat for a range of native flora and fauna including foraging habitat for the Regent Honeyeater and Swift Parrot. The project will also result in the removal of 1.88 hectares of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest. These potential consequences are assessed in more detail in Appendix 6 for each MNES.

At the national scale, based on species current distribution and status, this loss of habitat is not considered to be important to the MNES impacted by the project.

Loss of connectivity

Loss of connectivity as a result of the project will occur through direct loss of habitats and through minor fragmentation of vegetation and habitats as a result of construction of the pipeline. This impact could have both short and long term consequences in the form of direct loss and ongoing decline. However it is noted in EPBC Act conservation advice documents that allowances can be made for "breaks" of up to 30 metres between areas of MNES habitat, and that such breaks which may be the result of watercourses, tracks, paths, roads, etc., do not significantly alter the overall functionality of the ecological community, or habitat (CoA 2020).

The impact area associated with the construction of the pipeline is generally less than 30 meters wide and would only extend past 30 metres where ancillary works/infrastructure is required and these areas are intentionally located in areas of lower ecological values.

MNES likely to be most at risk of impacts associated with the loss of connectivity are those less mobile species, such as Dural Land Snail.

At the national scale, based on the impacted MNES' current distribution and status, loss of connectivity at this scale is not considered to be important to these EPBC listed species or communities.

Modification of habitat

Modification of retained habitats as a result of the project are likely to see the following occur; weed invasion, improper rehabilitation, increased edge effects and increased accessibility. This impact would occur in the long-term if not appropriately managed, all the above listed MNES could be affected.

Impacts associated with weed invasion and improper rehabilitation are expected to be successfully mitigated through the projects CEMP. Edge effects are not considered likely to be exacerbated by the project as the current landscape through which the impact area occurs is already highly edge effected, and increased access is unlikely to occur as a result of the project.

At the national scale, based on the impacted MNES' current habitat availability, quality and perceived threats, modification of habitat is not considered to be important to these EPBC listed species or communities.

Introduction of disease/pathogens

Disruption to ecosystems and soil as a result of the project has the potential to introduce or exacerbate pathogens and disease into retained habitats. This impact could have long-term consequences in the form of loss of individuals and loss of habitat if it is not appropriately avoided and mitigated, and if it was to occur would affect all the above listed MNES.

Key risks are considered to be introduction or spread *Phytophthora cinnamomi* and/or Myrtle Rust leading to a decline in forage habitats for mobile MNES, indirect loss of habitats for non-myrtaceae flora species, and potentially direct loss of Camden White Gum and Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

It is expected that through the implementation of strict hygiene protocols outlined in a biosecurity sub-section of the projects CEMP, impacts associated with the introduction of disease/pathogens can be successfully mitigated.

At the national scale, based on MNES' current habitat availability, quality and perceived threats, introduction of disease/pathogens is not considered to be important to these EPBC listed species or communities.

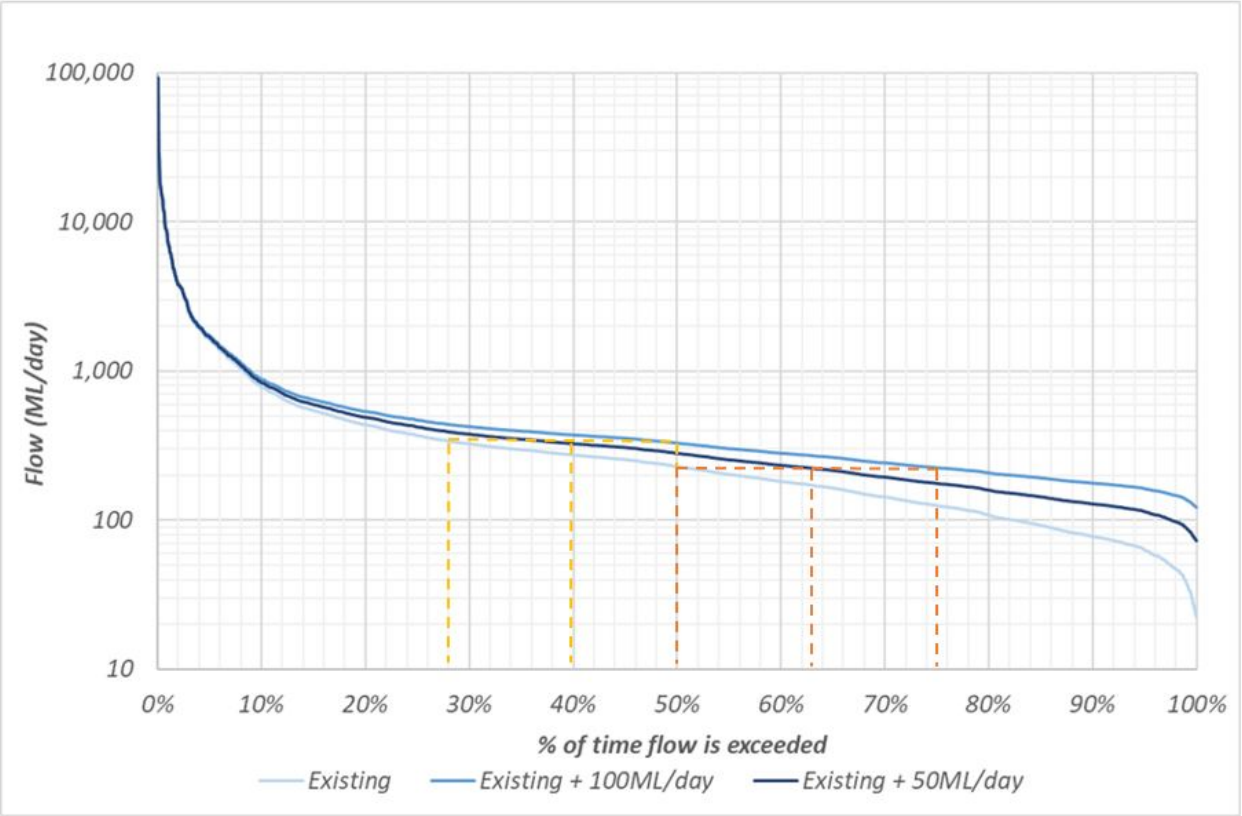
Altered hydrology

Indirect impacts to biodiversity values during the operational phase of the project are likely to occur as a result of alteration of inundation depth and duration. This relates to a minor increase in river depth resulting from the increased water released into the Nepean River system. The maximum increased inundation depth and duration have been modelled in accordance with the 100 ML/day treated water release (i.e. ultimate dry weather treatment capacity of the AWRC, planned for completion in 2036) as a 30 centimetre (median) to 60 centimetre (maximum) increase up to 12 kilometre upstream of Wallacia weir, and up to a 14 centimetre increase downstream to the Penrith weir, which includes the World Heritage reach of the Nepean River (Streamology 2021). It should be noted that this 100ML/day flow is considered a worst case scenario, possible once the plant is expanded to its maximum capacity and assuming all releases are into waterways. Releases will be lower when the AWRC is first built and capacity is only 50ML/day, with discharge levels unlikely to actually reach 100ML/day given recycled water schemes will encompass some of the future releases. The area subject to this assessment is illustrated in Figure 15.

Inundation extents have been modelled for a number of flow scenarios by Streamology (2021) as part of the hydrological assessment for the project's EIS. GIS and topographic models were used to determine the spatial extent of expected inundations for the various flow scenarios.

Terrestrial biodiversity values present within the 'bands' of the river bank between each of the current and future inundation extents are expected to be subject to differing changes to periodic inundation. Expected changes to inundation frequency are illustrated on Graph 1 below, and are described as follows:

- Biodiversity values present between the current low flow extent (25 ML/day) and current median flow extent (229 ML/day), are currently subject to inundation >50 % of the time.
    - With an increase of 50 ML/day into the river system the frequency with which these biodiversity values will be inundated will increase from >50 % of the time to >63% of the time.
    - With an increase of 100 ML/day into the river system the frequency with which these biodiversity values will be inundated will increase from >50% of the time to >74% of the time.
- Biodiversity values present between the current median flow extent (229 ML/day) and the future median flow extent for 50 ML/day releases (279 ML/day), are currently subject to inundation between 40-50 % of the time, which will increase to >50 % of the time.
- Biodiversity values present between the current median flow extent (229 ML/day) and the future median flow extent for 100 ML/day releases (329 ML/day), are currently subject to inundation between 27-50 % of the time, which will increase to >50 % of the time.



Graph 1 Flow duration curve at Wallacia Weir under Existing conditions, Existing + 50 ML/day and Existing + 100 ML/day

Table 41 provides details of the Camden White Gum individuals and habitat mapped as occurring on the banks of the Nepean River expected to be impacted by the change in mean river depth, and thus inundation frequency and extent.

Table 41 Camden White Gum individuals and habitat present within the 229 ML/day, 279 ML/day, and 329 ML/day inundation extents

Flow scenario	Camden White Gum
Existing conditions	
Biodiversity values between 25 ML/day and 229 ML/day inundation extents (ha)	11 individuals, 0.32 ha habitat
Increased 50 ML/day release scenario	
Increased 50 ML/day release scenario	11 individuals, 0.32 ha habitat
Existing conditions: 229 ML/day (ha)	11 individuals, 0.32 ha habitat
% change in inundation	9 % (individuals), 31 % (ha habitat)
Hectares change (ha)	0.10
Increased 100 ML/day release scenario	
Increased 100 ML/day release scenario	11 individuals, 0.32 ha habitat

Flow scenario	Camden White Gum
Existing conditions: 229 ML/day (ha)	11 individuals, 0.32 ha habitat
% change in inundation	9 % (individuals), 69 % (ha habitat)
Hectares change (ha)	0.22

A total of 713 individual trees were recorded during targeted surveys along the Nepean River undertaken by Carl Tippler Environmental (CTE) botanists in late-2020, between Wallacia and Bents Basin. The Approved Conservation Advice for *Eucalyptus benthamii* (Camden White Gum) (CoA 2014b) notes that the remnant population at Wallacia has a higher proportion of alleles not detected in larger populations and is an important source of genetic diversity. As such, this population meets the definition of an "Important Population", in accordance with the MNES Significant impact guidelines 1.1 (CoA 2013). This population is considered to comprise all individuals recorded (and those additional individuals not recorded) between Wallacia and Bents Basin, due to the consistent occurrence of trees in this stretch of the river, and movement of genetic material downstream from Bents Basin to Wallacia.

It can be seen from Table 41 that of these 713 trees recorded, 11 were recorded within the area between the current low flow (25 ML/day) inundation extant and the current median flow inundation extent (229 ML/day), and a total of 12 were recorded between the current low flow and future median flow inundation extents (279 ML/day, 329 ML/day). Trees were recorded by CTE using high accuracy Differential GPS units (+/-1 m), to minimise potential spatial error, and to further account for potential errors, GPS points located within 2 metres of the boundaries of the inundation extent polygons were selected, and included in the totals above.

To account for the areas of Camden White Gum habitat potentially impacted, a 30 metre buffer was applied to all 713 GPS points representing Camden White Gum individuals, and the mapped vegetation present within each inundation extent polygon, within 30 metres of an individual tree, was selected and assessed. Habitat potentially impacted includes:

- 0.32 hectares between the current low flow and current median flow inundation extents.
- 0.42 hectares of habitat between the current low flow and future (+50 ML/day) median flow inundation extant.
- 0.54 hectares of habitat between the current low flow and future (+100 ML/day) median flow inundation extant.

Mature trees with established root systems are not expected to be substantially affected by the increased frequency and duration of inundation expected to result from the proposed volumes of treated water to be released into the river system. However should negative impacts be realised as a result of the increased inundation and saturation of the trees' roots, these would only be expected to affect a small portion (up to 1.7%) of the population of Camden White Gums present within the area assessed.

Furthermore, the areas of habitat subject to increased inundation outlined above would also represent only a small fraction of the total potential habitat mapped within 30 metres of trees recorded along the river banks. A total of 34.9 hectares of native vegetation is mapped (OEH 2013) as occurring within 30 meters of a Camden White Gum, and as such potential impacts to up to 0.54 hectares of habitat, within the current and future median flow inundation extents, only represents 0.5 % of the habitat supporting the population.

The Approved Conservation Advice for *Eucalyptus benthamii* (Camden White Gum) (CoA 2014b) notes that one of the main threats to the species is 'changed hydrology, and that the species' natural habitat includes a combination of deep, fertile alluvial sands and a flooding regime that allows seedling establishment, with

recruitment occurring on disturbed or depositional bare soils following flooding. The changes to hydrological patterns within the Nepean River system as a result of the project are not expected to represent substantial or significant negative pressures on the species, as the increased water released into the system will result in a minor to negligible increase in flood frequency, which will not negatively impact upon post-flood opportunities for seedling recruitment.

Further assessment of the potential impacts to Camden White Gum have been undertaken in Section 11.2.1, and as part of an EPBC Act Significant Impact Criteria assessment (Appendix 6). The assessment found that a significant impact to the species was unlikely to occur.

However due to the somewhat uncertain nature of impacts associated with changes to hydrology and the potential timeframes within which any impacts may occur, ongoing monitoring of the biodiversity values present along the banks of the river system will be undertaken, and adaptive management will be implemented if future unexpected impacts are found to be occurring. Further information is provided in Section 11.5.

General disturbance from construction

Construction activity has potential to impact fauna and flora populations and ecological communities through increased noise, vibration, vegetation disturbance, and dust. These impacts would have short-term consequences, for the duration of the project construction phase and could affect the Regent Honeyeater and Swift Parrot.

At the national scale, based on species current habitat availability, quality and perceived threats, general disturbance from construction is not considered to be important to these EPBC listed species or communities.

Extent and nature of impacts

Table 42 provides an overview of the project impacts and their extent, nature and consequence to MNES of the study area.

Table 42 Extent and nature of impacts summary

Project impact	Extent/nature	Habitat or individuals to be impacted	Impact to MNES - consequence
Vegetation removal	Removal of up to 13.77 ha of native vegetation	Each of the following MNES will be impacted to some degree by the removal of native vegetation as a result of the project: • Camden White Gum • Downy Wattle • Spiked Rice-flower • Sydney Bush-pea • Dural Land Snail • Grey-headed Flying-fox • Koala • Large-eared Pied Bat • Regent Honeyeater • Swift Parrot	Short and long term: • Direct loss of habitat or community • Minor impacts to connectivity • Minor modification of habitat None of the impacts associated with the removal of native vegetation are considered likely to result in a significant impact to MNES.

Project impact	Extent/nature	Habitat or individuals to be impacted	Impact to MNES - consequence
	Removal of 1.88 ha of native vegetation	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	
	Removal of 0.22 ha of native vegetation	Coastal Swamp Oak (*Casuarina glauca*) Forest	
Construction activities	Indirect impacts: noise, vibration, dust, weed invasion	Each of the following MNES may be subject to indirect impacts associated with construction activities: • Downy Wattle • Sydney Bush-pea • Dural Land Snail • Grey-headed Flying-fox • Regent Honeyeater • Swift Parrot	Short term: • Introduction of disease/pathogens/ weeds leading to reduced habitat / condition • General disturbance from construction None of the impacts associated with the construction of the project are considered likely to result in a significant impact to MNES.
Operation	Alterations to the volume and frequency of lows in the Nepean River	Camden White Gum	Long term: • Altered hydrology None of the impacts associated with altered hydrology are considered likely to result in a significant impact to MNES.
	Fragmentation of habitats	Each of the following MNES will be impacted to some degree by the removal of native vegetation as a result of the project: • Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest • Coastal Swamp Oak (*Casuarina glauca*) Forest • Spiked Rice-flower • Sydney Bush-pea • Dural Land Snail.	Long term: • Minor fragmentation of habitats • Increased edge effects None of the impacts associated with fragmentation of habitats are considered likely to result in a significant impact to MNES.

9.6 Measures to avoid and minimise impacts to MNES

Measures to avoid and minimise impacts to MNES within the study area have been undertaken throughout the design phases completed to date, and are detailed in Section 10. Mitigation measures are proposed for the construction and operational phases of the project, which will ensure impacts to MNES are further reduced. Table 43 provides a broad list of proposed measures to be implemented to reduce impacts to MNES. Further details of mitigation measures committed to by the project are provided in Section 11.5.

Table 43 Summary of measures to avoid and minimise impacts to MNES

Measure to avoid and minimise impacts	Benefit to MNES
Biosecurity and hygiene procedures	Reduction in potential for introduction or spread of disease or pathogens.
Pre-clearance surveys	Ensure MNES are not injured or killed during vegetation clearance activities.
Vegetation retention	Vegetation retention wherever possible to provide resources for MNES.
Fauna sensitive construction practices including lighting, dust control, vibration controls	Reduced potential for indirect impacts from lighting, noise etc. on MNES in surrounding areas.
Revegetation with native species	Revegetation of areas within the road reserve that can link up with existing vegetative fauna corridors. Revegetation undertaken using locally occurring native species known to provide potential habitat for MNES.

