

Chapter 12

Biodiversity

Contents

Contents	i
12 Biodiversity	12-1
12.1 Assessment approach	12-1
12.2 Existing environment	12-3
12.3 Potential impacts – construction	12-15
12.4 Potential impacts – operation	12-23
12.5 Environmental mitigation measures	12-24

List of tables

Table 12-1 Biodiversity assessment areas	12-1
Table 12-2 Assessment area landscape context and connectivity	12-3
Table 12-3 Assessment area PCTs and associated TECs	12-7
Table 12-4 Threatened fauna species known or likely to occur in the development footprint	12-8
Table 12-5 Summary of direct impacts on threatened species credit species	12-16
Table 12-6 Potential indirect impacts of project construction	12-17
Table 12-7 Summary of prescribed biodiversity impacts during construction	12-20
Table 12-8 Relevant Key Threatening Processes	12-22
Table 12-9 Operational biodiversity impacts	12-23
Table 12-10 Biodiversity performance outcomes	12-25
Table 12-11 Environmental mitigation measures – biodiversity	12-25

List of figures

Figure 12-1 Biodiversity assessment area	12-2
Figure 12-2 Biodiversity assessment area at Blackheath	12-4
Figure 12-3 Biodiversity assessment area at Soldiers Pinch	12-5
Figure 12-4 Biodiversity assessment area at Little Hartley	12-6
Figure 12-5 Conceptual diagram showing THPSS groundwater relationship (headwater swamps and valley infill swamps)	12-9
Figure 12-6 Conceptual diagram showing THPSS groundwater relationship (hanging swamps)	12-9
Figure 12-7 Distribution of groundwater dependent ecosystems within the assessment area at Blackheath	12-10
Figure 12-8 Distribution of groundwater dependent ecosystems within the assessment area at Soldiers Pinch	12-11
Figure 12-9 Distribution of groundwater dependent ecosystems within the assessment area at Little Hartley	12-12
Figure 12-10 Strahler order and key fish habitat of waterways near the project	12-14

12 Biodiversity

This chapter summarises the biodiversity assessment carried out for the upgrade of the Great Western Highway between Blackheath and Little Hartley (the project). The full Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the Biodiversity Assessment Method (BAM) and is provided in Appendix H (Technical report – Biodiversity).

12.1 Assessment approach

The biodiversity assessment for the project comprised the following three areas shown in Figure 12-1 and described in Table 12-1.

Table 12-1 Biodiversity assessment areas

Area	Extent and description
Development footprint ¹	Represents the three areas of direct impacts associated with the project's construction. This area comprises the project's construction footprint, minus the areas that are being assessed as part of the Great Western Highway East – Katoomba to Blackheath Upgrade (Katoomba to Blackheath Upgrade) and the Great Western Highway Upgrade Program – Little Hartley to Lithgow (West Section) (Little Hartley to Lithgow Upgrade) projects.
Assessment area	Represents the area considered for prescribed and indirect impacts. This area includes the development footprint and the area of land within a 1500m buffer zone surrounding the development footprint. It also includes the area within a 500m buffer zone (taken from the centre line) of the tunnel alignment.
Study area	Represents the area subject to biodiversity field investigations to inform the existing environment.

Table notes:

1. This term is specific to the biodiversity assessment and has therefore been used in this chapter for consistency with the BDAR

The biodiversity assessment involved:

- a search of relevant databases to identify the existing biodiversity and natural environment features, such as landscape features, plant community types (PCTs), threatened and migratory species and their habitats previously recorded or predicted to occur and aquatic ecosystems in the assessment area
- a review of reports relevant to the project, including biodiversity assessments for the Great Western Highway East – Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade projects
- field surveys to:
 - verify the presence and determine the condition of vegetation within the assessment area (either as high, moderate or low), and targeted threatened species surveys to determine the presence of threatened species that could be potentially impacted by the project (carried out between November 2021 and May 2022)
 - validate the presence of aquatic and riparian ecosystem constraints identified in the desktop review, and to provide condition assessments of riparian habitats (carried out between August and September 2022)

- assessment of potential biodiversity impacts from the project including direct, indirect, serious and irreversible, and prescribed impacts in accordance with the BAM (DPIE, 2020a)
- identification of environmental mitigation measures and offsets required to manage these impacts.

Further detail regarding the biodiversity assessment methodology is provided in Appendix H (Technical report – Biodiversity). Further detail regarding the aquatic ecology assessment methodology is provided in Annexure H of Appendix H (Technical report – Biodiversity).

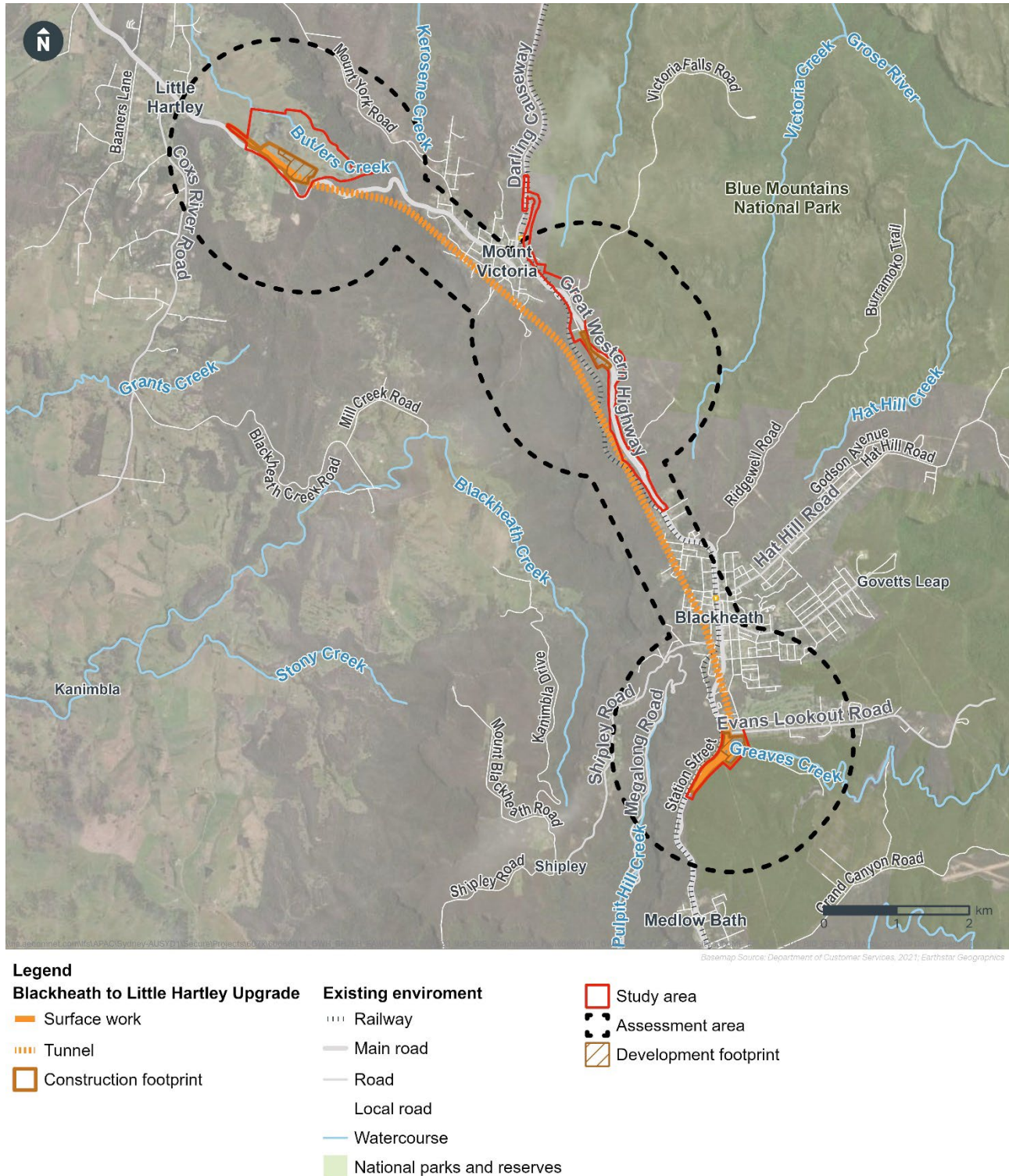


Figure 12-1 Biodiversity assessment area

12.2 Existing environment

This assessment considers a baseline environment, where the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade adjoining the project to the east and west respectively, are under construction and associated construction sites have been cleared of vegetation (see Figure 12-2 to Figure 12-4).

12.2.1 Landscape context and connectivity

The influence of landscape context on habitat suitability and connectivity (biodiversity links that connect different areas of habitat) for threatened species in the study area is described in Table 12-2.

Table 12-2 Assessment area landscape context and connectivity

Location	Landscape context	Connectivity
Blackheath construction site	Native vegetation is present in high condition and forms a dense woodland directly connected to the Blue Mountains National Park. Predominantly remnant bushland and covers a total of 26.85 ha.	Connectivity in this area is high allowing for unrestricted movement of terrestrial and arboreal (living in trees) fauna. Watercourses and drainage lines in this area also allow for the movement of amphibious species.
Soldiers Pinch construction site	Predominantly existing road infrastructure and patches of native bushland and covers a total of 67.25 ha.	Within this area there is substantial pre-existing fragmentation associated with the existing Great Western Highway road corridor, Browntown Oval and several dirt access tracks that pass through and are located directly adjacent to the construction footprint.
Little Hartley construction site	Predominantly cleared agricultural land for cattle grazing that covers a total of 106.02 ha.	Butlers Creek runs in an east-west orientation across this area and facilitates movement for aquatic and amphibious species with several native frog species detected during field investigations. The Blue Mountains Western Escarpment wildlife corridor also traverses the assessment area between Mount Victoria and Little Hartley providing valuable connectivity.