Expected achievability and effectiveness of avoidance and mitigation measures

The potential impacts of the project to habitats have been avoided and minimised through the design process to achieve a balance between the impact and the design requirements of the project. All mitigation measures proposed have been designed to be achievable throughout the duration of this project. The mitigation measures are achievable, and construction contracts will include clauses to ensure compliance with environmental management requirements of the contract.

Residual impacts remain after all avoidance and mitigation measures have been considered, and these are provided below. Further assessment of the effectiveness of mitigation measures committed to by the project is provided in Section 11.5.

9.7 Residual impacts to MNES

Residual impacts are unavoidable impacts that remain after avoidance and mitigation measures have been applied to an action. Residual impacts for the MNES are detailed in Table 44 below.

Table 44 Residual impacts to MNES

Residual project impact	Habitat or individuals to be impacted	Impact to MNES
Removal of 13.77 ha of native vegetation	• Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest • Coastal Swamp Oak (*Casuarina glauca*) Forest • Camden White Gum • Downy Wattle • Spiked Rice-flower • Sydney Bush-pea • Dural Land Snail • Grey-headed Flying-fox • Koala • Large-eared Pied Bat • Regent Honeyeater • Swift Parrot	Habitat removal, loss of individuals, loss of connectivity.
Indirect impacts: noise, vibration, dust, weed invasion	• Downy Wattle • Sydney Bush-pea • Dural Land Snail • Grey-headed Flying-fox • Regent Honeyeater • Swift Parrot	Temporary disturbance to individuals and/or permanent impacts to habitat quality.
Altered hydrology	• Camden White Gum	Loss of individuals and habitat.
Fragmentation of habitats	• Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest • Coastal Swamp Oak (*Casuarina glauca*) Forest • Spiked Rice-flower • Sydney Bush-pea • Dural Land Snail	Increased edge effects and potential isolation.

9.8 Offsetting of residual impacts to MNES

Impacts to MNES as a result of the project have been determined to not be significant, in accordance with Significant Impact Guidelines 1.1 - Matters of National Environmental Significance (CoA 2013). As such offsetting in accordance with the EPBC Act Environmental Offsets Policy (CoA 2012) and the EPBC Act is not required.

Impacts to all MNES will however be offset in accordance with the NSW BOS through either direct establishment of Biodiversity Stewardship Sites to generate biodiversity credits to offset the project's impacts, through securing biodiversity credits from the open market, or from payment to the Biodiversity Conservation Fund.

10. Avoidance and minimisation of impacts

This section identifies the potential impacts of the proposal on the biodiversity values of the impact area and impact assessment area, and includes measures taken to date and additional recommendations to assist the final design of the development to further avoid and minimise impacts on biodiversity within and surrounding the impact area, impact assessment area and broader study area.

10.1 Actions to avoid and minimise project impacts

The principal means to reduce impacts on biodiversity values within the impact area and impact assessment area is to avoid and/or minimise the removal of native vegetation and fauna habitat. Additional recommendations include measures to mitigate residual impacts after all measures to avoid and minimise impacts have been considered.

The project location has been selected, in part, to minimise impacts to the native vegetation and flora and fauna habitats present within the broader study area, as much as engineering and constructability constraints will allow.

The project design phase occurred over three stages; 50 %, 80 % and 100 % percent design completion. At the 50 % design stage, prior to any fieldwork being undertaken, a preliminary desktop constraints assessment was completed to identify areas of high biodiversity constraint within an initial broad landscape assessment area (Biosis 2020), and to guide selection of alignment alternatives. This preliminary constraints assessment identified the presence of multiple TECs, meeting BC Act and EPBC Act listing criteria such as; Cumberland Plains Woodland, Castlereagh Ironbark Forest, Cumberland Shale-Gravel Transition Forest, River-flat Eucalypt Forest and Shale Sandstone Transition Forest. Database searches identified known populations of listed threatened species within and adjacent to alignment options, and areas of conservation significance, such as World Heritage Areas, National Heritage Places, National Parks and Reserves, Council Reserves, BioBank sites and Cumberland Priority Conservation Areas, were also highlighted.

Preliminary design workshops were held with Sydney Water environmental staff and project managers, designers and engineers, and Biosis ecologists to review the results of the preliminary biodiversity constraints assessment. Workshops were focussed on avoiding impacts to areas of higher biodiversity constraint such as TECs, high condition PCTs, riparian areas, threatened species habitat etc, through alignment revisions/refinement. Multiple avoidance options were workshopped including underbores, moving the alignment to avoid impacts to vegetation, narrowing of the alignment, locating the alignment in the roadway, relocating/redesigning ancillary areas, considering alternative construction methods etc.

Following initial design workshops rapid visual inspections to confirm the findings of the preliminary constraints assessment, and to confirm initial PCT mapping (based on aerial imagery and landscape constraints) was undertaken. The rapid inspections helped to refine native vegetation extent mapping such that a more accurate assessment of potential impacts could be undertaken. Furthermore, initial rapid assessments confirmed the presence of a large area of intact EPBC Act and BC Act listed Shale Sandstone Transition Forest between Wallacia to Warragamba along Silverdale Road, where the 50 % design was situated at this stage of the project. In addition, the field investigation detected the presence of a Grey-headed Flying-fox camp at Blaxland's Crossing Reserve in Wallacia. These findings guided design refinements to specifically avoid impacts these biodiversity values.

Detailed field investigations occurred between the 50 % and 80 % design phase over the majority of the impact area between Lansdowne and Wallacia. These surveys identified multiple constraints in the form of

Downy Wattle and Native Pear in the Lansdowne Reserve BioBank Site, in addition to further patches of; Cumberland Plains Woodland, Castlereagh Ironbark Forest, Shale-Gravel Transition Forest and Swamp Oak Floodplain Forest. Further design workshops were held following the collection of detailed and field validated biodiversity data, and avoidance of impacts to areas supporting biodiversity values was again undertaken.

Detailed mapping of the locations of Downy Wattle and Native Pear within Lansdowne BioBank site was undertaken to determine the extent and bounds of the populations, and to gauge the potential for avoidance impacts in the area. Meetings with the project team (including designers, engineers and ecologists) and Canterbury-Bankstown Council officers, were held at the BioBank site to observe the landscape constraints from a constructability viewpoint and determine a feasible diversion of the then current pipeline route. These meetings resulted in a redesign of the pipeline route, and an alternative construction methods being selected, allowing for significant avoidance of impacts within the BioBank site itself as well as the adjacent Lansdowne Reserve and Shortland Brush reserve. This included the avoidance of impact to the majority of the Downy Wattle and Native Pear populations, as well as large areas of intact Cumberland Shale Plains Woodland and River-flat Eucalypt Forest.

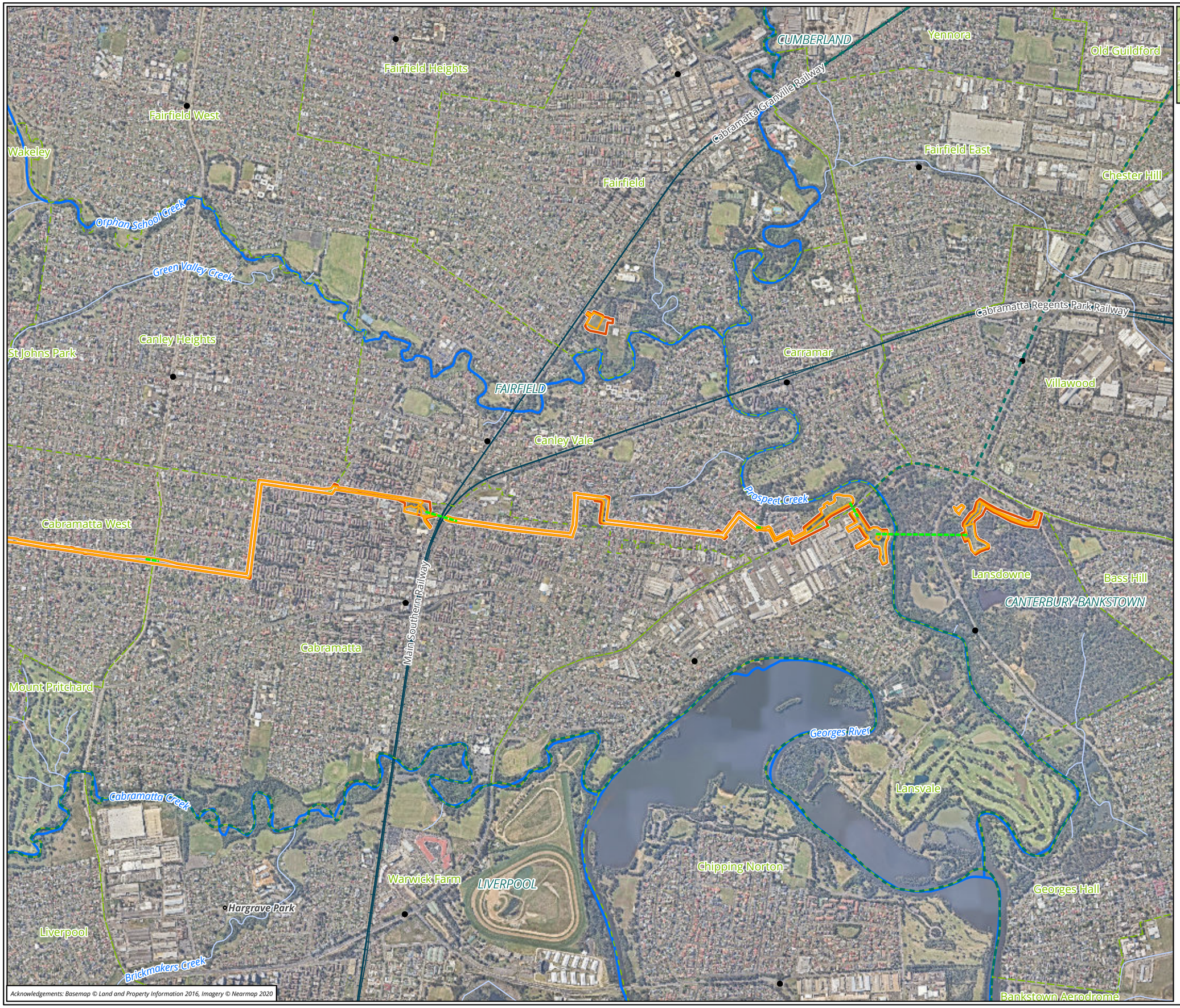
Further design revisions and alignment selection during the iterative project design process, subject to ongoing feedback from ecologists, result in the following broad scale reduction of impacts to biodiversity values:

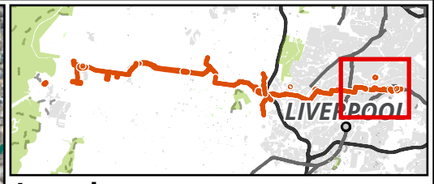
- Reduced impacts to Cumberland Plain Woodland, River-flat Eucalypt Forest and Swamp Oak Floodplain Forest TECs in the Lansvale, Canly Vale, St Johns Park area through underboring, alignment selection and design refinements.
- Reduced impacts to Cumberland Plain Woodland within Western Sydney Parklands and River-flat Eucalypt Forest across Kemps Creek through alignment narrowing.
- Avoidance of Existing Non-certified areas along Cross Street at Kemps Creek, and recued impacts to Existing Certified land through alignment narrowing.
- Reduced impacts to Swamp Oak Floodplain Forest at South Creek through route selection and alignment narrowing.
- Reduced impacts to Swamp Oak Floodplain Forest and River-flat Eucalypt Forest by underboring Badgerys Creek.
- Avoidance of impacts to Cumberland Plain Woodland along Elizabeth Drive through locating the alignment in the paddocks well north of remnant vegetation in the road reserve.
- Reduced impacts to Cumberland Plain Woodland through locating the ancillary compound along Park Rad within areas of existing disturbance.
- Reduced impacts to Cumberland Plain Woodland and Shale Gravel Transition Forest by locating the alignment within the roadway along sections of Park Road.
- Reduced impacts to Coastal Freshwater Wetlands, Swamp Oak Floodplain Forest and River-flat Eucalypt Forest by underboring Jerrys Creek.
- Avoidance of direct impacts and minimisation of indirect impacts to the Grey-headed Fly-fox camp at Wallacia, as well as direct impacts to Camden White Gum, though relocating the Nepean River underbore in Fowler Reserve, on the southern side of Silverdale Road.
- Completely avoiding impact to Shale Sandstone Transition Forest through redesign of the alignment from along Silverdale Road and Nortons Basins Road, to along Bents Basin Road and ultising a long underbore to the outlet at the Warragamba River. This design revision substantially reduced impacts to native vegetation and threatened species habitat at the western end of the project alignment.

Other methods employed for avoidance of biodiversity values include micro-siting of the alignment to avoid patches of thinned to intact TEC's where possible. This method has allowed for avoidance of intact Castlereagh Ironbark Forest and Castlereagh Scribbly Gum Woodland as well as the majority of individuals within a large population of *Dillwynia tenuifolia* and *Pultenaea parviflora* and habitat for Cumberland Plain Land Snail in the bushland block on the corner of Western Road and Cross Street at Kemps Creek.

Figure 13 and Figure 14 show the final and alternative alignments considered to avoid or minimise impacts on biodiversity values, the final proposal footprint (including construction and operation).

Ongoing minimisation of impacts during the construction and operational phases of the project will be ensured through implementation of the mitigation measures outlined in Section 11.5 below.





Legend

- Impact area
- Impact assessment area
- Underbore

Figure 13.1 Final development footprint

0 160 320 480 640 800

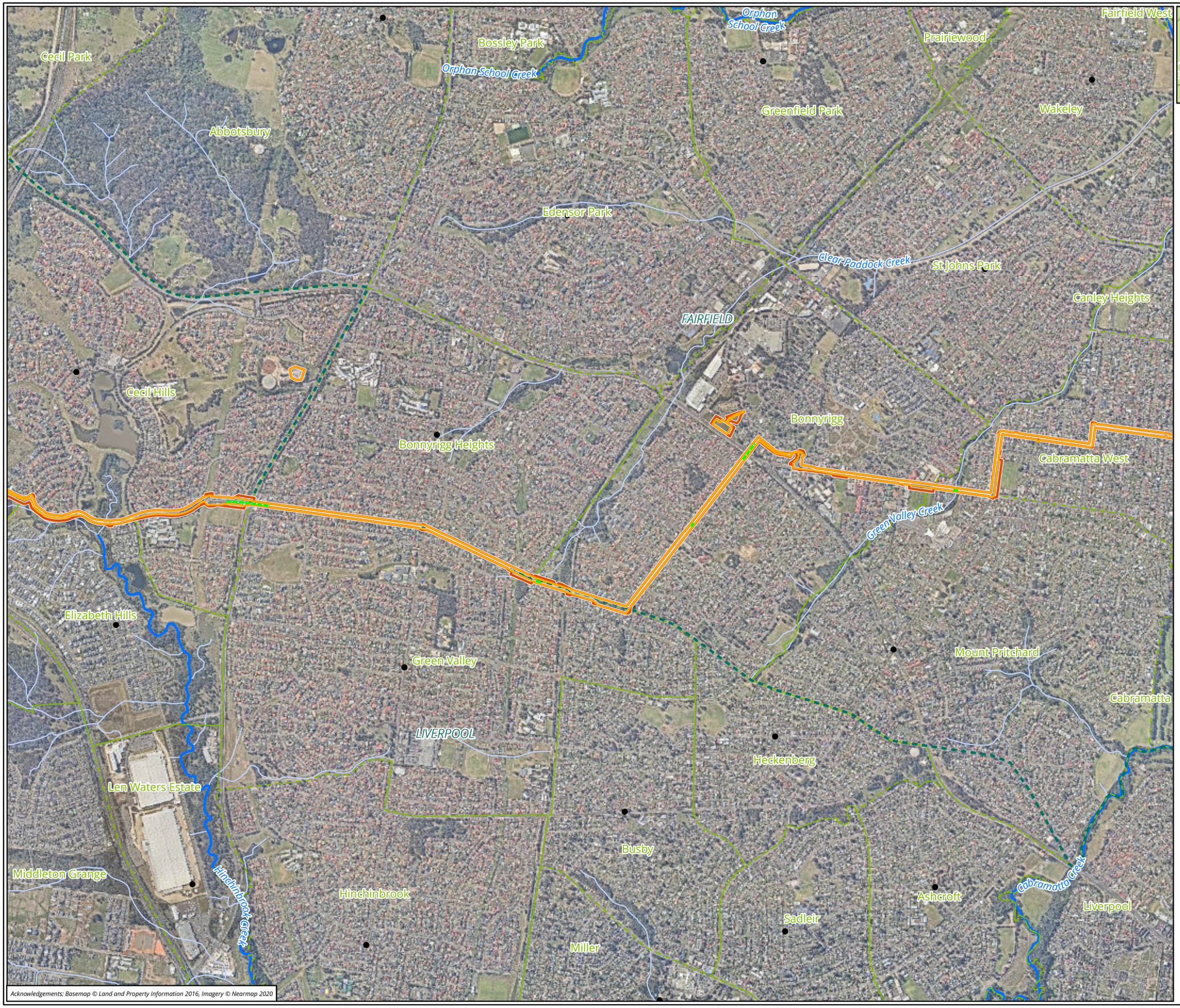
Metres

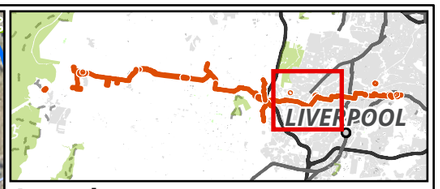
N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00