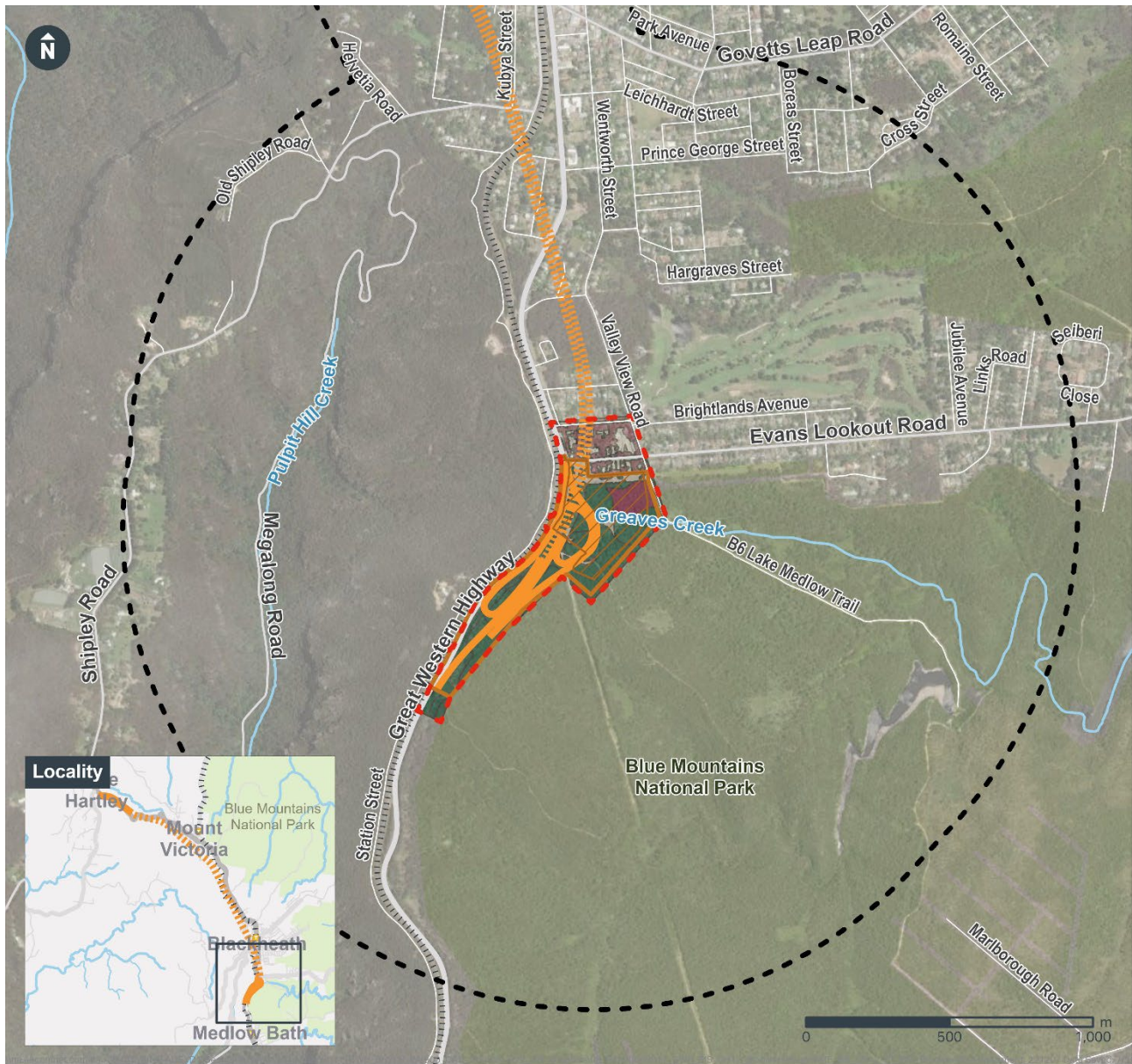


Figure 12-2 Biodiversity assessment area at Blackheath

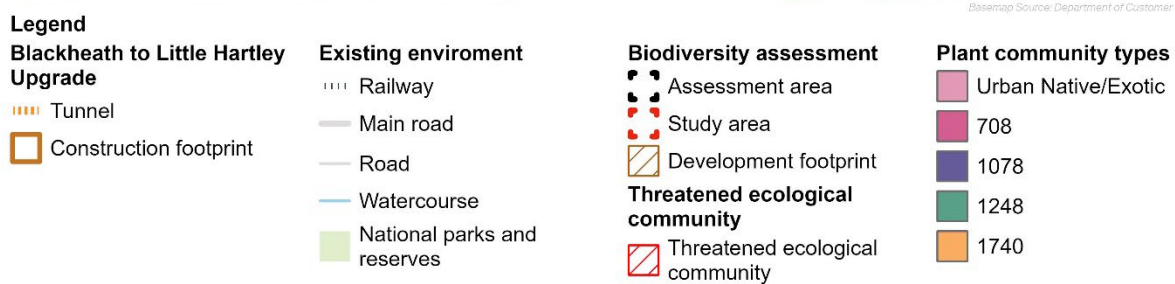
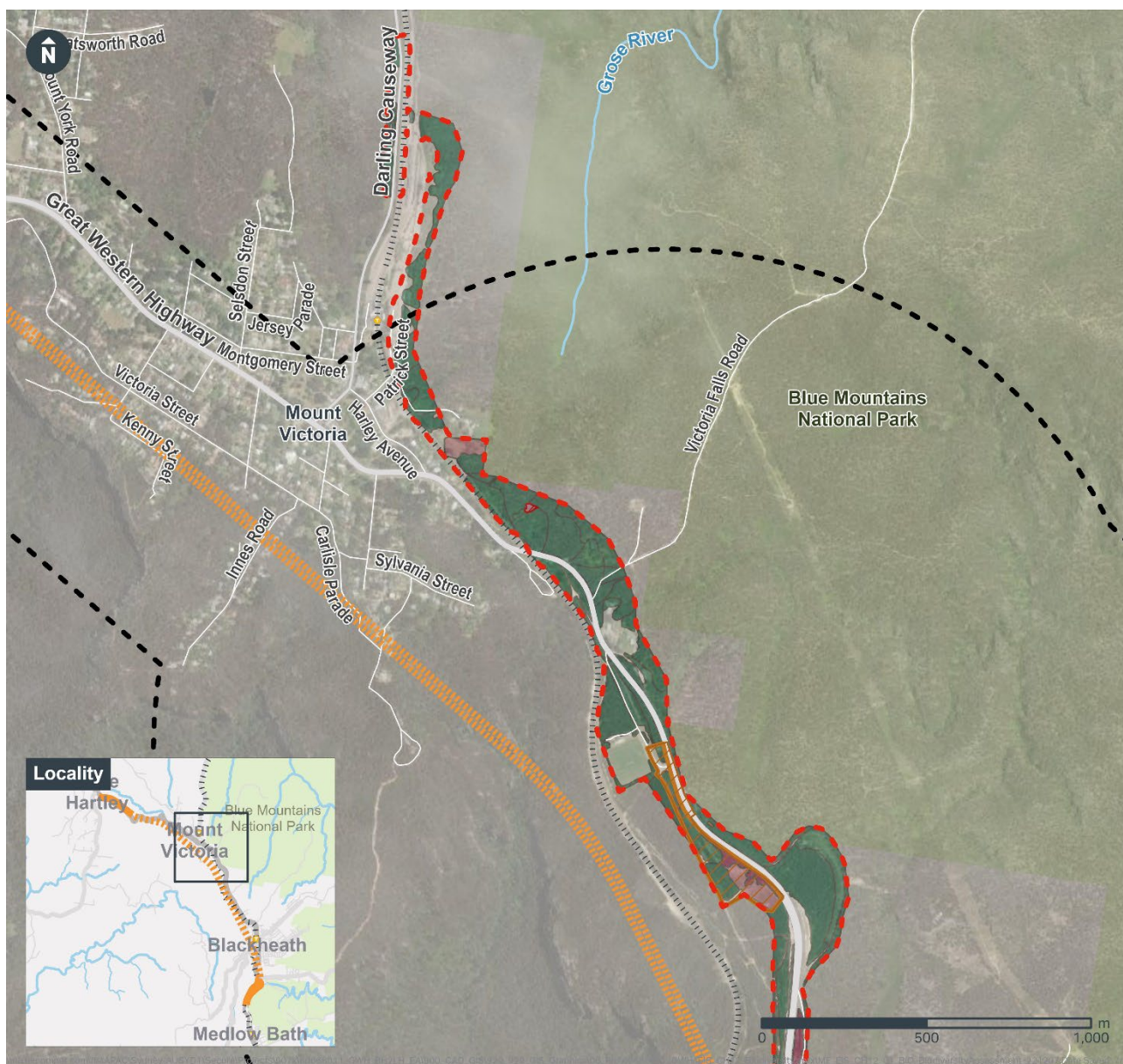


Figure 12-3 Biodiversity assessment area at Soldiers Pinch

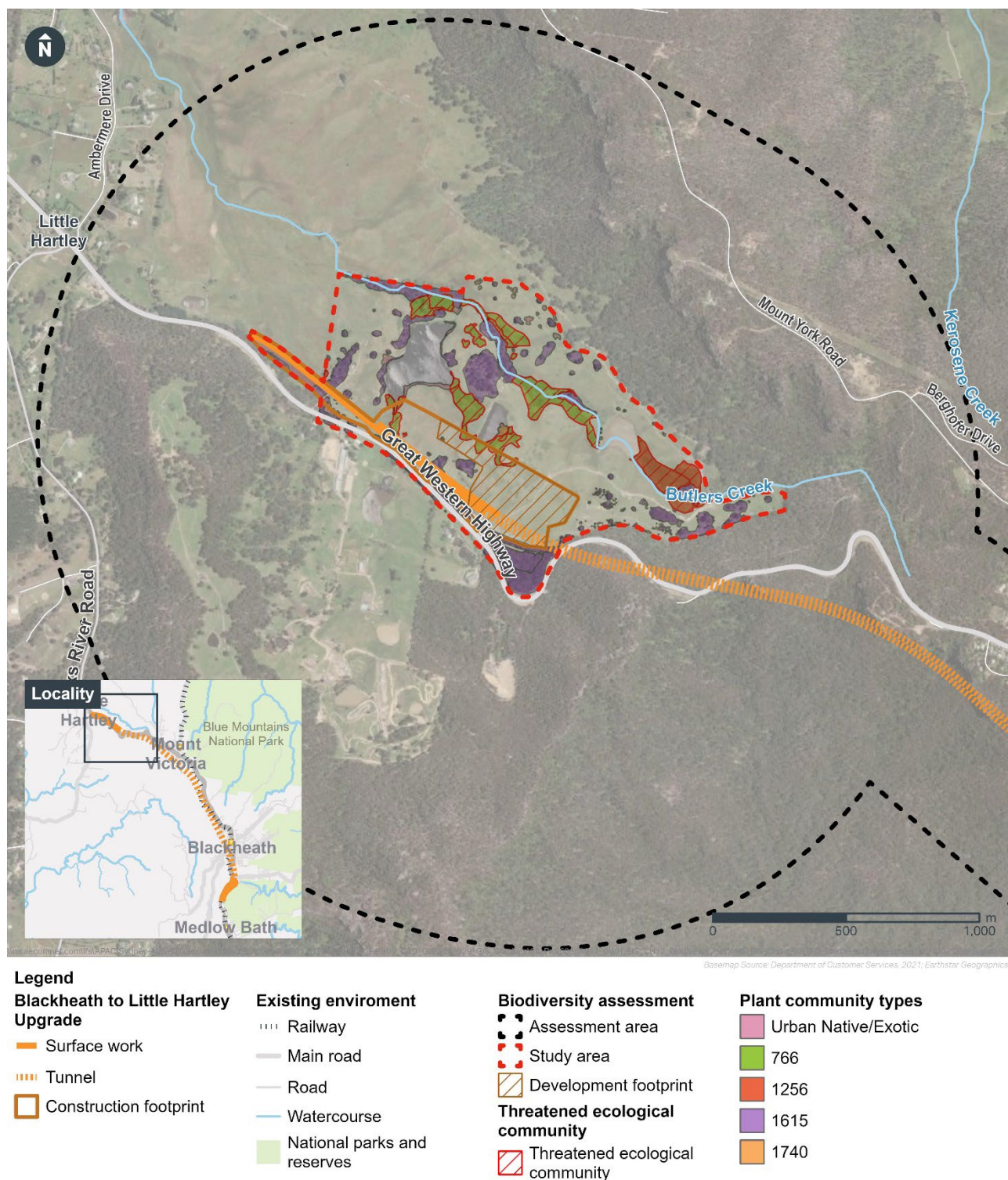


Figure 12-4 Biodiversity assessment area at Little Hartley

12.2.2 Native vegetation and threatened ecological communities

Seven PCTs were recorded in the study area. These seven PCTs meet the relevant criteria for two Threatened Ecological Communities (TECs) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and one TEC listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A summary of each PCT, associated TEC and listing is provided in Table 12-3.

Details of how each PCT meets each element of the scientific determination, including geographical location, characteristic species, soils and geology can be found in Section 4 of Appendix H (Technical report – Biodiversity).