Legend

- Impact area
- Impact assessment area
- Underbore

Figure 13.2 Final development footprint

0 160 320 480 640 800

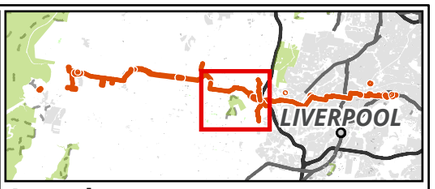
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Impact area
- Impact assessment area
- Underbore

Figure 13.3 Final development footprint

0 160 320 480 640 800

Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00

Legend

- Impact area
- Impact assessment area
- Underbore

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Nearmap 2020

Figure 13.4 Final development footprint

0 160 320 480 640 800

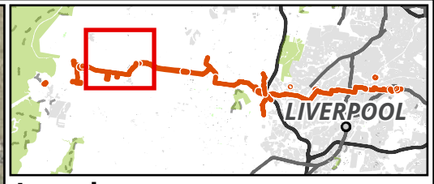
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Impact area
- Impact assessment area
- Underbore

Figure 13.5 Final development footprint

0 160 320 480 640 800

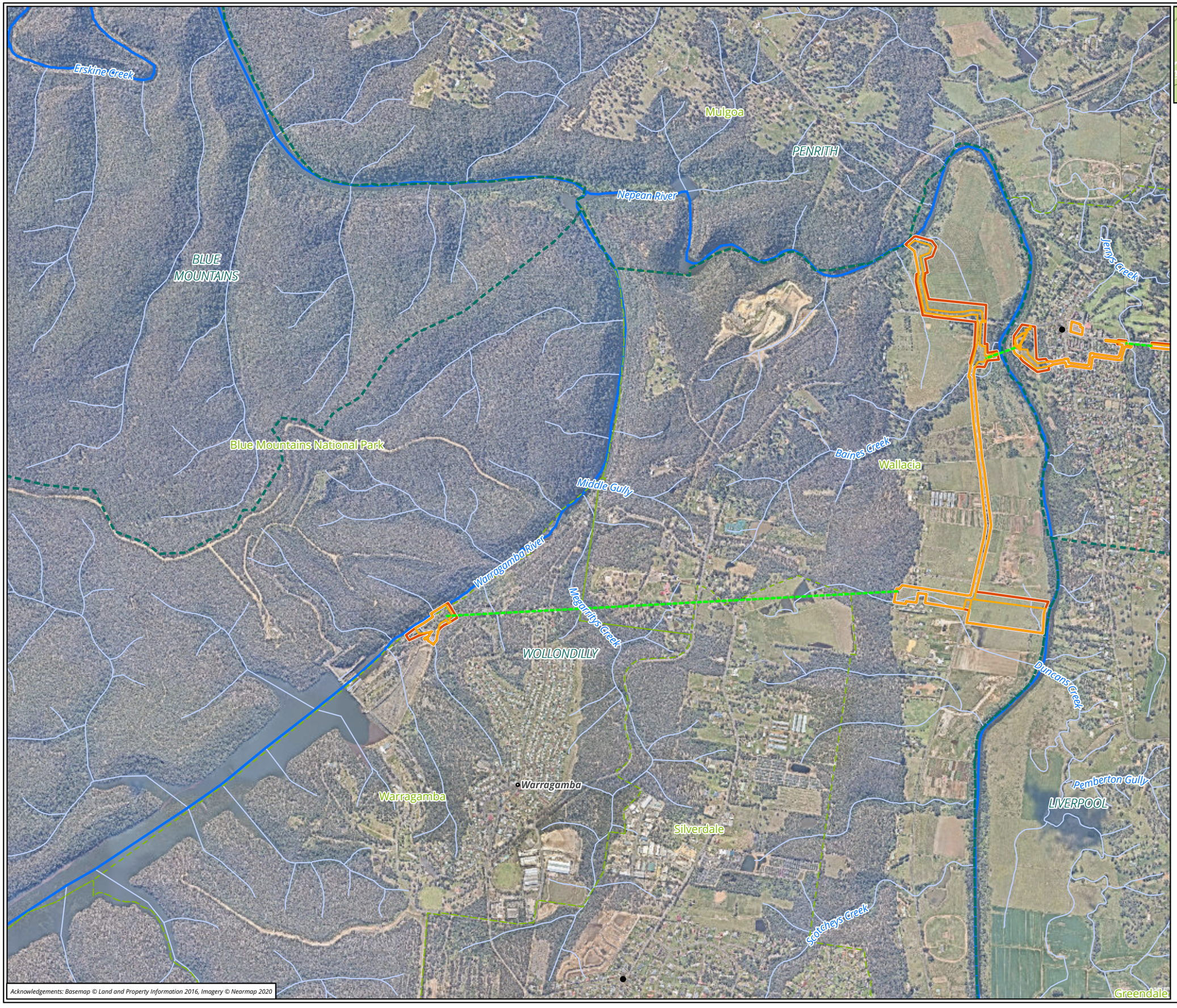
Metres

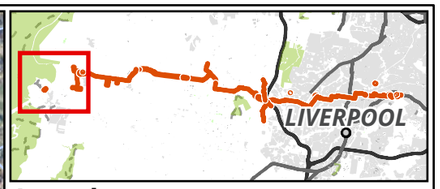
N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00





Legend

- Impact area
- Impact assessment area
- Underbore

Figure 13.6 Final development footprint

0 160 320 480 640 800

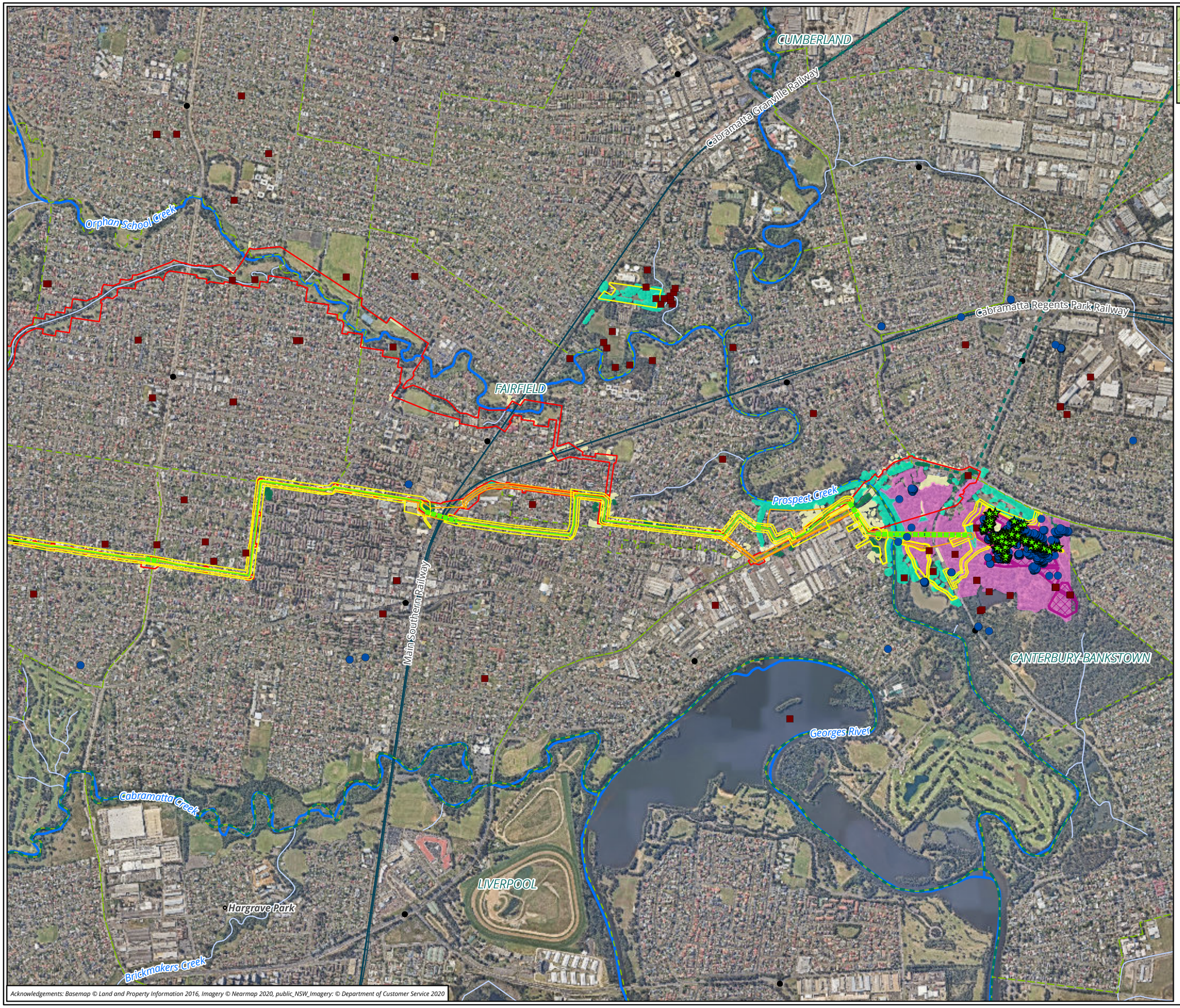
Metres

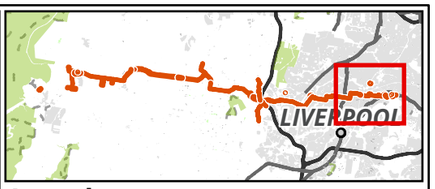
N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 23 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00





Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- Biodiversity Stewardship Sites
- Threatened flora records (Biosis)
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- EPBC Act TEC
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Figure 14.1 Alternative options and avoidance

0 160 320 480 640 800

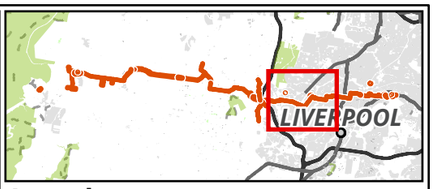
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Nearmap 2020, public_NSW_Imagery: © Department of Customer Service 2020

Figure 14.2 Alternative options and avoidance

0 160 320 480 640 800

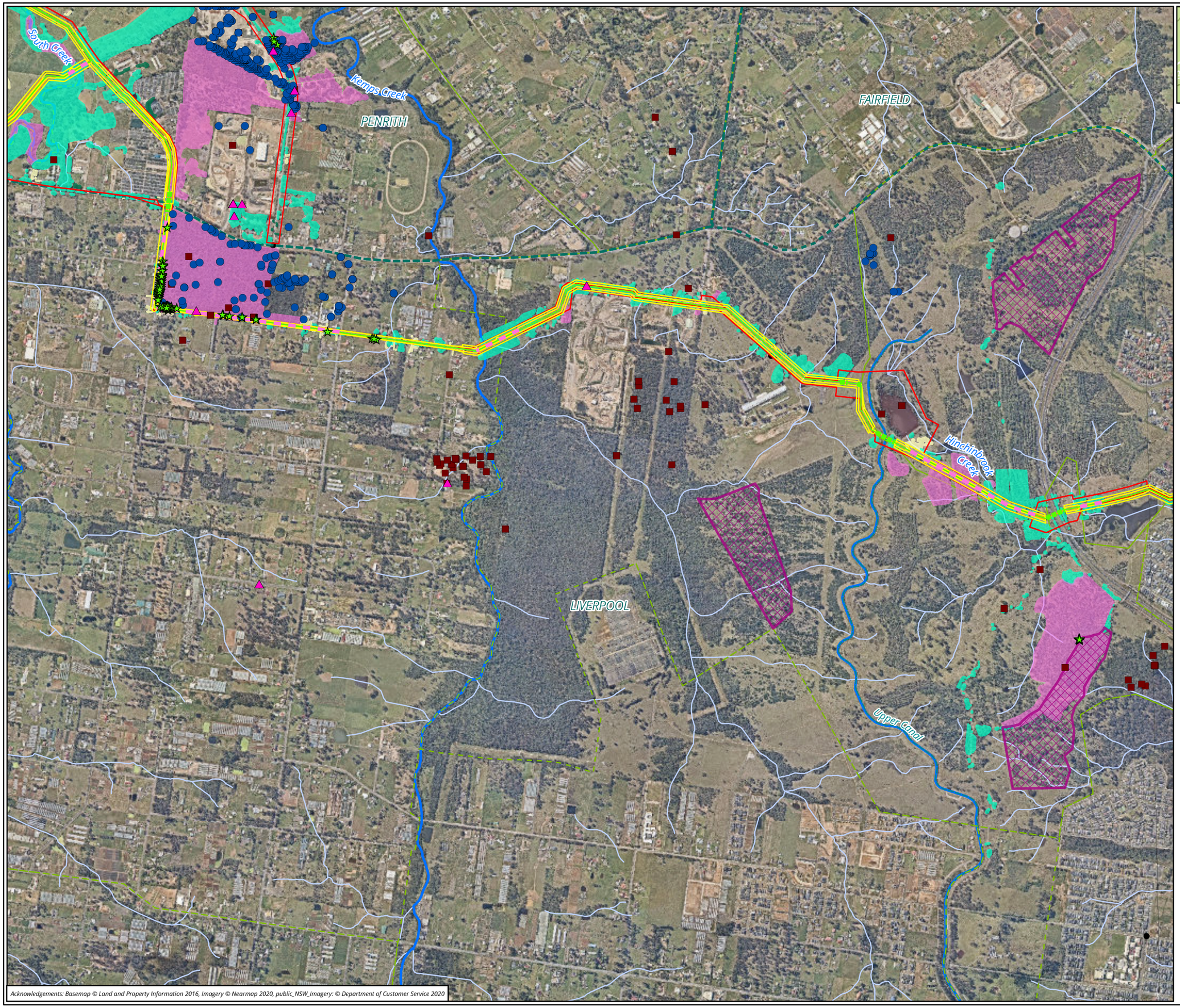
Metres

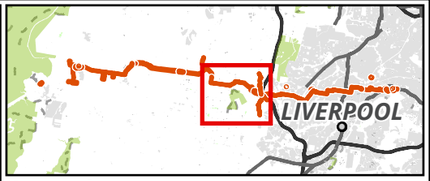
N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00





Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- IA narrowing
- Biodiversity Stewardship Sites
- Threatened flora records (Biosis)
- Threatened fauna records (Biosis)
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- EPBC Act TEC
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Figure 14.3 Alternative options and avoidance

0 160 320 480 640 800

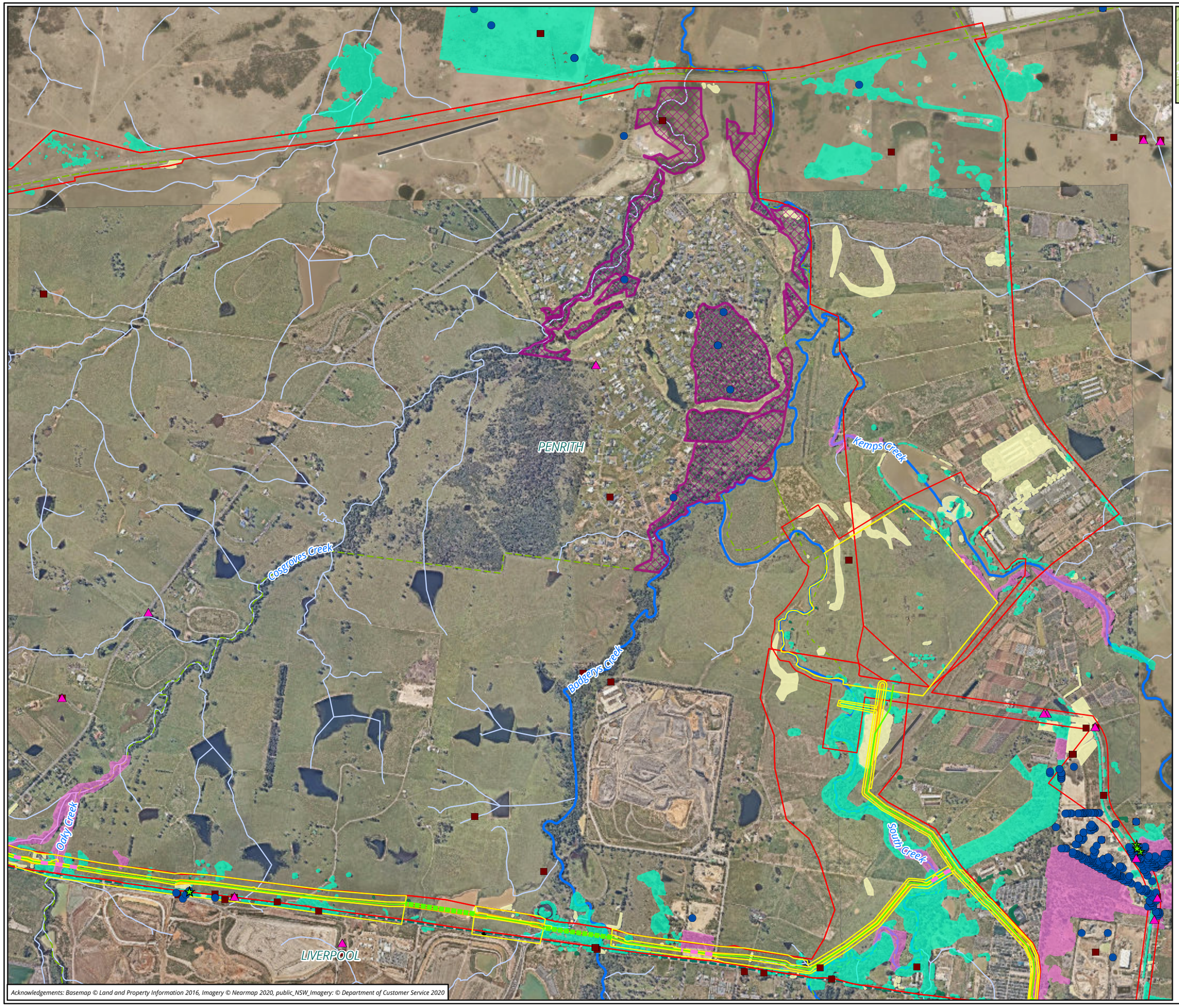
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- IA narrowing
- Biodiversity Stewardship Sites
- Threatened flora records (Biosis)
- Threatened fauna records (Biosis)
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- EPBC Act TEC
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Figure 14.4 Alternative options and avoidance