The extent and distribution of the PCTs within the study area is shown in Figure 12-2 to Figure 12-4. Section 4.1 of Appendix H (Technical report – Biodiversity). These are shown in Figure 12-7 to Figure 12-9.

Table 12-3 Assessment area PCTs and associated TECs

PCT	Associated TEC
PCT 708 Blue Mountains Mallee Ash - Dwarf Casuarina heath of the upper Blue Mountains, Sydney Basin Bioregion	Nil
PCT 1078 Prickly Tea-tree - sedge wet heath on sandstone plateaux, central and southern Sydney Basin Bioregion	<ul style="list-style-type: none"> Blue Mountains Swamps in the Sydney Basin Bioregion listed as vulnerable under BC Act
PCT 1248 Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion	Nil
PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion	<ul style="list-style-type: none"> Temperate Highland Peat Swamps on Sandstone (THPSS) listed as endangered under the EPBC Act Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions listed as endangered under the BC Act
PCT 1615 Monkey Gum - Eucalyptus blaxlandii shrubby open forest on basalt of the Sydney Basin	Nil
PCT 1740 Tall Spike Rush freshwater wetland	Nil
PCT 766 Carex sedgeland of the slopes and tablelands	<ul style="list-style-type: none"> Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions listed as endangered under the BC Act

12.2.3 Threatened flora

No threatened flora species were found during field surveys or considered likely to occur within the development footprint.

12.2.4 Threatened fauna

Field surveys carried out for the project identified two threatened fauna species within the development footprint. Another threatened species, the Purple Copper Butterfly, was identified as having a high likelihood of occurrence within the development footprint based on habitat assessment, despite not being identified during field surveys.

Table 12-4 lists the threatened fauna species known or likely to occur within the development footprint.

Table 12-4 Threatened fauna species known or likely to occur in the development footprint

Species	Common name	BC Act ¹	EPBC Act ¹	Likelihood of occurrence
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Detected via call detection. Areas of suitable habitat are associated with PCTs in the development footprint and are within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.
<i>Petauroides volans</i>	Greater Glider	-	E	Detected during spotlighting surveys. Areas of suitable habitat align with PCT 1248 which include hollow-bearing trees within connected vegetation.
<i>Paralucia spinifera</i>	Purple Copper Butterfly	E	V	Areas of suitable habitat align with areas of <i>Bursaria spinosa</i> or within 40m of <i>Bursaria spinosa</i> within PCT 1248.

Table notes:

1. V = Vulnerable, E = Endangered under the EPBC Act

12.2.5 Groundwater dependent ecosystems

Three PCTs within the study area at Little Hartley are associated with high probability GDEs:

- PCT 766 Carex sedgeland of the slopes and tablelands
- PCT 1256 Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion
- PCT 1615 Monkey Gum - Eucalyptus blaxlandii shrubby open forest on basalt of the Sydney Basin.

The remaining PCTs within the study area at Blackheath, Soldiers Pinch and Little Hartley are likely to use groundwater but are not considered dependent on it.

An additional high probability GDE is mapped outside of the Little Hartley study area but within the assessment area at Little Hartley, along with several moderate probability GDEs. Several medium probability GDEs have also been mapped either directly above the tunnel alignment or within the surrounding assessment area.

Some GDEs within the assessment area are classified as THPSS and are listed as endangered under the EPBC Act including:

- headwater swamps (formed near catchment divides at the headwaters of streams where gradients are shallow)
- valley infill swamps (occur on steeper gradients in the valleys of larger waterways)
- hanging swamps (occur in steep valley walls where there is groundwater seepage).

A conceptual representation of the dependency of GDEs such as THPSS on groundwater is illustrated in Figure 12-5 and Figure 12-6.

GDEs within the study area and assessment area are shown in Figure 12-7 to Figure 12-9.

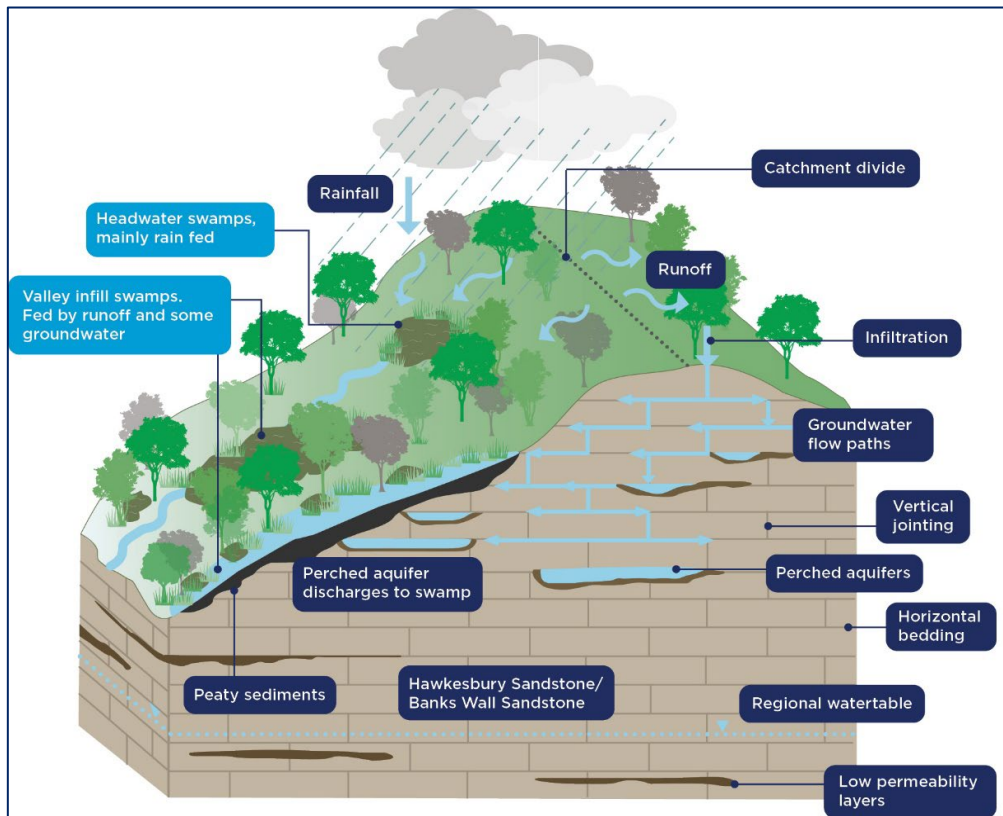


Figure 12-5 Conceptual diagram showing THPSS groundwater relationship (headwater swamps and valley infill swamps)