0 160 320 480 640 800

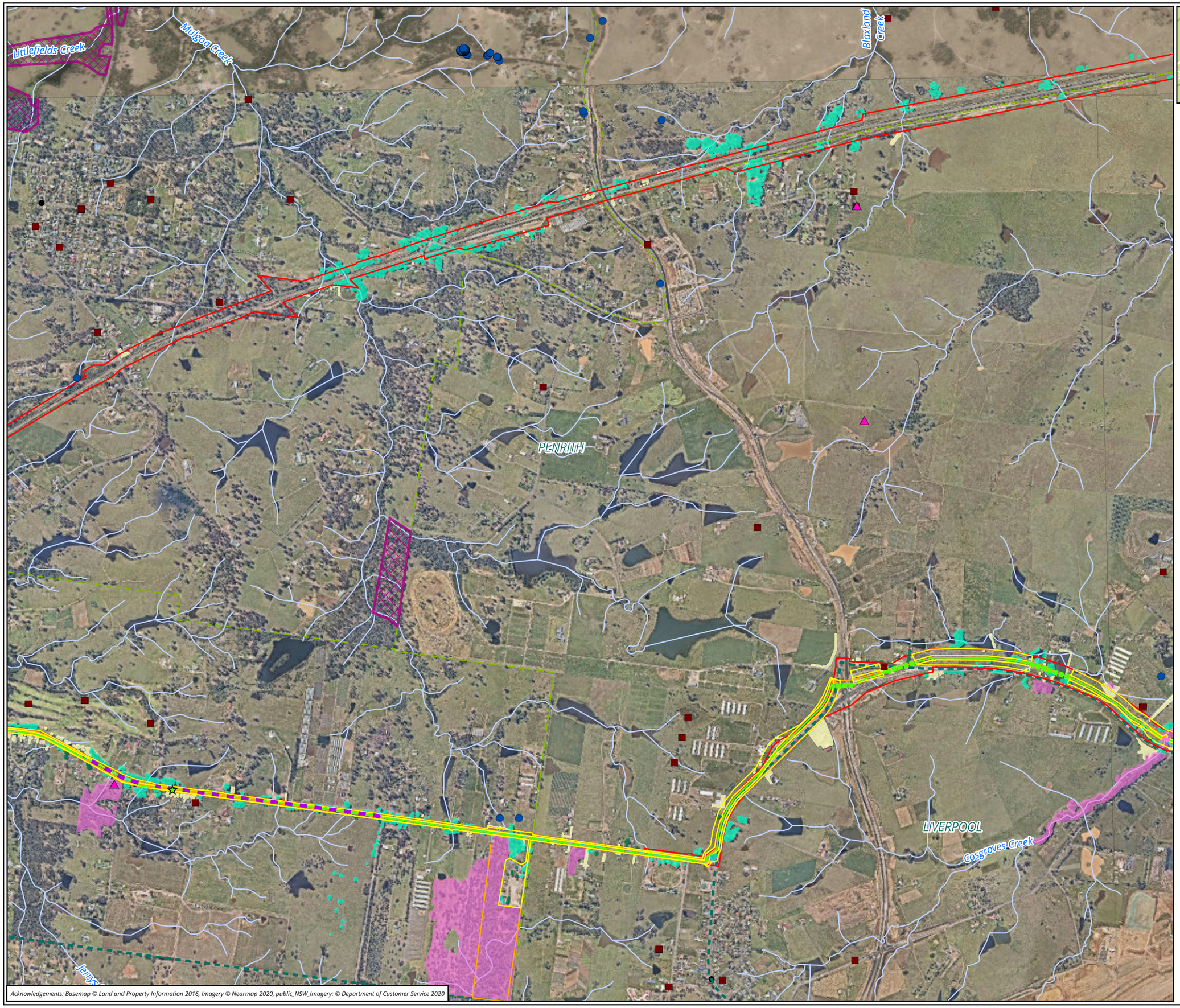
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- IA narrowing
- In roadway
- Biodiversity Stewardship Sites
- Threatened flora records (Biosis)
- Threatened fauna records (Biosis)
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- EPBC Act TEC
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Figure 14.5 Alternative options and avoidance

0 160 320 480 640 800

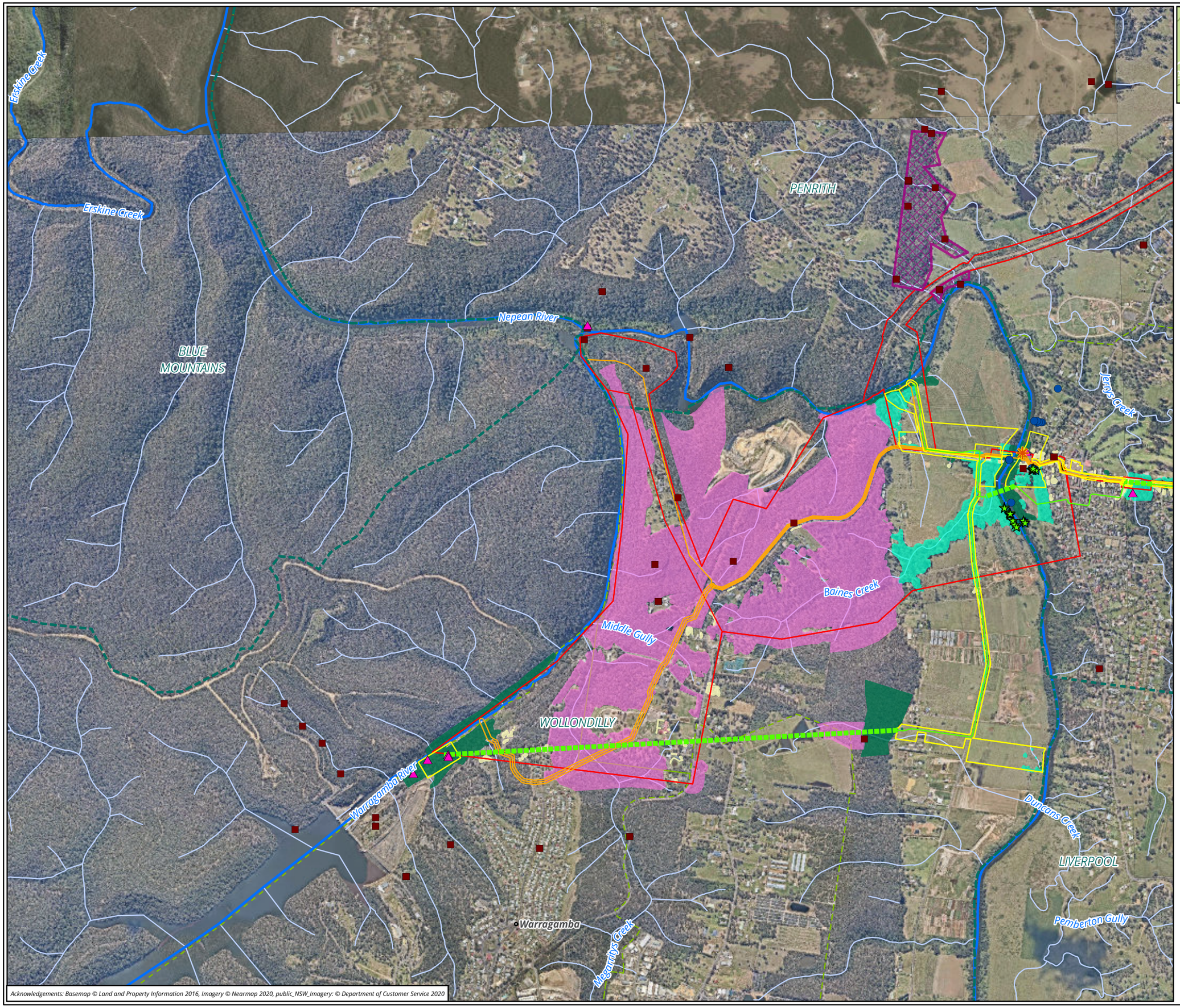
Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00



Legend

- Underbore
- EIS alignment
- 80% design
- Pre-80% design
- Initial assessment areas
- Grey-headed Flying-fox camp
- Biodiversity Stewardship Sites
- Threatened flora records (Biosis)
- Threatened fauna records (Biosis)
- Threatened flora records (Bionet)
- Threatened fauna records (Bionet)
- EPBC Act TEC
- BC Act TEC
- Non-threatened native vegetaton
- Non-native vegetation

Figure 14.6 Alternative options and avoidance

0 160 320 480 640 800

Metres

N

Scale: 1:20,000 @ A3 *Coordinate System: PCS: GDA 1994 MGA Zone 56*

biosis

Matter: 31617,
Date: 24 September 2021,
Prepared for: CW, Prepared by: LH, Last edited by: lharley
Location: P:\31600s\31617\Mapping\31617_Working\31617_BDAR2020.mxd 00

11. Assessment of residual impacts

Assessment of direct and indirect impacts unable to be avoided has been undertaken in accordance with the BAM (DPIE 2020a).

11.1 Direct impacts

Direct impacts arising from the project include:

- Removal of native vegetation and flora and fauna habitats.
- Removal of known habitat for threatened flora species, and individual plants.
- Removal of known and assumed habitat for threatened fauna species.
- Removal of BC Act listed TECs.
- Removal of EPBC Act listed TECs.
- Removal of habitats considered to be potential SAIIs.
- Removal of threatened flora habitat assumed present in unsurveyed section of the impact area at Kemps Creek.
- Removal of native vegetation, threatened flora, and TECs from 'Existing Certified' areas.

Assessment of the above impact is provided in Table 45, these impacts will be permanent and will occur from the outset of the project. Mitigation measures and safeguards outlined in Section 11.5 will help to minimise the potential impacts to biodiversity values that remain present within the impact area and impact assessment area.

Table 45 Assessment of direct impacts

Potential direct impact	Location / description of impact	Significance of impact
Removal of native vegetation and flora and fauna habitats	Removal of 13.77 ha of native vegetation from 8 PCTs throughout the impact area, supporting habitat for a range of threatened and non-threatened flora and fauna species.	The majority of the vegetation and habitats impacted by the project has undergone historical modification through clearing and other detrimental landuse practices, with 86 % of the vegetation impacted considered to be in 'Thinned' of 'Scattered Trees' ecological condition, and just 14 % recorded as 'Intact'. Whilst the removal of 13.77 ha of native vegetation and native species habitats by the project could be considered a substantial impact, when considered in the context of the size of the project area, and the general landscape through which the alignment traverses, the impact of native vegetation removal are not considered to be significant. The impact area equates to approximately 213 ha, spanning over 40 kilometers of linear project area, and thus removal of 13.77 ha of native vegetation equates to just 6 % of the total area impacted by the project. Substantial efforts have been made through the project to reduce and minimise impact to native vegetation habitats, and this process has resulted in the residual impacts being large comprised of degraded, fragmented, and edge effected ecological values.
Removal of known and expert mapped habitat for threatened flora species and individual plants	The project will result in the removal of the following threatened flora individuals / habitat: • Downy Wattle – 7 individuals, 0.16 ha of known habitat • Native Pear – 0 individual, 0.03 ha of known habitat • Sydney Bush-pea – 0 individuals, 0.01 ha of known habitat • Spiked Rice-flower – 0 individuals, 2.99 ha of expert mapped habitat	As with impacts to native vegetation, impacts to threatened flora species and habitats are not considered significant when assessed in the context of the scale of the project. Direct impacts to a total of 7 individual plants, and 3.19 ha of known or expert mapped habitat, are considered to be an acceptable outcome for a project with impacts spanning such a large area. Again it should be noted that significant efforts have been undertaken to minimise and avoid impacts to threatened flora over the course of the project. The most substantial of which, being the decision to undertake a more expensive construction under-boring method to avoid impacts to a large number of Downy Wattle and Native Pear individuals, and a quite substantial area of habitat, within the Lansdowne Reserve Stewardship Site. None of the project impacts to threatened flora are considered 'significant impacts' for the purposes of the EPBC Act.
Removal of known habitat for threatened fauna species	The project will result in the removal of the following 'known' threatened fauna habitat: • 13.77 ha of native vegetation forming forage habitat for highly mobile bird and bat BAM ecosystem credit species ○ This includes potential forage habitat for Regent Honeyeater	As with impacts to native vegetation, overall direct impacts to threatened fauna habitats are not considered significant when assessed in the context of the scale of the project. Targeted surveys and habitat assessments have concluded that the majority of the impact area supports only marginal quality habitat for threatened fauna species, having undergone degradation through historical landuse. Impacts to potential microbat breeding habitat at the Warragamba Dam environmental flows outlet site have been assumed based on the presence of potential habitat, and the recording of species credit microbats on ultrasonic detectors. It should be noted that no bats were recorded exiting the man-made habitat features during stag

Potential direct impact	Location / description of impact	Significance of impact
	and Swift Parrot listed as Critically Endangered under the EPBC Act. • Removal of 1.56 ha low potential breeding habitat (and buffer) for Large Bent-winged Bat based on the presence of rocky cliff faces, and the man-made tunnel and vertical (vent) shaft at the Warragamba Dam environment flows outlet area. • Removal of 3.48 ha species credit forage habitat for Large –eared Pied Bat based on the presence of the potential habitat comprising sandstone cliffs and overhangs along the Warragamba River and Nepean River gorges. • Removal of 7.62 ha of species credit habitat for Southern Myotis based on the removal of native vegetation from within 200 m of potential forage habitat (waterbodies). • Removal of 8.95 ha of expert mapped habitat for Cumberland Plain Land Snail. • Removal of 1.45 ha of expert mapped habitat for Dural Land Snail.	watches undertaken in October 2020, and analysis of ultrasonic bat call data strongly suggests that the habitat within the impact area in not being utilised for roosting/breeding activities (refer Section 8.2.3). Further assessment of impacts to potential microbat breeding habitat is provided in Appendix 5as SAII assessments. Impacts to threatened snail species have been assessed by largely desktop-based threatened species expert assessment and reports (Clark 2021a, 2021b). As with other threatened species habitat impacts, impacts are assessed as not significant given the small proportion of habitat impacted when compared to that available to the species in the vicinity of the impact area and impact assessment area. None of the project impacts to threatened fauna are considered 'significant impacts' for the purposes of the EPBC Act.
Removal of BC Act listed TECs (excluding 'Existing Certified')	The project will result in the removal of the following BC Act listed TECs: • 4.37 ha of Cumberland Plain Woodland (CEEC) • 0.02 ha of Freshwater wetlands on coastal floodplains (EEC)	Impacts to BC Act listed TECs have been avoided and minimised throughout the design phase of the project, which most noticeably includes the total avoidance of impacts to BC Act listed CEEC Shale Sandstone Transition Forest in the Sydney Basin Bioregion (Shale Sandstone Transition Forest). The TEC occurs at the western end of the project alignment (and was impacted by previous version of the impact area), and has been avoided through alignment redesign and utilisation of under-boring construction methods from Bents Basin to the Warragamba Dam environmental flows outlet point.