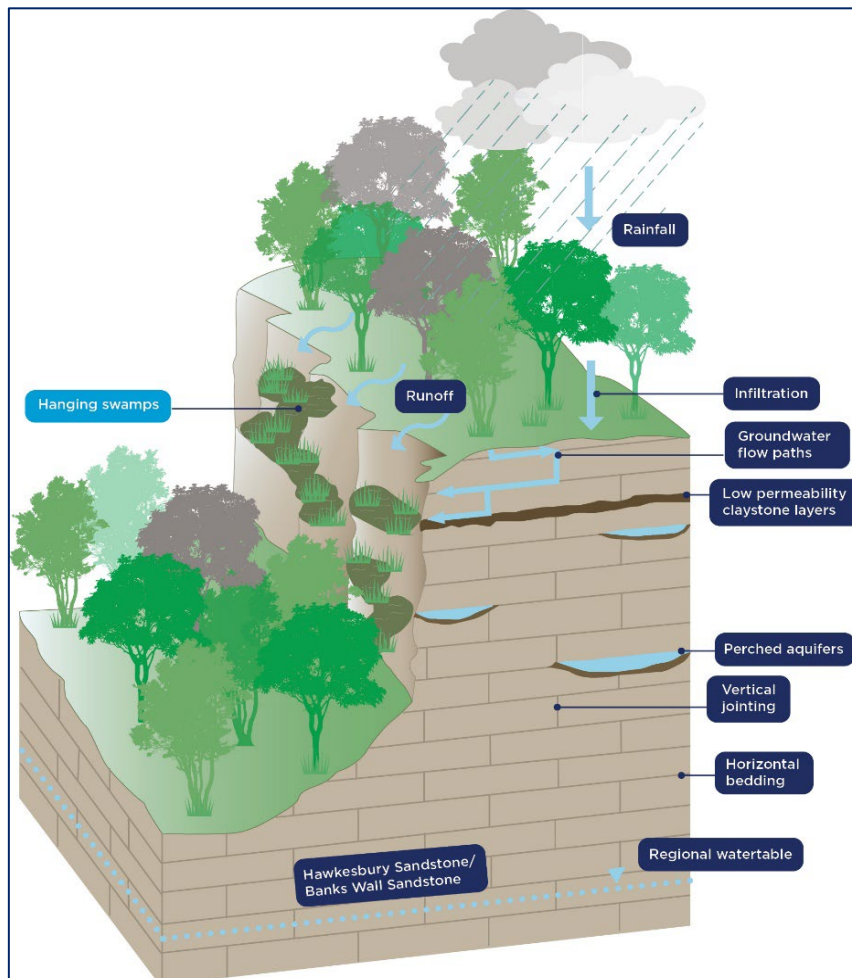


Figure 12-6 Conceptual diagram showing THPSS groundwater relationship (hanging swamps)

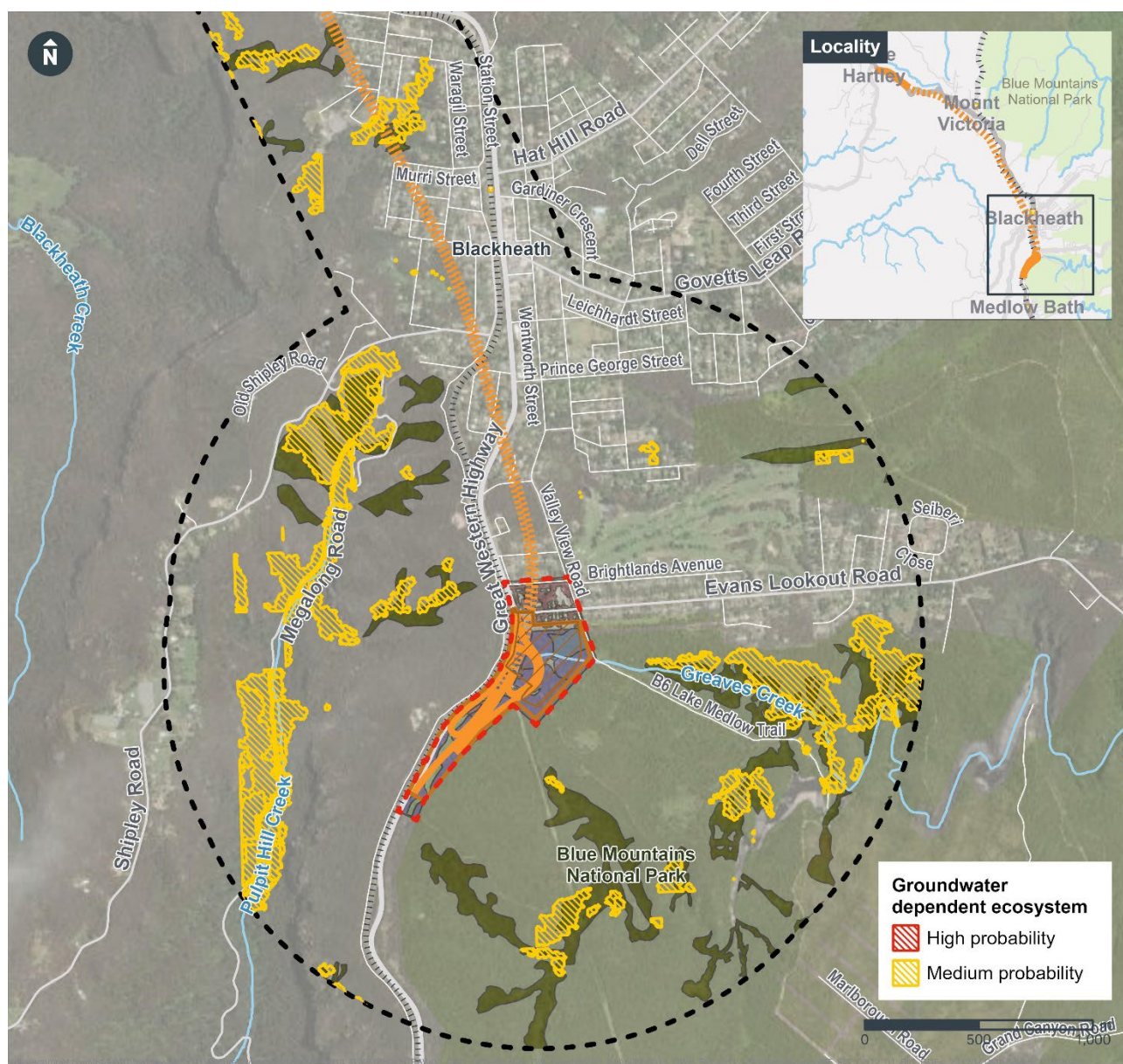


Figure 12-7 Distribution of groundwater dependent ecosystems within the assessment area at Blackheath