Potential direct impact	Location / description of impact	Significance of impact
	• 4.39 ha of River-flat Eucalypt Forest (EEC) • 1.54 ha of Shale Gravel Transition Forest (EEC) • 0.88 ha of Swamp Oak Floodplain Forest (EEC)	Impacts to TEC vegetation are considered generally unavoidable in the locational context of the project, with almost all vegetation types present within the broader project area related to BC Act listed vegetation. Impacts to less than 5 hectares of any one TEC, within a project area of 213 hectares, and to vegetation that is generally in lower ecological condition, are considered an acceptable level of impact for a project of the scale of the current investigation.
Removal of EPBC Act listed TECs (excluding 'Existing Certified')	The project will result in the removal of the following EPBC Act TECs: • 0.22 ha of Coastal Swamp Oak Forest (EEC) • 1.88 ha of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)	As with impacts to the BC Act TECs, impact avoidance and minimisation has resulted in a reduction of project impacts, with residual impacts to just two EPBC Act listed TECs, in non-BioCertified (and Strategically Assessed) areas. With project design being able to completely avoid impacts to EPBC Act listed CEEC Shale Sandstone Transition Forest of the Sydney Basin Bioregion and Cooks River / Castlereagh Ironbark Forest of the Sydney Basin Bioregion. Due to the largely degraded nature of the vegetation impacted by the project, the majority of the vegetation meeting the requirements for listing under the BC Act did not meet the minimum requirements for listing under the EPBC Act. This not only illustrates the success of the project in avoiding impacts to threatened vegetation, but also the avoidance of impacts to vegetation of higher ecological that would meet the EPBC Act listing requirements. Impacts to 1.88 hectares of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and 0.22 hectares of Coastal Swamp Oak Forest are considered acceptable for a project of this scale. Furthermore none of the impacts to TECs are considered 'significant impacts' for the purposes of the EPBC Act.
Removal of habitats considered to be potential SAIIs (excluding 'Existing Certified')	The project will result in the removal of habitat for the following entities, which is considered to be a potential SAII: • Direct removal of 4.37 ha of BC Act listed Cumberland Plain Woodland vegetation • Direct removal of 1.56 ha of low potential breeding habitat for Large Bent-winged Bat and very low potential breeding habitat for Large–eared Pied Bat and Little Bent-winged Bat based on the presence of natural and man-made habitat at the Warragamba Dam environment flows outlet area.	Project impacts considered potential SAIIs relate to small areas, and small proportions of potential habitat in both the immediate vicinity and broader locality to each of the species considered. Impacts are also based on the assumption of presence of breeding habitat for microbats, as required by the BAM, where analysis of call data clearly shows the presence of roosting/breeding bats is highly unlikely. Survey to exclude species; from breeding on the far side of the Warragamba River was not possible due to access difficulties and restrictions. Impacts to Cumberland Plain Woodland have been avoided and minimised throughout the project design phase, such that residual impact have been restricted to 4.37 ha. Direct impacts to low potential microbat breeding habitat include 1.56 ha around the Warragamba treated water environmental flows outlet which equates to very small portion of the extent of the commensurate potential habitat available in the locality, particularly downstream along the Warragamba River on both side of the gorge. Indirect impacts to potential breeding habitat resulting from vegetation removal within the BAM prescribed breeding buffers for Sooty Owl and microbat habitat on the far side of the Warragamba River will impact on a very small portion of the commensurate habitat potentially available to these species in the locality.

Potential direct impact	Location / description of impact	Significance of impact
	• Indirect impacts to potential breeding habitat for Large–eared Pied Bat, Large Bent-winged Bat, Little Bent-winged Bat and Sooty Owl based on the presence of high quality potential habitat comprising sandstone cliffs, crevices and potential caves, present on the far side of the Warragamba River, opposite the Warragamba Dam environment flows outlet structure. Impacts are associated with vegetation removal within the impact area within 100 – 200 m 'breeding habitat buffer areas' that would be required by the BAM if breeding was recorded / assumed present on the far side of the river.	Further detailed SAII assessments are provided in Appendix 5.
Removal of threatened flora habitat assumed present in unsurveyed section of the impact area at Kemps Creek	The project will result in the removal of habitat assumed present for the following species, between Brandown Quarry and Cross Street, Kemps Creek: • *Dillwynia tenuifloia* – 0.05ha of assumed habitat • Juniper-leaved Grevillea – 0.05ha of assumed habitat • Native Pear – 0.51ha of assumed habitat • Matted Bush-pea – 0.05ha of assumed habitat • Netted Bottle Brush – 0.46ha of assumed habitat	Habitat present in the area where presence has been assumed for the adjacent species ranges from thinned, degraded and patchy PCT 849 vegetation to higher quality intact PCT 835 vegetation closer to the Kemps Creek watercourse. Species presence has been assumed as access could not be gained to survey this location.

Potential direct impact	Location / description of impact	Significance of impact

Removal of native vegetation, threatened flora, and TECs from 'Existing Certified' areas	The project will result in the removal of the following biodiversity values from Existing Certified (and Strategically Assessed) areas:
	• BC Act listed TECs including:
	  ○ 0.98 ha of Cumberland Plain Woodland (CEEC)
	  ○ 0.02 ha of River-flat Eucalypt Forest (EEC)
	  ○ 0.04 ha of Shale Gravel Transition Forest (EEC)
	  ○ 0.02 ha of Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion (VEC)
	  ○ 0.12 ha of Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion (EEC)
	• EPBC Act listed TECs including:
	  ○ 0.03 ha of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CEEC)
	  ○ 0.01 ha of Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion (VEC)
	  ○ 0.03 ha of Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion (EEC)
	• *Dillwynia tenuifloia* – 134 individuals
	• Sydney Bush-pea – 100 individuals
		All impacted biodiversity values within Existing Certified land have been assessed and offset in accordance with previous state and Commonwealth approvals.

Potential direct impact	Location / description of impact	Significance of impact
Removal of potential Koala habitat	The project will remove 13.77 ha of habitat containing Koala feed tree species that has the potential to be used for dispersal foraging and possibly breeding by Koalas.	As outlined in Table 40, the EPBC Act Koala referral guidelines (CoA 2014a) have been applied to the project and the habitats supported were found not to be critical to the survival of the species. Targeted surveys for the presence of Koala were undertaken at key locations along the project alignment where recent records of the species occur, and some degree of habitat connectivity is present (Figure 9). These locations were selected as they are considered most likely to be where evidence of Koala would be found along the project alignment. No signs of the species were detected, and as such there is no evidence to suggest Koala have recently utilised habitats within the project area. This is supported by a general lack of records of the species within 10 kilometres of the project, across the majority of the alignment, over the last 20 years. Exceptions to this include records associated with the Campbelltown (and Holsworthy) population which has highly limited connectivity to the project's impact area, and around Western Sydney Parklands and near Warragamba which were the subject of targeted surveys. Koalas are unlikely to utilise habitats present within the project area as movement corridors, due to the narrow, disturbed and fragmented nature of the vegetation present across the majority of the impact area, with the possible exception again of Western Sydney Parklands and near the Warragamba Dam. furthermore the project will not result in permanent barriers to movement if Koalas aware to move through the area in the future, and a cleared easement of up to 30 m would not present a substantial barrier for a dispersing Koala to cross. The construction of the treated water outlet at Warragamba represents a large piece of permanent infrastructure within a broad locality that has potential to be utilised for dispersing Koalas, however it is located adjacent to the existing Warragamba Dam infrastructure and as such, it is considered unlikely that Koalas would be moving through the area to be impacted. Based on the habitats within the impact area not being considered critical to the survival of the species, the lack of detection during targeted surveys, and the negligible impacts to potential movement of Koalas, the project is considered unlikely to result in any substantial impacts to the species, or local populations.

11.2 Indirect impacts

Potential indirect impacts arising from the project are outlined and addressed in Table 46 below. Indirect impacts have been assessed based on a number of factors, including:

- The presence of native vegetation and habitats directly adjacent to the impact area, i.e. within the impact assessment area, and the potential for those retained patches of vegetation and habitat to be negatively affected by the project.
- The presence of biodiversity values on and adjacent to the banks of the Nepean River and the potential for impacts relating to an increased wetted perimeter as a result of increased river depth due to the release of treated water at the Wallacia Weir.
- The presence of biodiversity values on the far side of the Warragamba River and the potential for impacts resulting from the construction and operation of the environmental flows treated water outlet near the Warragamba Dam.
- Landscape scale impacts to species habitat connectivity.

Table 46 Assessment of indirect impacts

Potential indirect impact	Location / description of impact	Significance of impact
Inadvertent impacts on adjacent habitat or vegetation within the impact assessment area.	A total of 23.23 ha of native vegetation, comprising 8 PCTs, has been mapped within the impact assessment area (outside Existing Certified land), which encompasses a wider area, generally 12.5 metres either side of the impact area, primarily to allow for design flexibility after the EIS is approved, however it also allows for assessment of indirect impacts. Inadvertent impacts that may occur within this wider area are expected to be most likely during the construction phase of the project, and include factors such as: • Clearing, or excavation, of vegetation and habitats (including threatened species habitats) outside the approved extents. • Impacts associated with soil compression, trampling and dumping via access to the impact area. • Stockpiling of materials outside approved areas. • Sedimentation of areas resulting from poor environmental controls surrounding excavations. • Introduction and/or spreading of exotic weed species.	Whilst there is some potential that inadvertent impacts, such as those listed adjacent may occur, construction safeguards (see Section 11.5) will be implemented and documented in a Construction Environmental Management Plan. It can be expected that these safeguards will be implemented by the professional contractors engaged to construct the project, and this will be sufficient to manage the potential for inadvertent impacts to adjacent habitats or vegetation.
Inadvertent impacts on adjacent habitat or vegetation opposite and surrounding the environmental flows treated water outlet near the Warragamba Dam.	The release of treated water as environmental flows into the Warragamba River, just downstream of the Warragamba Dam is a key component of the project, and is expected to increase the health of that river system. However construction and operation of the outlet structure and ancillary facilities has the potential to indirectly impact on native fauna species (including threatened species) utilising the habitats in the surrounding locality. High quality vegetation and habitats occur on the far side of the Warragamba River contiguous with the Blue Mountains National Park and Burragorang State Conservation Area. Mature vegetation present in this area is likely to support a range of tree hollows that may be utilised by native fauna species for breeding, including species	Construction activities at the treated water outlet will include the items listed below and are expected to run for a period of between 6 to 12 months: • The launch / receivable point of the (approx. 2.5 kilometre) horizontal direction drill (HDD) from Bents Basin Road operating 24 hours a day during critical stages of drilling operations, potentially extending for 6 months. • Clearing, excavation and installation for footing of outlet structure, gabion wall, rip rap, permanent roadway and stair access from Core Pare Road. • Installation of construction access road from Core Pare Rodd. Operation activities will include release of between 700 L/s (project stage 1) and 1389 L/s (project stage 2), with pumps and discharge running 20 hours per day. A noise and vibration assessment has been completed by Aurecon Arup (2020) for the construction and operation phases of the project. The assessment includes a desktop

Potential indirect impact	Location / description of impact	Significance of impact
	considered in this assessment such as Gang-gang Cockatoo, Glossy Black-Cockatoo, Barking Owl, Powerful Owl, Sooty Owl, Masked Owl. The rocky sandstone cliff line habitat present may also be utilised by species such as Large-eared Pied Bat, Little Bent-winged Bat, Large Bent-winged Bat and Sooty Owl for roosting and potentially breeding. The mature trees in the deep riparian gorge may support breeding opportunities for raptors such as White-bellied Sea Eagle, Little Eagle and Square-tailed Kite. Where these breeding opportunities potentially exist within the BAM prescribed 'breeding habitat buffers' of between 100 to 200 m for the above listed species, they could be considered to be indirectly impacted by the construction and operation of the treated water outlet. Indirect impacts may occur as a result of noise, light and vibration impacts during construction and operation, and increased disturbance and activity within close proximity (100-200 m) of potential breeding habitat, both of which have the potential to lead to abandonment of breeding sites, as a worst case scenario. Potential impacts to biodiversity values adjacent to the Wallacia weir treated water outlet are considered to be less likely and less significant due to the more disturbed nature of the habitats within 100 – 200 m of the outlet structure, and therefore the lower likelihood of this area being used as breeding habitat.	survey covering approximatively 100 m each side of the current pipeline centreline. This area is considered sufficient for the assessment of vibration impact, while noise impacts could occur at greater distances than 100 m, especially in non-built-up areas, the current survey is considered to have identified the nearest worst case receivers (Aurecon Arup 2020). Specific assessment of construction works associated with compound C1, located at the treated water discharge location, has been undertaken as part of the noise and vibration assessment (Aurecon Arup 2020). The construction phase assessment included items such as site establishment, earthworks and civil, commissioning, and landscaping and restoration as part of the typical construction activities for trenchless construction or HDD, as well as construction of the discharge structure and maintenance access. The assessment found that sound pressure levels will range from 109 dBA to 124 dBA across the various stages of construction, with earlier stages of earthworks/civil requiring an excavator (30t) and hydraulic hammer emitting the most noise (124dBA). Micro-tunnelling / direction drill equipment, which may operate for 24 hours per day, 7 days a week, for 6 months at this location are noted as emitting sound pressure levels of 112 dBA. The assessment also provides the reduced sound pressure levels based on separation distance to the sensitive receivers, which in this case would be fauna roosting/nesting within 100 m to 200m of the plant. During the five construction phases the noise levels can be expected to range between approximately 55 dBA (200 m from plant) and 61 dBA (100 m from plant) up to 69 dBA (200 m from plant) and 75 dBA (100 m from plant) (Aurecon Arup 2020). These noise levels are expected to occur during daytime hours. The noise and vibration assessment states that 75dBA is considered Highly Noise Affected Noise Management Levels, and this 75dBA threshold is likely to be reached when the excavator (30t) and hydraulic hammer is in operation. It is expected that this plant will only operate during daytime hours, and could be considered to potentially impact nocturnal fauna within roosting 100 m to 200 m of the impact area. Drilling operations are required to be undertaken 24 hours per day for a period of three to six months, and therefore a number of noise and vibration emitting

Potential indirect impact	Location / description of impact	Significance of impact
		equipment may cause disturbance to both diurnal (roosting) and nocturnal (foraging) fauna during the night. Based on the equipment listed as required for construction activities at compound C1 in the noise and vibration assessment report, maximum night time sound pressure levels, potentially impacting upon fauna within 100m to 200m of the impact area are expected to range from between 58 dBA to 64 dBA (Aurecon Arup 2020), based on operation of the micro-tunnelling / direction drill equipment. Whilst these activities do not fall into the Highly Noise Affected Noise Management Levels, they are considered to have the potential to disturb fauna in the locality. Night works will also require the work site to be lit to the required work health and safety standards, and this lighting has the potential to disturb roosting diurnal fauna, and disorientate foraging nocturnal fauna. Lighting impact are expected to occur for a period of 6 months. During the operational phase of the project potential noise from the water discharge will be limited, as the treated and environmental flow pipelines will discharge into a weir structure which is elevated and situated back from the river edge, such that water will flow down the river edge, rather than cascade directly into the river like a waterfall (Aurecon Arup 2020). Disturbance to fauna from noise, light and potentially vibration during construction is considered likely occur within the vicinity of the treated water outlet near the Warragamba Dam. However, the disturbance will be temporary in nature, and there is unlikely to be significant ongoing disturbances during the operation phase of the project. Whilst the disturbance during construction has the potential to impact on fauna utilising the high quality habitats adjacent to the impact area, these habitats are not limited in the locality, with the vegetation being of a similar maturity and successional stage in the broader surrounds, and the rocky sandstone cliff line habitat being present both back upstream, but more so downstream from the Warragamba Dam. It should be noted that the 24 hour HDD drilling operation will minimise duration impacts and risk of tunnelling failure (Aurecon Arup 2020), and mitigation measures outlined in Section 11.5 are provided to minimise potential impacts to fauna in the area.

Potential indirect impact	Location / description of impact	Significance of impact
		Where the above considered indirect impacts are associated with fauna species considered at risk to potential SAIIS, further assessment is provided in Appendix 5
Inadvertent impacts on adjacent habitat or vegetation within the Lansdowne Reserve Stewardship Site	Lansdowne Reserve Stewardship Site (formerly BioBank Site) is located at the eastern extent of the impact are and impact assessment area, where the brine pipeline joins the existing Malabar wastewater network. Impacts will occur adjacent to the Stewardship Site only, with no direct impacts within the site boundaries. Impacts will include: • Clearing of roadside vegetation (Cumberland Plain Woodland TEC) for access along Tillett Parade, to the north of the Stewardship Site. • Clearing of vegetation (Cumberland Plain Woodland TEC) from a slope to the west of the Stewardship Site to access the wastewater system access location. • Clearing of the relatively disturbed area surrounding the wastewater system access location to the west of the Stewardship Site.	Significant efforts have been made to date to avoid direct impacts to the Lansdowne Reserve Stewardship Site, including multiple re-designs of construction methodologies and access options. Multiple site visits were undertaken by Biosis ecologists and Sydney Water project engineers to workshop potential options in this location and to ensure potential impacts were clearly identified. Following which, a site meeting was held between project staff and Council staff to discuss the options available. After which, the current design was decided upon. Impacts to the Stewardship Site, based on the current impact area are considered likely to be negligible. Minor clearing / trimming is required along the edge of the vegetation contiguous with the Stewardship Site's northern boundary, and a strip of clearing 20 m wide will be required to the west of the site for access. However neither of these impacts are likely to result in substantial indirect impacts to the vegetation and habitats present within the site, as they will not substantially increase edge effects, or result in substantially increased fragmentation. The clearing required for access, to the west of the Stewardship Site will be rehabilitated following the completion of the construction phase of the project. The impacts associated with the site compound at the wastewater system access point will also be negligible due to the current disturbed nature of the vegetation in the location, and the future rehabilitation of the area once construction works are completed. Minor impacts to the threatened flora species Downy Wattle, are likely to occur to the north of the Stewardship Site, however this will not have a substantial or significant impact upon the population and/or habitats present within the site.
Reduced viability of adjacent habitat due to edge effects.	Survey and mapping of vegetation and habitats within the impact assessment area has allowed for assessment of potential edge effects along the length of the linear project alignment. The impact area comprises 13.77 ha of native vegetation (excluding Existing Certified areas), which occurs generally within 12.5 metres either side of the pipeline alignments but is wider or narrower in	The potential for the project to significantly or substantially increase edge effects to adjacent vegetation and habitats is considered relatively low. Vegetation present within and adjacent to the project alignment is largely already subject to moderate to high levels of edge effects, and efforts have been made to minimise and avoid impact to vegetation in higher ecological condition and parts of large connected areas. Impacts at Lansdowne Reserve will not increase edge effects in that location, nor will

Potential indirect impact	Location / description of impact	Significance of impact
	certain areas, and across the entire 80 ha site at the AWRC. The impact assessment area comprises an additional 23.23 ha of native vegetation (excluding Existing Certified areas), which occurs generally within a further 12.5 m either side of the impact area. As linear infrastructure utilising mainly open trenching construction methods, the project has the potential to increase edge effects to the 23.23 ha of native vegetation with the impact assessment area, and potentially vegetation and habitats further again from the project's impact area.	the next 14 kilometres (approx.) of pipeline through suburban areas, to Western Sydney Parklands. The impact area is located largely within already cleared areas of Western Sydney Parklands, and thus edge effects will not be increased in that location. Potential edge effects may occur as a result of the requirement for the pipeline to cross through the intact vegetation at Kemps Creek (watercourse) utilising open trenching construction methods. The impact area then generally occurs in road verges and along vegetated edges through Kemps Creek (suburb), up to and including the AWRC, and west along Elizabeth Drive to The Northern Road. Vegetation in this area is already highly fragmented and patchy, comprising largely of scattered paddock trees and disturbed road verge vegetation, with watercourses generally underbored. South Creek will not be underbored, however a culvert crossing already exists in the location where the alignment crosses the creek. The impact area then generally follows Park Road to Wallacia, with the Nepean River being underbored. Minor increases to edge effects may be realised either side of the river where vegetation clearing is required on the floodplain to the east, and at the top of bank, and further up on the floodplain of the west, for the alignment and to facilitate the underbore. The areas of vegetation removal are not substantial in these locations, with only approximately 0.7 ha of clearing required. Limited clearing of native vegetation is required to the Wallacia weir, and south along Bents Basin Road, following which a long underbore to the Warragamba Dam environmental flows outlet prevents edge effects from occurring through the intact vegetation in this location. The outlet structure site is located at the edge of an area of vegetation already disturbed by the dam spillway and access roads, and the outlet itself will not create substantial edge effects in this location. An increase in edge effects will not be significant to the 23.23 ha of vegetation immediately adjacent to the impact area, along the majority of the project alignment, due to the already disturbed and edge effected nature of the vegetation. An increase to edge effects may occur along the approximately 230 m length of the

Potential indirect impact	Location / description of impact	Significance of impact
		alignment that crosses though intact vegetation surrounding Kemps Creek (watercourse), this will be somewhat mitigated by the future rehabilitation of the impact area following the completion of the construction phase of the project. Increased edge effects at South Creek are considered to be relatively minor due to the already highly edge effected nature of the vegetation where the alignment crosses the creek.
Reduced viability of adjacent habitat due to noise, dust or light spill	The project will emit noise, dust and light during the construction and operational phases, and due to the use of both open trenching and HDD construction methods some aspects will occur both during the day and at night. Impacts associated with dust are expected to be negligible as a result of standard construction safeguards, and the construction program not requiring large areas of land to be 'opened-up' at any one time. Noise and light spill impacts at the environmental flows treated water outlet near the Warragamba Dam have been addressed above, however the potential for impacts may occur elsewhere along the project alignment. Underbores will be used at a number of locations along the alignment where watercourses or roadways (or other infrastructure) make trenching a less desirable option. In these locations noise and light impact will occur 24 hours per day whilst drilling is undertaken and there is the potential for this to disturb fauna species in the vicinity. Trenching and associated construction activities, such as plant access and deliveries, has the potential to disturb fauna species during the day through noise impacts and may alter foraging or roosting activities. The AWRC site will emit noise during the operation phase of the project, as will the treated water outlets (assessed above), and air valves present along the pipeline alignment have the potential to cause noise impacts.	Where the impact area occurs within suburban and semi-rural areas, and the construction method consists solely of daytime activities, the project's potential impacts associated with noise and light (and potentially vibration) are considered to be minor. This is due to the general low quality of fauna habitats within and adjacent to the project alignment. Potential exceptions include the Kemps Creek (watercourse) riparian area, and the bushland block between Cross Street, Western Road, Elizabeth Drive and Devonshire Road, at Kemps Creek (suburb). However no significant fauna populations are known to occur in these areas, nor were any recorded during surveys undertaken for the current assessment. Notwithstanding the above however, is the potential for disturbance to the Grey-headed Flying-fox camp at the Nepean River, which occurs at least 160 m from the impact area. Construction activities in this location will be include both open trenching, and underboring of the Nepean River, with works to occur during both daytime construction hours, and at night, for a period of 8 to 12 weeks (Aurecon Arup 2020). The Grey-headed Flying-fox camp does not meet the EPBC Act definition of a nationally-important flying-fox camp as the camp was found to contain approximately 2000 individuals and is considered a colonial roost comprised of adult and sub-adult males with no gravid or lactating females or dependent young present. The camp is considered a temporary refuge and is known to fluctuate in size based on the presence of males in this location, or elsewhere at breeding colonies. Construction activities have the potential to disturb the Grey-headed Flying-foxes in this location during to noise and vibration impacts, which depending on the severity of the disturbance, could as a worst case scenario result in the abandonment of the camp. Anticipated sound pressure levels are expected to be highest during micro-

Potential indirect impact	Location / description of impact	Significance of impact
		tunnelling / directional drilling activities which are listed as having sound pressure levels of 58-60 dBA when 150 m 200 m from the receiver (flying-fox camp). This level of noise disturbance is greater than the daytime rating background level of 40-45 dBL at this location, and also the 'noise affected' level of 55 dBA. The expected noise disturbance is however below the threshold for Highly Noise Affected Noise Management Levels (Aurecon Arup 2020). Disturbance is expected to occur during daylight hours for a period of between 8 to 12 weeks (Aurecon Arup 2020), and as a worst case scenario may cause some or all of the flying-foxes to abandon the camp. As the camp is not a breeding camp, or considered important in accordance with the EPBC Act, no offsetting of potential impacts is required, and no specific management of construction activities to project the camp is considered necessary.
Transport of weeds and pathogens to/from the site to/from adjacent vegetation	Indirect impacts associated with the transport of weeds and/or pathogens is not considered to be substantial as a result of the construction or operation of the project. Standard construction safeguards will be in place to prevent this impact and biosecurity risk from occurring. However there is a potential for weed and pathogens to be spread to/from novel areas as a result of the increased wetted perimeter surrounding the Nepean River.	Despite the potential for increased spread of propagules through the waterway either from areas previously less frequently inundated, or into areas not currently inundated, the potential for substantial novel outbreaks of weeds or pathogens is not considered likely to be at a level that would result in substantial change to ecosystem function. Areas upstream of the Wallacia weir are already subject to weed inputs, and pathogens may also be present, and areas downstream of the Wallacia weir, are considered likely to be resilient enough to prevent significant new outbreaks from establishing.
Increased risk of starvation, exposure and loss of shade or shelter	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Loss of breeding habitats	Potential breeding habitats associated with the project's impact area include hollow-bearing trees, and other large old trees that may provide raptor nesting opportunities. As outlined in Section 8.2.3 targeted surveys for breeding habitats for those species considered likely to occur within the study area found such resources to be limited within the impact area. As outlined in Section 11.1 above, direct impacts to potential breeding	Tree hollows of various sizes were recorded throughout the impact area and will be removed by the project. However, hollows suitable to support breeding of threatened owl and/or cockatoo species were however found to be highly limited. Tree hollows that may support potential breeding habitat for threatened microbat species also occur within the impact area and will be removed as a result of the project. The proportion of hollows removed by the project compared to those present within the broader landscape is not considered likely to be high, based on the hollows mapped

Potential indirect impact	Location / description of impact	Significance of impact
	habitat for microbat species may occur as a result of impacts to the vertical (vent) shaft at the environmental flows treated water outlet near the Warragamba Dam. Indirect impacts associated with disturbance to potential breeding habitat of the far side of the Warragamba River are also outlined above.	during fieldwork (Figure 10) and the data collected as part of the detailed fauna habitat assessments. Indirect impacts associated with the loss of breeding habitats are not considered likely to be substantial or significant to any locally occurring threatened, or non-threatened, species.
Trampling of threatened flora species	Standard construction safeguards (establishing exclusions zones) are considered sufficient to prevent errant access to adjacent habitats that would potentially result in the trampling of threatened flora at Lansdowne Reserve, Park Road, or along Cross Street and Western Road at Kemps Creek. These are the only locations along the project alignment where this potential indirect impact has some likelihood of occurrence.	Potential indirect impacts associated with the trampling of threatened flora species are considered negligible.
Inhibition of nitrogen fixation and increased soil salinity	The project will result in the removal of a total of 21.68 ha of vegetation, comprising native PCTs and urban street trees or larger infestations of exotic species. This level of vegetation removal (plus the removal of area of exotic grassland) will occur over an area of approximately 213 ha. Following completion of construction the majority of the impact area, that is currently vegetated, will be rehabilitated back to an appropriate level of vegetation cover.	Based on the low proportion of vegetation removal across the relatively large impact area, and the rehabilitation of areas post construction, indirect impacts associated with inhibition of nitrogen fixation and increased soil salinity are considered to be negligible.
Fertiliser drift	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Rubbish dumping	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Wood collection	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Bush rock removal and disturbance	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Increase in predatory species populations	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Increase in pest animal	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.

Potential indirect impact	Location / description of impact	Significance of impact
populations		
Increased risk of fire	The project in unlikely to alter the existing fire risk or current fire regimes operating within the impact area, or broader locality.	Potential for this indirect impact to occur is considered negligible, and the requirements for legislated bushfire hazard reduction and asset protection will be implemented during construction and operation of the project.
Disturbance to specialist breeding and foraging habitat, e.g. Beach nesting for shorebirds	Potential for this indirect impact to occur is considered negligible.	Potential for this indirect impact to occur is considered negligible.
Fragmentation of movement corridors	The impact area crosses a number of features that provide somewhat limited opportunities for movement of biodiversity values across the landscape. Major connectivity features associate with the impact area include: • Prospect Creek and Lansdowne Reserve • Western Sydney Parklands, Kemps Creek and Hinchbrook Creek • South Creek and Badgerys Creek • Nepean River • Warragamba River and the Greater Blue Mountains Area	Where these connectivity features are crossed via open trenching construction methods minor localised disruption to movement corridors will occur. Connectivity will be generally disrupted by the 15 m to 20 m wide pipeline easement. It is noted in EPBC Act conservation advice documents that allowances can be made for "breaks" of up to 30 metres between areas of MNES habitat, and that such breaks, which may be the result of watercourses, tracks, paths, roads, etc., do not significantly alter the overall functionality of the ecological community, or habitat (CoA 2020). As such, breaks in connectivity caused by the future pipeline easement are not considered to be substantial in nature. Potential exceptions to this are less mobile threatened species such as Cumberland Plain Land Snail and Dural Land Snail. The movement corridor associated with the Kemps Creek riparian corridor is likely to be most substantially impacted, with the project impacting upon an approximately 15 m wide strip of intact native vegetation over approximately 230 m length. The project impact is located at the northern extent of the large patch of bushland contiguous with Kemps Creek Nature Reserve, further north of which the riparian vegetation reduces in width to areas between 100 m wide, down to areas of 20 m wide, before the connected vegetation ends at the dammed waterbody immediately north of the AWRC site. Due to this reduction in width and expected reduction in condition of the connectivity feature, and the lack additional connected habitats over 4.5 kilometres to the north, the impact of the break in connectivity along Kemps Creek, as a result of the project is not considered likely to substantially impact upon local populations of flora or fauna species.

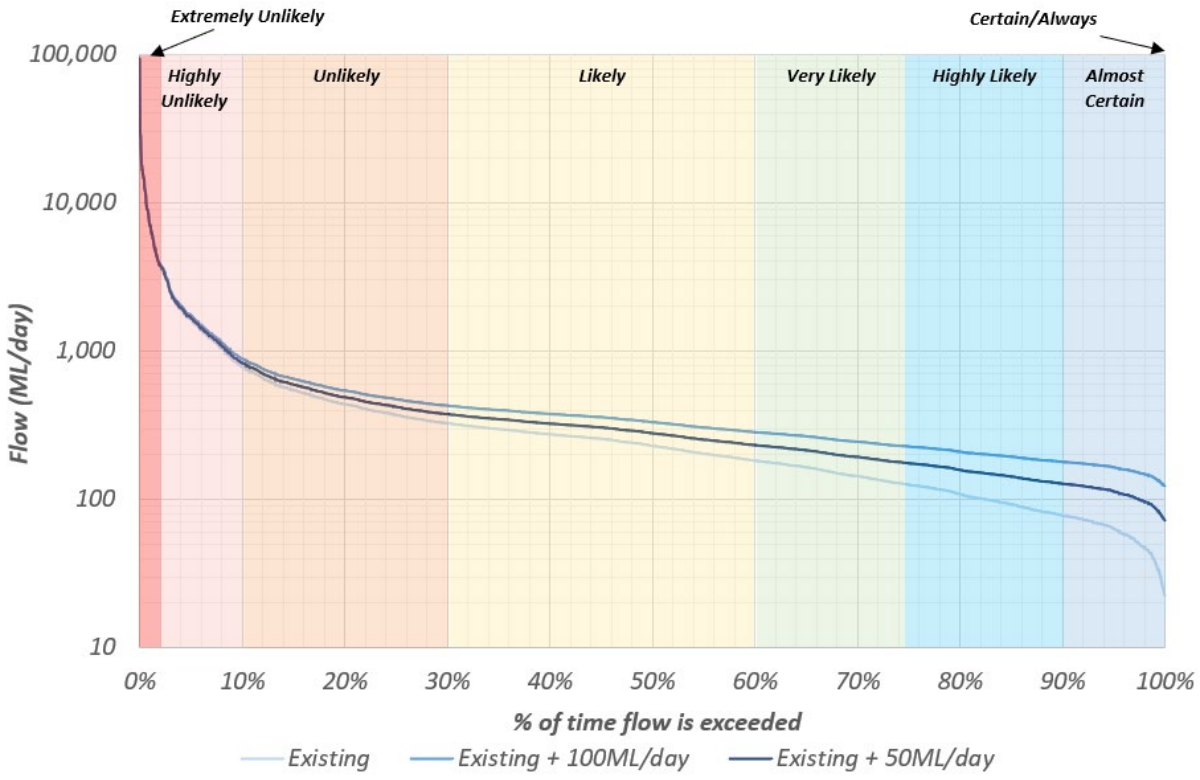
Potential indirect impact	Location / description of impact	Significance of impact
		Connectivity through Western Sydney Parklands is already disrupted by existing easements and historically cleared vegetation, and the project will not increase fragmentation in the area. Connectivity impacts potentially relevant to the remaining connectivity features listed, are considered negligible due to either underboring, minimal vegetation clearing, or existing disturbances.

11.2.1 Indirect impacts on adjacent habitat or vegetation along the banks of the Nepean River system

Indirect impacts to biodiversity values during the operational phase of the project are likely to occur as a result of alteration of inundation depth and duration. This relates to a minor increase in river depth resulting from the increased water released into the Nepean River system. The maximum increased inundation depth and duration have been modelled in accordance with the 100 ML/day treated water release (i.e. ultimate dry weather treatment capacity of the AWRC, planned for completion in 2036) as a 30 centimetre (median) to 60 centimetre (maximum) increase up to 12 kilometre upstream of Wallacia weir, and up to a 14 centimetre increase downstream to the Penrith weir, which includes the World Heritage reach of the Nepean River (Streamology 2021). It should be noted that this 100ML/day flow is considered a worst case scenario, possible once the plant is expanded to its maximum capacity and assuming all releases are into waterways. Releases will be lower when the AWRC is first built and capacity is only 50ML/day, with discharge levels unlikely to actually reach 100ML/day given recycled water schemes will encompass some of the future releases. The area subject to this assessment is illustrated in Figure 15.