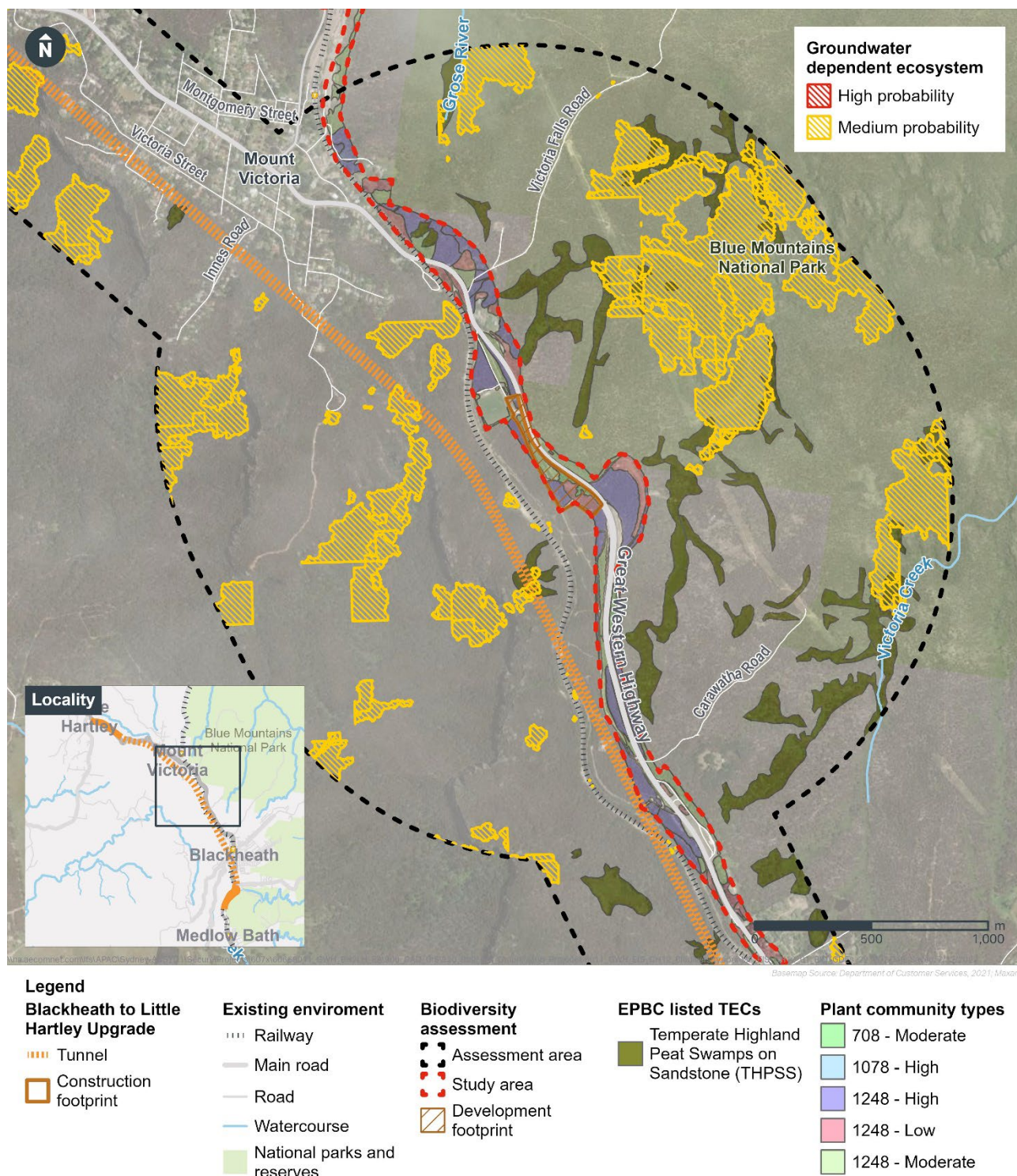


Figure 12-8 Distribution of groundwater dependent ecosystems within the assessment area at Soldiers Pinch

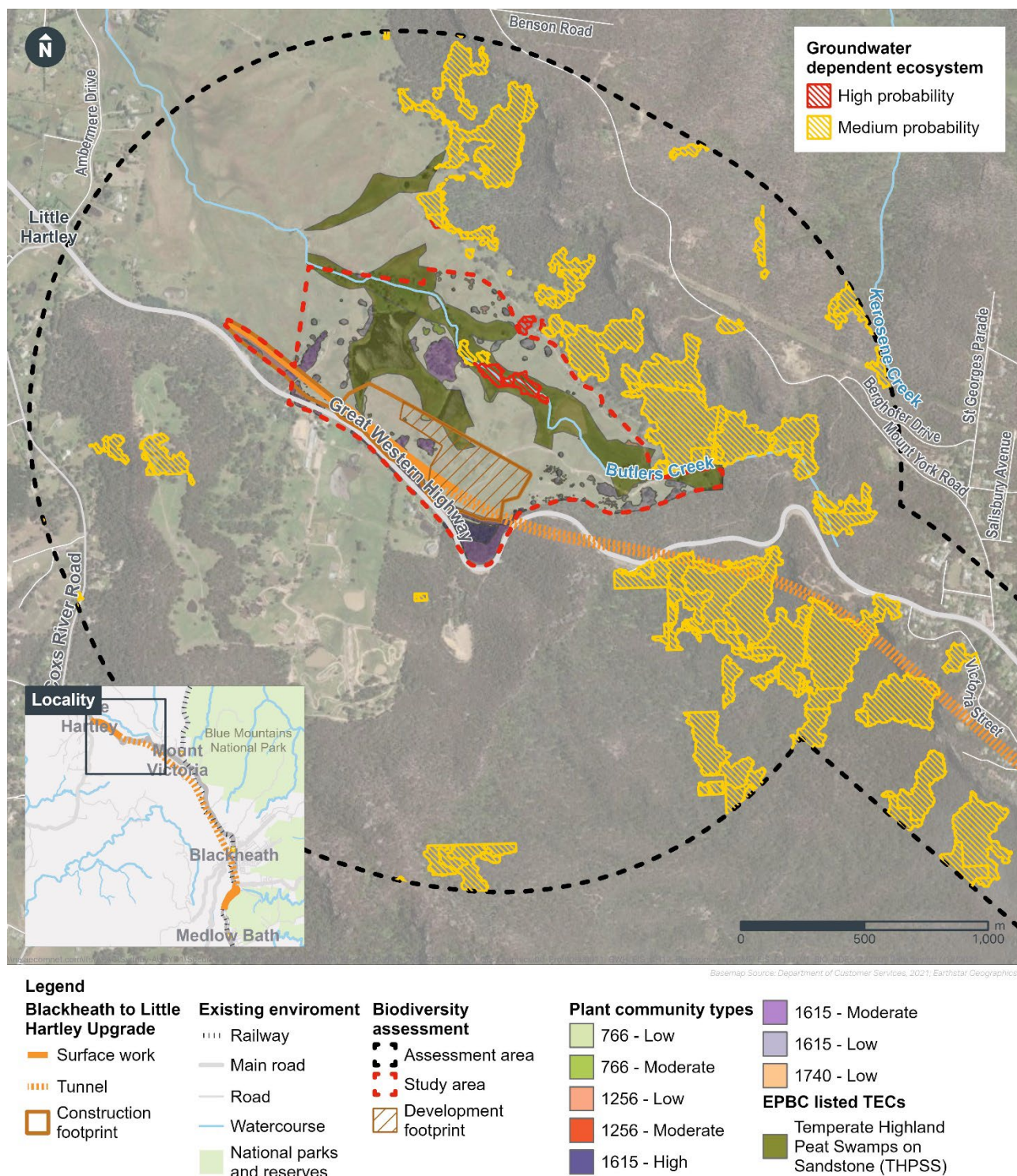


Figure 12-9 Distribution of groundwater dependent ecosystems within the assessment area at Little Hartley