Inundation extents have been modelled for a number of flow scenarios by Streamology as part of the hydrological assessment for the project's EIS. GIS and topographic models were used to determine the spatial extent of expected inundations for the various flow scenarios. The flow duration curve below (Graph 2) for the Nepean River, downstream of Wallacia weir, was used to quantify the probability and frequency of inundation for terrestrial biodiversity values present on the riverbanks, and within the boundaries of the various inundation extent polygons.

This graph indicates that a flow of 100,000 ML/day is extremely unlikely, occurring approximately 0.01% of the time. Whereas a lower flow of 25 ML/day occurs 99.9% of the time, with ecological features within this 25 ML/day inundation extent expected to be inundated almost constantly.



Graph 2 Annotated flow duration curve at Wallacia Weir under Existing conditions, Existing + 50 ML/day and Existing + 100 ML/day

Potential impacts are likely to occur as a result of the mean water level rise leading to increased frequency of inundation of biodiversity values present on the lower portions of the riverbanks. Potential impacts to biodiversity values have been assessed based on the current median flow in the river system of 229 ML/day, and the expected future median flows of 279 ML/day (with increased 50 ML/day releases), and 329 ML/day (with increased 100 ML/day releases) (Graph 2). Terrestrial biodiversity values present within (below) the inundation extent polygons, developed for these three median flow scenarios, are (or will be) inundated at least 50 % of the time.

Terrestrial biodiversity values present outside the project's impact area and impact assessment area, along the banks of the Nepean River, have been assessed via:

- Existing aerial vegetation mapping projects, including OEH (2013) to map vegetation in the Cumberland IBRA subregion and Tozer et al (2010) used for the Wollemi IBRA subregion.
- BioNet species records.
- Camden White Gum records collected by Biosis surrounding the impact assessment area, using standard hand-held GPS units.
- Camden White Gum records collected by CTE between Wallacia and Bents Basin in late 2020, using high accuracy Differential GPS units (+/-1 m).

Based on the above, terrestrial biodiversity values potentially affected by the increased water released to the Nepean River include:

- Coastal Upland Swamp TEC
- Cumberland Plain Woodland TEC
- River-flat Eucalypt Forest TEC
- Sydney Turpentine-Ironbark Forest TEC
- Camden White Gum individuals and habitats
- Non-threatened riparian and floodplain vegetation providing habitat for habitat for threatened and non-threatened flora and fauna species such as White-bellied Sea Eagle, Southern Myotis, Platypus, numerous frog and bird species.

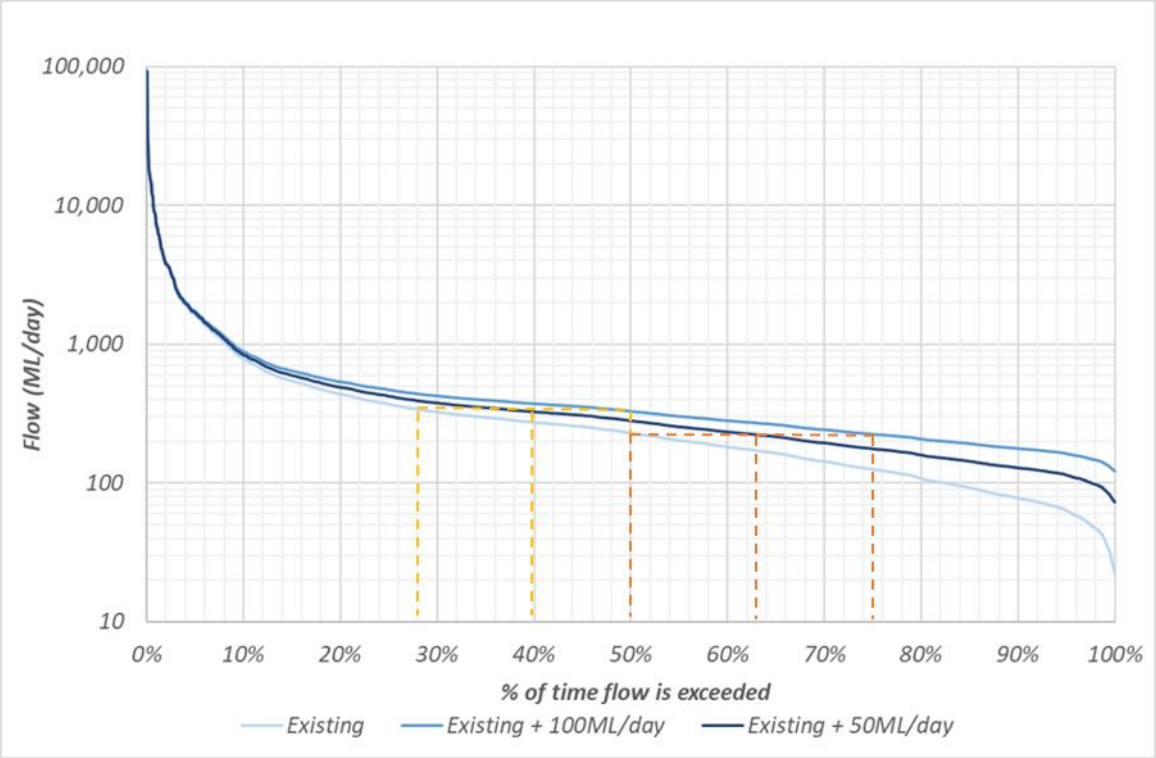
It is acknowledged that there is a level of inaccuracy in the data used to assess potential impacts relating to altered hydrology, especially in the aerial vegetation mapping, which in places covers the entire Nepean River, rather than just its banks. To standardise the analysis of potential impacts to terrestrial vegetation along the river banks, the inundation extent polygon for the lowest flow scenario provided by Streamology (being 25 ML/day) was used to clip out vegetation polygons mapped within the waterway. This approach is considered appropriate as anything present within (below) the 25 ML/day inundation extent polygon can be considered to be permanently inundated, and thus terrestrial vegetation and habitats would be unable to persist. Furthermore, the data used is considered best available, and any inaccuracies are considered to be within an acceptable level of tolerance for the scale of the assessment.

The total area and extent of terrestrial biodiversity values subject to potential impacts have been calculated based on the vegetation polygons mapped between the low flow inundation extent (ie the 25 ML/day inundation extent polygon) and the current median flow inundation extent (229 ML/day), and the two future median flow inundation extents (279 ML/day and 329 ML/day). The median flow inundation extent has been used as a baseline to assess impacts, as biodiversity values present are subject to flooding 50 % of the time and would be expected to be well adapted to the periodic inundation. However biodiversity values outside

(above) the current median flow inundation extent are subject to less frequent inundation, may be less tolerant of inundation, and thus may be negatively affected by increased inundation.

Terrestrial biodiversity values present within the 'bands' of the river bank between each of the current and future inundation extents are expected to be subject to differing changes to periodic inundation. Expected changes to inundation frequency are illustrated on Graph 3 below, and are described as follows:

- Biodiversity values present between the current low flow extent (25 ML/day) and current median flow extent (229 ML/day), are currently subject to inundation >50 % of the time.
    - With an increase of 50 ML/day into the river system the frequency with which these biodiversity values will be inundated will increase from >50 % of the time to >63% of the time.
    - With an increase of 100 ML/day into the river system the frequency with which these biodiversity values will be inundated will increase from >50% of the time to >74% of the time.
- Biodiversity values present between the current median flow extent (229 ML/day) and the future median flow extent for 50 ML/day releases (279 ML/day), are currently subject to inundation between 40-50 % of the time, which will increase to >50 % of the time.
- Biodiversity values present between the current median flow extent (229 ML/day) and the future median flow extent for 100 ML/day releases (329 ML/day), are currently subject to inundation between 27-50 % of the time, which will increase to >50 % of the time.



Graph 3 Flow duration curve at Wallacia Weir under Existing conditions, Existing + 50 ML/day and Existing + 100 ML/day

Table 47 provides details of the biodiversity values mapped as occurring on the banks of the Nepean River, along the 36 kilometre stretch expected to be impacted by the change in mean river depth, and thus inundation frequency and extent.

Table 47 Terrestrial biodiversity values present within the 229 ML/day, 279 ML/day, and 329 ML/day inundation extents

Flow scenario	PCT 743	PCT 835	PCT 849	PCT 1078	PCT 1105	PCT 1181	PCT 1284	PCT 1292	Camden White Gum
Existing conditions									
Biodiversity values between 25 ML/day and 229 ML/day inundation extents (ha)	0.03	3.7	0.01	0.04	0.01	0.31	0.03	0.54	11 indiv. 0.32 ha
Increased 50 ML/day release scenario									
Existing conditions: 229 ML/day (ha)	0.03	3.7	0.01	0.04	0.01	0.31	0.03	0.54	11 indiv. 0.32 ha
+50 ML/day releases: 279 ML/day (ha)	0.04	4.46	0.01	0.06	0.01	0.35	0.03	0.55	12 indiv. 0.42 ha
% change in inundation	33 %	21 %	0 %	50 %	0 %	13 %	0 %	2 %	9 % (indiv.) 31 % (ha)
Hectares change (ha)	0.01	0.76	0.00	0.02	0.00	0.04	0.00	0.01	0.10
Increased 100 ML/day release scenario									
Existing conditions: 229 ML/day (ha)	0.03	3.7	0.01	0.04	0.01	0.31	0.03	0.54	11 indiv. 0.32 ha
+100 ML/day releases: 329 ML/day (ha)	0.04	5.15	0.01	0.07	0.02	0.39	0.04	0.57	12 indiv. 0.54 ha
% change in inundation	33	39	0	75	100	26	33	6	9 % (indiv.) 69 % (ha)
Hectares change (ha)	0.01	1.45	0.00	0.03	0.01	0.08	0.01	0.03	0.22

It can be seen from the above table that eight separate PCTs are likely to be subject to changes in hydrological regime as a result of increased treated water releases to the Nepean River. Those PCTs with the largest area subject to potential impacts include:

- PCT 835 Cumberland River-flat Forest (comprising River-flat Eucalypt Forest EEC) – up to 5.15 ha affected.
- PCT 1181 Hinterland Sandstone Gully Forest – up to 0.39 ha affected.
- PCT 1292 Water Gum - Coachwood riparian scrub along sandstone streams, Sydney Basin Bioregion (Sandstone Riparian Scrub) – up to 0.57 ha affected.

PCT 835 and PCT 1292 are both riparian / floodplain PCTs occurring in close proximity to watercourses and thus would be expected to be subject to the largest area of change. PCT 1181 is a more terrestrial gully forest community and is less strongly associated with riparian zones, however the PCT often occurs down to the water level, and in a mosaic pattern with PCT 1292 in steep sandstone river gorges, such as that present through the Blue Mountains National Park and around Bents Basin. Potential impacts to these PCTs are detailed further below.

The remaining five PCTs affected include two that are strongly associated with riparian zones and floodplains, those being:

- PCT 1078 Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion (Tree-tree - sedge wet heath) (comprising Coastal Upland Swamp EEC).
- PCT 1105 River Oak Open Forest.

Both of these PCTs are subject to large proportional changes, however these changes are to small total areas and are again expected due to the characteristic landscape position of these communities.

The final three PCTs affected are terrestrial forest / woodland PCTs, including:

- PCT 743 Brown Barrel - Mountain Grey Gum tall moist forest on basalts of the Southern Highlands Bioregion and Sydney Basin Bioregion.
- PCT 849 Cumberland Shale Plains Woodland (comprising Cumberland Plain Woodland CEEC).
- PCT 1284 Turpentine - Smooth-barked Apple moist shrubby forest of the lower Blue Mountains, Sydney Basin Bioregion (comprising Sydney Turpentine-Ironbark Forest CEEC).

Total areas of these five PCTs affected by the altered hydrology patterns equate to no more than 0.07 hectares for a single PCT, over the entire 36 kilometre extent of the area modelled for impacts. This level of potential change is not considered likely to be result in substantial or significant impacts to these PCTs, or the habitats they support, as a result of changes in mean inundation extent or frequency.

Furthermore, it is important to note that no new PCTs are effected by changes resulting from the increased water released into the river system, when PCTs present within the current mean and future mean inundations extents are compared. This illustrates that all vegetation and habitats present within the area subject to the proposed changes are already subject to some form of dynamic and periodic inundation, and the minor increase in river depth is unlikely to result in substantial change to the current equilibrium and result in negative impacts.

Whilst it is noted that all PCTs present within the area assessed for hydrological impacts are subject to existing dynamic and periodic inundation conditions, the most likely potential consequence of increased inundation frequency is a change to the species composition. It is considered most likely that this change would occur most substantially as an increase in species richness, cover and abundance of water-tolerant groundcover plants, and the associated reduction in the presence of species better adapted to drier conditions. Large

established trees are likely to remain relatively unaffected due to deep established root systems; however a change in zonation over time may alter regeneration patterns. Mid-storey species are considered likely to respond in a similar manner to the groundcover vegetation, however where small trees are a major component of the mid-storey these species are likely to be less affected. Table 48 below provides details on species listed characteristic for each strata of each subject PCT (from BioNet Vegetation Classification database), and includes a general assessment of the expected inundation tolerance of each group.

Those PCTs (and strata) listed as having characteristic species with a low inundation tolerance are considered likely to be more affected by potential changes to species composition, than those PCTs (and strata) considered to be more tolerant to inundation.

Table 48 PCTs affected by altered hydrological regime and inundation tolerance

PCT	Vegetation class	Upper stratum species and inundation tolerance	Mid stratum species and inundation tolerance	Ground stratum species and inundation tolerance
PCT 743	Southern Escarpment Wet Sclerophyll Forests	*Eucalyptus fastigata, Eucalyptus cypellocarpa, Eucalyptus radiata* subsp. *radiata, Acacia melanoxylon* **Low inundation tolerance**	*Clematis aristata, Coprosma quadrifida, Hedycarya angustifolia, Rubus parvifolius, Hymenanthera dentata* **Low inundation tolerance**	*Adiantum aethiopicum, Dianella caerulea, Dichondra repens, Echinopogon ovatus, Eustrephus latifolius, Geranium potentilloides, Glycine clandestina, Hardenbergia violacea, Hibbertia scandens, Lomandra longifolia, Microlaena stipoides* var. *stipoides, Poa labillardierei var. labillardierei, Poranthera microphylla, Pteridium esculentum, Schelhammera undulata, Stellaria pungens, Tylophora barbata, Veronica plebeia, Helichrysum scorpioides, Hydrocotyle peduncularis, Viola hederacea* **Low inundation tolerance**
PCT 835	Coastal Floodplain Wetlands	*Eucalyptus tereticornis, Angophora floribunda, Eucalyptus amplifolia* subsp. *amplifolia* **Moderate inundation tolerance**	*Acacia parramattensis, Bursaria spinosa* subsp. *spinosa, Sigesbeckia orientalis* **Moderate inundation tolerance**	*Microlaena stipoides* var. *stipoides, Oplismenus aemulus, Dichondra repens, Entolasia marginata, Solanum prinophyllum, Pratia purpurascens, Desmodium gunnii, Echinopogon ovatus, Commelina cyanea, Veronica plebeia* **Moderate inundation tolerance**
PCT 849	Coastal Valley Grassy Woodlands	*Eucalyptus moluccana, Eucalyptus tereticornis* **Low inundation tolerance**	*Bursaria spinosa* subsp. *spinosa* **Low inundation tolerance**	*Dichondra repens, Cheilanthes sieberi* subsp. *sieberi, Aristida vagans, Microlaena stipoides* var. *stipoides, Themeda australis, Brunoniella australis, Desmodium gunnii, Opercularia diphylla, Wahlenbergia gracilis, Dichelachne micrantha, Paspalidium distans, Eragrostis leptostachya, Lomandra filiformis, Lomandra multiflora, Dianella longifolia, Oxalis perennans, Euchiton sphaericus, Goodenia hederacea, Aristida ramosa, Arthropodium milleflorum, Austrodanthonia tenuior, Cymbopogon refractus, Echinopogon caespitosus* **Low inundation tolerance**
PCT 1078	Coastal Heath Swamps	*n/a*	*Baeckea linifolia, Banksia ericifolia, Epacris obtusifolia, Hakea teretifolia, Leptospermum juniperinum, Sprengelia incarnate* **High inundation tolerance**	*Drosera binata, Empodisma minus, Gymnoschoenus sphaerocephalus, Lepidosperma limicola, Leptocarpus tenax, Xyris operculata* **High inundation tolerance**