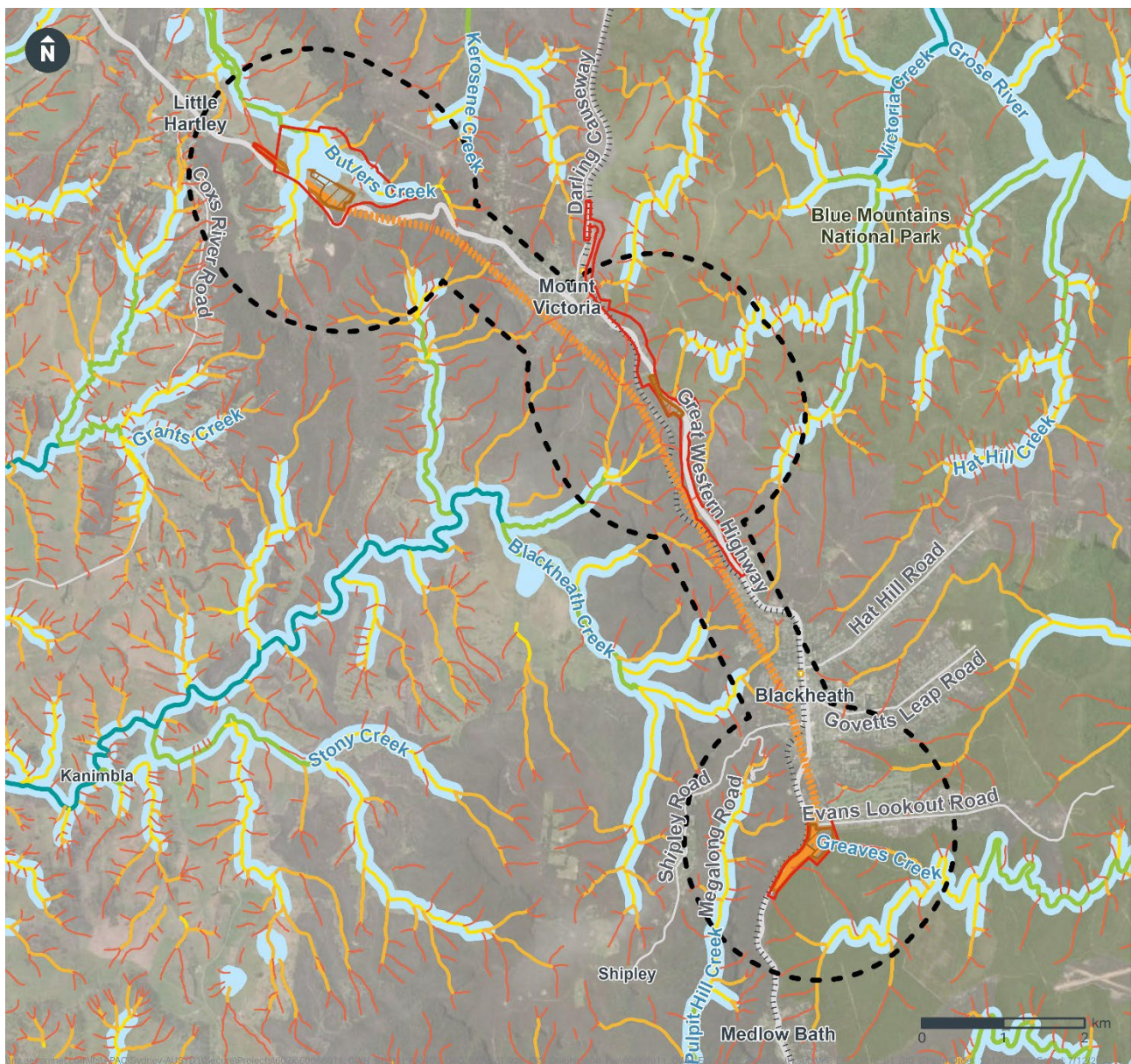
12.2.6 Existing aquatic environment

The project is located within the Hawkesbury catchment with the closest river-mouth being the Parramatta River located around 98 kilometres south-east of the project.

Several waterways originate from the assessment area. These waterways and their Strahler stream order, along with Key Fish Habitat (KFH) as mapped by the NSW Department of Primary, are shown in Figure 12-10 (Department of Primary Industries (DPI), 2022).

The ecological condition of these waterways ranges from 'poor' to 'excellent', with the majority of waterways considered to be in 'excellent' condition. At Butlers Creek, upstream areas are categorised as 'excellent', whereas downstream areas that approached pasture grassland are considered 'poor'.

Waterways originating from the assessment area are not considered habitat for threatened species or endangered populations listed under the *Fisheries Management Act 1994* (FM Act) and there are no records of threatened aquatic species. However, the waterways do flow into the Grose River and Cocks River, which are mapped as habitat for the Macquarie Perch (*Macquaria australasica*), listed as endangered under the EPBC Act and FM Act.



Base map Source: Department of Customer Services, 2021; Earthstar Geographics

Figure 12-10 Strahler order and key fish habitat of waterways near the project

12.2.7 Wetlands of international importance

No wetlands of international importance occur within the development footprint or assessment area. The nearest wetland is the Pitt Town Lagoon, located 53 kilometres to the east of the project. The project lies approximately 93 kilometres north-west of the nearest Ramsar wetland of international importance, being Towra Point Nature Reserve south of Sydney. The project would not drain to this catchment.

12.2.8 Matters of national environmental significance

The following matters of national environmental significance (MNES) under the EPBC Act are relevant to the project:

- two threatened fauna species listed under the EPBC Act have been recorded (Large-eared Pied Bat and Greater Glider) and a further eight are considered likely to have potential habitat within the development footprint, including Regent Honeyeater, Gang-gang Cockatoo, Large-eared Pied Bat, Spotted-tailed Quoll, Broad-headed Snake, Swift Parrot Purple Copper Butterfly, Greater Glider, Koala and Grey-headed Flying Fox
- one threatened ecological community (THPSS) listed as endangered under the EPBC Act
- the potential to support migratory species (but no areas considered significant habitat for migratory species)
- the Greater Blue Mountains Area listed on the World Heritage List and Australia's National Heritage List
- the Greater Blue Mountains Area – Additional Values nominated for inclusion on Australia's National Heritage List.

12.3 Potential impacts – construction

12.3.1 Avoidance and minimisation of impacts

The project has been designed to minimise impacts on biodiversity in the following ways:

- a tunnel option between Blackheath and Little Hartley minimising surface impacts including vegetation clearance
- design and location of the Blackheath and Little Hartley construction sites have been minimised and partially located within the footprints of the Katoomba to Blackheath and Little Hartley to Lithgow Upgrades, already cleared for construction of these projects, minimising the total impact to vegetation
- the water supply pipeline between the Little Hartley construction footprint and Lithgow would be located wholly within the existing and/or new road reserves and the indicative alignment thereby avoiding vegetation clearing or direct impacts to biodiversity.

While the water supply pipeline would cross waterways, a less intrusive methodology (for example underboring or attachment to bridges) would be adopted in these locations to minimise direct impacts on riparian corridors or Key Fish Habitat.

Further detail on efforts to avoid and minimise impacts on biodiversity values is described in Chapter 3 (Project alternatives and options) and Appendix H (Technical report – Biodiversity).

12.3.2 Direct impacts

As stated in Section 12.2, the assessment considers a baseline environment, where the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade adjoining the project to the east and west respectively, are under construction and associated construction sites have been cleared of vegetation. As a result, the project's direct impacts have been determined with reference to the construction footprint required by the project, minus the overlapping areas that are being assessed by the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade (referred to as the development footprint).

Potential direct impacts arising from the project include:

- removal of native vegetation and flora and fauna habitats
- removal of known habitat for threatened fauna species.

Direct impacts to native vegetation arising from the project includes the removal of:

- 7.40 hectares of high condition native vegetation
- 1.54 hectares of moderate condition native vegetation
- 0.77 hectares of low condition native vegetation
- at least 20 hollow-bearing trees.

Direct impacts would also occur to 0.43 hectares of Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions as a result of the project. No direct impacts would occur to mapped areas of Blue Mountains Swamps in the Sydney Basin Bioregion or THPSS.

This vegetation removal will require an offset in accordance with the BAM and the Commonwealth EPBC Act Environmental Offsets Policy (Department of Sustainability, Environment, Water, Population and Communities, 2012), described in Section 12.5.3. Areas of retained native vegetation within the assessment area are known and predicted to support the same native vegetation and TECs as those being directly impacted by the project. In the context of native vegetation retained and impacts to the Greater Blue Mountains World Heritage Area avoided, direct impacts to native vegetation are considered minor.

Direct impacts to threatened species relate to impacts to their habitat. Given that the areas of retained native vegetation adjacent to the construction footprint are known and predicted to support the same native vegetation and TECs as those being directly impacted, direct impacts to threatened species are considered minor.

Table 12-5 provides a summary of direct impacts to threatened species credit species (threatened species requiring targeted surveys or expert reports to confirm their presence) arising from the project.

Table 12-5 Summary of direct impacts on threatened species credit species

Species name	Common name	BC Act	EPBC Act	Sensitivity to gain class	Serious and irreversible impact entity?	Habitat or individuals to be impacted
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Vulnerable	Vulnerable	Very high	Yes	9.13 ha
<i>Petauroides volans</i>	Greater Glider	-	Endangered	High	No	0.35 ha
<i>Paralucia spinifera</i>	Purple Copper Butterfly	Endangered	Vulnerable	High	No	7.33 ha

12.3.3 Indirect impacts

Table 12-6 provides a summary of the potential indirect impacts arising from construction of the project.