PCT	Vegetation class	Upper stratum species and inundation tolerance	Mid stratum species and inundation tolerance	Ground stratum species and inundation tolerance
PCT 1105	Eastern Riverine Forests	*Casuarina cunninghamiana* **High inundation tolerance**	*Acacia floribunda, Acacia mearnsii, Pandorea pandorana, Stephania japonica, Urtica incisa, Hymenanthera dentata* **Moderate inundation tolerance**	*Dichondra repens, Lomandra longifolia, Microlaena stipoides* var. *stipoides, Oplismenus aemulus* **Moderate inundation tolerance**
PCT 1181	Sydney Coastal Dry Sclerophyll Forests	*Angophora costata, Corymbia gummifera, Banksia serrata, Eucalyptus piperita, Eucalyptus pilularis, Eucalyptus punctata, Syncarpia glomulifera, Eucalyptus agglomerata* **Low inundation tolerance**	*Persoonia linearis, Persoonia levis, Phyllanthus hirtellus, Leptospermum trinervium, Lomatia silaifolia, Banksia spinulosa, Platysace linearifolia, Ceratopetalum gummiferum, Acacia ulicifolia, Acacia terminalis, Allocasuarina littoralis, Xylomelum pyriforme, Banksia serrata, Dodonaea triquetra, Grevillea mucronulata, Eriostemon australasius* **Low inundation tolerance**	*Entolasia stricta, Pteridium esculentum, Dianella caerulea, Smilax glyciphylla, Xanthosia pilosa, Lomandra longifolia, Lepidosperma laterale, Lomandra obliqua, Phyllanthus hirtellus, Lomandra multiflora, Lomandra filiformis, Gonocarpus teucrioides, Pomax umbellata, Austrostipa pubescens, Lomandra cylindrica, Xanthorrhoea arborea* **Low inundation tolerance**
PCT 1284	North Coast Wet Sclerophyll Forests	*Syncarpia glomulifera, Angophora costata, Eucalyptus deanei, Eucalyptus piperita, Acacia elata, Allocasuarina torulosa* **Low inundation tolerance**	*Cissus hypoglauca, Clematis aristata, Elaeocarpus reticulatus, Leucopogon lanceolatus, Pandorea pandorana, Persoonia linearis* **Low inundation tolerance**	*Billardiera scandens, Blechnum cartilagineum, Calochlaena dubia, Dianella caerulea, Eustrephus latifolius, Geitonoplesium cymosum, Lepidosperma laterale, Lomandra longifolia, Pteridium esculentum, Smilax glyciphylla, Tylophora barbata, Viola hederacea* **Low inundation tolerance**
PCT 1292	Eastern Riverine Forests	*Tristaniopsis laurina, Ceratopetalum apetalum* **High inundation tolerance**	*Lomatia myricoides, Tristania neriifolia, Leptospermum morrisonii* **High inundation tolerance**	*Lomandra longifolia, Entolasia stricta, Schoenus melanostachys, Lomandra fluviatilis, Sticherus flabellatus* **High inundation tolerance**

As expected, there is a clear correlation between inundation tolerance of characteristic species and the topographical / hydrological associations of each PCT. As such, it can be seen that those PCTs with larger areas subject to altered hydrological patterns (as outlined in Table 47) also comprise characteristic species more tolerant of inundation.

As outlined above, the three PCTs subject to largest potential change (in terms of area affected) include:

- PCT 835 Cumberland River-flat Forest (comprising River-flat Eucalypt Forest EEC) – up to 5.15 ha affected.
- PCT 1181 Hinterland Sandstone Gully Forest – up to 0.39 ha affected.
- PCT 1292 Sandstone Riparian Scrub – up to 0.57 ha affected.

From Table 48 it can be seen that all strata in PCT 1292 Sandstone Riparian Scrub comprise highly inundation tolerant characteristic species, and are therefore not expected to be subject to substantial changes in species composition. PCT 835 Cumberland River-flat Forest comprises moderately inundation tolerant characteristic species, and PCT 1181 Hinterland Sandstone Gully Forest supports low inundation tolerant characteristic species. As such, changes to species composition are considered more likely to occur within these PCTs, within the areas between the current and future mean inundation extents (229 ML/day, 279 ML/day and 329 ML/day).

Should potential changes in species composition occur within these two PCTs, within the areas subject to changes in mean inundation extent (PCT 835 - 5.15 ha and PCT 1181 - 0.39 ha), these changes are considered to be minor in nature based on the areas present in the locality, and across the broader landscape.

A total of approximately 256 hectares of PCT 835 Cumberland River-flat Forest is mapped within 100 metres of the watercourse, and as such altered species composition within up to 5.15 hectares would only represent 2 % of the vegetation in the locality. Furthermore approximately 170 hectares of PCT 1181 Hinterland Sandstone Gully Forest vegetation is mapped within 100m of the watercourse, and changes to 0.39 hectares would represent just 0.2 % of the mapped vegetation. Vegetation within 100 metres of the watercourse is considered a suitable comparison as it would broadly be considered part of the same patch in accordance with the BAM.

When considered at a broader subregional scale, potential impacts are indiscernible, with over 9000 hectares of PCT 835 Cumberland River-flat Forest, and over 84,000 hectares of PCT 1181 Hinterland Sandstone Gully Forest mapped in the Cumberland and Wollemi IBRA subregions, by OEH (2013) and Tozer et al (2010).

As outlined above, due to the small areas (no more than 0.07 hectares per PCT) affected by the expected changes in inundation extent and frequency, substantial impacts to the remaining five PCTs from altered species composition are considered highly unlikely over the modelled 36 kilometre stretch of the Nepean River.

Consideration has also been given to how the increased releases of treated water may affect terrestrial biodiversity values during higher flow (flooding) events. A 1000 ML/day flow approximately equates the 1 in 10 year flood event (Streamology 2021b), which is considered to occur frequently enough to have some effect on biodiversity values present within the modelled inundation extent. As such, this flow was used as a basis for further comparison of potential impacts during higher flow events. However, this level of inundation currently occurs approximately 9% of the time(Graph 3), and with the maximum expected increase of 100 ML/day, this frequency only increases by approximately 1%. This increase is considered likely to result in a negligible affect to terrestrial biodiversity values present within the inundation extent polygon. Even higher flow events occur less frequently still, and represent larger volumes of water passing through the system, and as such the effect of the proposed maximum level of water released is expected to have less and less influence of the inundation extents of the higher flow events.

Further to potential impacts to PCTs and associated habitats, Camden White Gum individuals and habitat are also known to occur along the banks of the Nepean River within the area subject to the expected change in inundation depth and frequency. A total of 713 individual trees were recorded during targeted surveys along the river by undertaken by Carl Tippler Environmental (CTE) botanists in late-2020, between Wallacia and Bents Basin. It can be seen from Table 47 that of these 713 trees recorded, 11 were recorded within the area between the current low flow (25 ML/day) inundation extant and the current median flow inundation extent (229 ML/day), and a total of 12 were recorded between the current low flow and future median flow inundation extents (279 ML/day, 329 ML/day). Trees were recorded by CTE using high accuracy Differential GPS units (+/-1 m), to minimise potential spatial error, and to further account for potential errors, GPS points located within 2 metres of the boundaries of the inundation extent polygons were selected, and included in the totals above.

To account for the areas of Camden White Gum habitat potentially impacted, a 30 metre buffer was applied to all 713 GPS points representing Camden White Gum individuals, and the mapped vegetation present within each inundation extent polygon, within 30 metres of an individual tree, was selected and assessed. Habitat potentially impacted includes:

- 0.32 hectares between the current low flow and current median flow inundation extents.
- 0.42 hectares of habitat between the current low flow and future (+50 ML/day) median flow inundation extant.
- 0.54 hectares of habitat between the current low flow and future (+100 ML/day) median flow inundation extant.

As noted above, mature trees with established root systems are not expected to be substantially affected by the increased frequency and duration of inundation expected to result from the proposed volumes of treated water to be released into the river system. However should negative impacts be realised as a result of the increased inundation and saturation of the trees' roots, these would only be expected to affect a small portion (up to 1.7%) of the population of Camden White Gums present within the area assessed.

Furthermore, the areas of habitat subject to increased inundation outlined above would also represent only a small fraction of the total potential habitat mapped within 30 metres of trees recorded along the river banks. A total of 34.9 hectares of native vegetation is mapped (OEH 2013) as occurring within 30 meters of a Camden White Gum, and as such potential impacts to up to 0.54 hectares of habitat, within the current and future median flow inundation extents, only represents 0.5 % of the habitat supporting the population.

The Approved Conservation Advice for *Eucalyptus benthamii* (Camden White Gum) (CoA 2014b) notes that one of the main threats to the species is 'changed hydrology, and that the species' natural habitat includes a combination of deep, fertile alluvial sands and a flooding regime that allows seedling establishment, with recruitment occurring on disturbed or depositional bare soils following flooding. The changes to hydrological patterns within the Nepean River system as a result of the project are not expected to represent substantial or significant negative pressures on the species, as the increased water released into the system will result in a minor to negligible increase in flood frequency, which will not negatively impact upon post-flood opportunities for seedling recruitment.

Whilst altered hydrological regimes are likely to occur within the Nepean River system as a result of the project, and may impact upon eight different PCTs, expected to represent four state and Commonwealth listed TECs, and at least 12 individuals and known habitat for Camden White Gum, the magnitude of the potential impacts are considered minor in nature. Changes in inundation patterns have been modelled to occur (Steamology 2021) along a narrow linear band on native vegetation over a large area and as such will not result in substantial impacts to any particular aspect of the biodiversity values present within the existing dynamic river system.

Further assessment of the potential impacts to Camden White Gum have been undertaken as part of an EPBC Act Significant Impact Criteria assessment (Appendix 6). The assessment found that a significant impact to the species was unlikely to occur.

However due to the somewhat uncertain nature of impacts associated with changes to hydrology and the potential timeframes within which any impacts may occur, ongoing monitoring of the biodiversity values present along the banks of the river system will be undertaken, and adaptive management will be implemented if future unexpected impacts are found to be occurring. Further information is provided in Section 11.5.

11.3 Prescribed impacts

Assessment of prescribed biodiversity impacts in accordance with Section 9.2 of the BAM are outlined and addressed in Table 49 below and shown in Figure 15.

Table 49 Assessment of prescribed impacts

Prescribed impact	Location / description of impact	Significance of impact
Karst, caves, crevices, cliffs, rocks and other geological features of significance	Sandstone cliffs occur along the Warragamba River surrounding the environmental flows treated water outlet near the Warragamba Dam, and have the potential to support a number of threatened species including: • Large-eared Pied Bat • Large Bent-winged Bat • Little Bent-winged Bat • Sooty Owl Direct impact to potential habitats may occur within the impact area, and indirect impacts to areas within the BAM prescribed 'breeding buffers' for the above listed species may also occur relative to habitats potentially present on the far side of the Warragamba River. These habitats are not considered to represent important areas of habitat to the above listed species within the bioregion, due to the abundance of similar habitat features, both in close proximity to the impacts area, and further afield, which could be utilised by these wide ranging species. Rocky areas within the portion of the impact area surrounding the environmental flows treated water outlet near the Warragamba Dam, were considered to have the potential to support Broad-headed Snake and Brush-tailed Rock Wallaby. Targeted survey was undertaken in October 2020 for Broad-headed Snake, and between December 2020 and January 2021 for Bush-tailed Rock Wallaby, and the species, or traces of the species, were not recorded. Scattered rock is known to be important refuge habitat for Broad-headed Snake, but not for Brush-tailed Rock Wallaby. However substantial occurrences of scattered rock were not recorded within the impact area.	Potential habitat supported by caves, crevices and cliffs occurs within the impact area surrounding the environmental flows outlet at Warragamba. Habitats on the far side of the river supported by similar caves, crevices and cliffs, appear to occur in high condition vegetation and as such are more likely to support higher quality habitats for the target species. Ground survey in this area was not possible. As noted in Section 11.2 the project has the potential to impact on fauna utilising the high quality habitats within and surrounding the impact area, however these habitats are not limited in the locality, with the vegetation being of a similar maturity and successional stage in the broader surrounds, and the rocky sandstone cliff line habitat being present both back upstream, but more so downstream from the Warragamba Dam. Geological impacts are expected to be minor and localised in both the short and long term, and the project will not result in impacts to the environmental processes critical to the formation or persistence of these rocky habitat features. Further assessment of impacts to the species listed adjacent is included in Appendix 5. The project will remove approximately 1.56 ha of vegetation supporting rocky areas in this location, however large expanses of similar habitat occurs in the vicinity and would remain available to any Broad-headed Snake and Brush-tailed Rock Wallaby individuals that could occur in the broader area. Therefore the project is not expected to result in impacts of a level substantial enough to threaten the persistence of either species at a local or bioregional scale.

Prescribed impact	Location / description of impact	Significance of impact
Impacts to habitat associated with human-made structures and non-native vegetation	The disused tunnel and man-made vertical (vent) shaft present at the environmental flows treated water outlet near Warragamba Dam have the potential to support threatened microbat species. It has been assumed these support Large-eared Pied Bat, Large Bent-winged Bat and Little Bent-winged Bat. Furthermore an abandoned building present on the AWRC site has the potential to support roosting habitat for threatened microbat species, as do any large culverts present along the project alignment. These structures are relatively small in size and are only considered likely to support the above listed species on an occasional basis. Furthermore, as outlined in Section 8.2.3, they are considered unlikely to be being utilised for breeding. As such, none of the human made structures present within the impact area, that may potentially be supporting fauna habitat, are considered important at a bioregional scale. Non-native vegetation has been mapped across the impact area however never in sufficient quantities, or suitable locations to provide valuable habitat to threatened species.	The disused tunnel will not be impacted by the project, and occurs to the south of the project's impact area. The vertical (vent) shaft however will be impacted by underboring and construction of the treated water outlet and ancillary structures. Stag watching undertaken in October 2020 did not record any microbats exiting either man-made structure, and analysis of ultrasonic call data strongly suggests no roosting activity is occurring within the impact area (refer Section 8.2.3). As such, impacts to threatened species of microbats associated with the man-made structures at the Warragamba Dram project area are not considered to be substantial or significant. Furthermore any potential impacts can be mitigated through installation of passive exclusion measures on the open shaft prior to any impact occurring. Impacts to any microbats present within the abandoned building or possible large culverts can also successfully mitigated through pre-clearance surveys and/or installation of passive exclusion measures prior to any impact. Therefore the project is not expected to result in impacts of a level substantial enough to threaten the persistence of fauna species at a local or bioregional scale. The project will not result in impacts to threatened species or ecological communities associated with non-native vegetation.
Impacts to connectivity of habitat for threatened entities	As outlined above, the impact area crosses a number of features that provide somewhat limited opportunities for movement of biodiversity values across the landscape. Major connectivity features associate with the impact area include: • Prospect Creek and Lansdowne Reserve • Western Sydney Parklands, Kemps Creek and Hinchbrook Creek • South Creek and Badgerys Creek	None of the connectivity features listed adjacent form key components that link areas of habitat for threatened species at a local or bioregional scale, and the project will not result in a permanent barrier to connectivity in any of the locations listed adjacent. Connectivity will be generally disrupted by the 15 m to 20 m wide pipeline easement, however this would only represent an obstacle to the least mobile of species, such as

Prescribed impact	Location / description of impact	Significance of impact
	• Nepean River • Warragamba River and the Greater Blue Mountains Area All flora and fauna species and ecological communities recorded as present within the impact area and impact assessment area rely on habitat connectivity to some degree for persistence. Habitat connectivity is more important for species with reproductive strategies that require movement of individuals or reproductive material through the landscape. The project will not result in the creation of barriers which would prevent the movement of threatened species between habitats critical for the maintenance of their life cycle.	Cumberland Plain Land Snail and Dural Land Snail. The pipeline easement will be revegetated to ensure groundcover vegetation is, at a minimum, of the same ecological condition to that in the surrounding undisturbed areas, which will in turn alleviate connectivity impacts to ground-dwelling snails and other less mobile species. As permanent barriers to movement will not be created as a result of the project, the consequences of the potential impacts are considered to be minor when assessing the bioregional persistence of the suite of species and ecological communities that rely of the connectivity features relevant to the project.
Water quality, water bodies or any hydrological processes that sustain threatened entities	The project will result in an increased water volume in the Nepean River as a result of the proposed 50 ML/day and 100 ML/day treated water discharges. This aspect of the project has the potential to impact upon Camden White Gum and River-flat Eucalypt Forest TEC.	These impacts are addressed in Sections 9, 11.2 and Appendix 6
Impacts of wind strikes on protected animals	This prescribed impact is not relevant to the project.	This prescribed impact is not relevant to the project.
Vehicle strikes on threatened fauna or fauna that are part of a TEC	The project may result in increased vehicle traffic during the construction phase of the project along the entire alignment, and during the operational phase at the AWRC site. This increased vehicle traffic has the potential to impact upon native fauna species that are active during the day, and generally with a higher potential for impact in areas where refuge/forage habitat exists immediately adjacent to areas where vehicle movements will occur. However, the majority of the alignment occurs in locations that are generally urbanised, with only isolated areas free of traffic at the current time. Furthermore, no threatened species of animals, or animals that make up part of a TEC, are commonly associated with the project area to the degree where an increase in vehicle strike is likely to occur.	The likelihood of vehicle strike occurring as a result of the project is considered very low, and will not negatively impact upon the persistence of native fauna species at the local or bioregional scale.