Table 12-6 Potential indirect impacts of project construction

Indirect impact	Relevance to the project
Inadvertent impacts on adjacent habitat or vegetation	Inadvertent impacts on adjacent habitat or vegetation have the potential to occur as a result of non-targeted vegetation clearance during construction. With the implementation of the environmental mitigation measures outlined in Section 12.5, impacts to adjacent habitat or vegetation as a result of the project would be minimised.
Reduced viability of adjacent habitat due to edge effects	Habitats adjacent to the construction footprint are currently subject to a high degree of edge effects (such as introduction of weeds, erosion and sedimentation, and increased noise, dust and light), due to their close proximity to the existing Great Western Highway. An increase in edge effects is therefore not expected to occur as a result of construction with the exception of the potential for weed spread, which would be minimised or prevented through the implementation of the environmental mitigation measures in Section 12.5. Remaining areas of native vegetation within a 50 metre buffer surrounding the construction footprint have also been assessed for their potential to be impacted by edge effects. Areas of vegetation that would become isolated patches (i.e. less than 0.25 hectares in size), or which are currently unfragmented or undisturbed and would be subsequently impacted by a new edge, have had an offset credit calculated. The full process of calculating these offset credits for indirect credits is detailed in Section 9 of Appendix H (Technical report – Biodiversity).
Reduced viability of adjacent habitat due to noise, dust or light spill	Elevated levels of noise, lighting and dust are expected as a result of construction of the project. Vehicle movements during construction, particularly during earthwork, spoil handling, stockpiling and spoil transportation, are likely to generate dust. Noise and light from the project are expected during construction works, and light is expected during night works and other works which require lighting. Noise and light from construction may attract insects as food for microbats. Adverse impacts from noise, dust or light spill would be minimised or prevented through the implementation of the environmental mitigation measures outlined in Section 12.5.
Transport of weeds and pathogens from the site to adjacent vegetation	Increased transport of pathogens and weeds from construction is unlikely to occur as the construction footprint already occurs adjacent to the existing Great Western Highway. Potential impacts from the transport of weeds and pathogens would be managed through the environmental mitigation measures outlined in Section 12.5.
Increased risk of starvation, exposure and loss of shade or shelter	The habitat present in the development footprint represents potential habitat for native species, including the Large-eared Pie Bat, Purple Copper Butterfly and Greater Glider. Due to the small area of threatened species habitat proposed for removal and large areas of equivalent habitat in areas directly adjacent the project, the project would not result in an increased risk of starvation, exposure and loss of shade or shelter.
Loss of breeding habitats	Breeding habitat for the Greater Glider would be impacted by the project. However, retained vegetation in adjacent areas provides higher quality habitat and would not be reduced by the project.

Indirect impact	Relevance to the project
Trampling of threatened flora species	No threatened flora species were found or are considered likely to occur within the development footprint. Therefore, the trampling of threatened species is unlikely. Unexpected finds are to be managed in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Roads and Maritime Services, 2011b).
Inhibition of nitrogen fixation and increased soil salinity	Excavation or soil disturbance at the surface would be restricted to the construction footprints. Tunnelling excavation would reach a depth of up to around 200 metres below the surface at the deepest point, which is unlikely to affect surface nitrogen fixation. Changes to groundwater could potentially lead to impacts on soil salinity. Groundwater seepage into the tunnel would be redirected to a treatment plant, and surface water would be redirected to discharge points which would include bioretention filtration.
Fertiliser drift	No fertiliser is proposed to be used and therefore there are no indirect impacts proposed from fertiliser drift expected as part of the project.
Rubbish dumping	The construction footprint already occurs adjacent the existing Great Western Highway where levels of rubbish dumping from passing traffic are most likely moderate, particularly in the township areas. Standard environmental controls for the project would help to minimise potential rubbish dumping.
Wood collection	Construction of the project is unlikely to increase access to retained vegetation beyond current access capacity. Based on future use of the project, members of the public are not expected to undertake wood collection within the retained vegetation and landscaping around portal entrances. If wood collection does occur adjacent to portal entrances, it is unlikely to occur at a level that would have a detrimental effect.
Bush rock removal and disturbance	Bush rock may be removed within the development footprints. Removal of bush rock would be managed via mitigation measures outlined in the project construction environmental management plan (CEMP), including re use of bush rock, where possible.
Increase in predatory species populations	Portions of the construction footprint already occur within a semi-urbanised setting with pets. The vegetation clearance proposed by the project is unlikely to exacerbate predatory species populations. There may be temporary effects to predatory species such as Red Fox <i>Vulpes vulpes</i> associated with construction if rubbish is not adequately controlled. Lighting during construction of the project has the potential to attract predators and/or prey, however it is not expected that this would occur to a level that is detrimental. Indirect impacts from rubbish dumping and light spill during construction would be managed through the environmental mitigation measures outlined in Section 12.5.
Increase in pest animal populations	There is potential for an increase in pest animal populations during construction if general rubbish is not adequately controlled around construction footprints. Waste disposal management measures would be implemented during construction and would reduce resources available for pest species, preventing an increase in these species.

Indirect impact	Relevance to the project
Increased risk of fire	The project may result in an increased risk of fire during construction due to an increase in the use of machinery within the construction footprint. Appropriate fire suppressions and mitigation measures would be required at all construction sites. Mitigation measures to reduce the risk of construction work starting a bushfire and to manage the impact of bushfire events are provided in Chapter 22 (Hazards and risks).
Emissions	Construction of the project would result in emissions from construction plant and equipment and construction traffic. Measures to mitigate adverse emissions from the project are presented in Chapter 9 (Air quality).
Disturbance to specialist breeding and foraging habitat	No breeding habitat for assessed species credit species occurs within the development footprint. It is unlikely that the project would result in indirect impacts to breeding habitat for threatened species, such as Purple Copper Butterfly and Greater Glider.
Fragmentation of movement corridors	Movement corridors are currently not restricted in width and availability through the area, as there are large tracts of intact vegetation adjacent to sections of the Great Western Highway. The project would result in the removal of native vegetation from the development footprint that fringes retained native vegetation, to allow for the construction sites. The removal of vegetation is unlikely to fragment movement corridors, as extensive remnant vegetation adjacent to the construction footprint would remain intact and would not be fragmented.

12.3.4 Serious and irreversible impacts

No serious and irreversible impacts (SAIL) are expected as a result of the project. Though the Large-eared Pied Bat is considered to meet the principles for SAIL outlined in Clause 6.7 of the Biodiversity Conservation Regulation 2017, no breeding habitat is present for the Large-eared Pied Bat within the development footprint, and therefore there are no mapped areas of SAIL for this species.

12.3.5 Prescribed impacts

Table 12-7 provides a summary of the potential indirect impacts arising from construction of the project.

Table 12-7 Summary of prescribed biodiversity impacts during construction

Prescribed biodiversity impact	Nature	Extent
Areas of geological significance	Cliff lines and crevices within the rocky mountainous region of the Greater Blue Mountains represent potential habitat for native fauna, particularly for microbats, the Brush-tailed Rock Wallaby and the Broad-headed Snake.	Impacts to areas of geological significance may occur within the areas directly above the tunnel alignment. There is one cliff line to the south of the Soldiers Pinch construction footprint that crosses into the modelled settlement zone of influence and may be affected by settlement in excess of 5 millimetres. Updated settlement modelling will be carried out based on further design development, to confirm the anticipated levels of settlement beneath areas of geological significance (including cliff lines and GDEs). Where updated modelling indicates settlement may be more than 20 millimetres (consistent with the settlement threshold applied to sensitive structures), a before after control impact design monitoring program is recommended within these areas to detect and mitigate impacts accordingly.
Human-made structures and non-native vegetation	Human made structures and non-native vegetation may provide habitat to threatened or non-threatened fauna species.	No human made structures providing habitat to threatened or non-threatened fauna species occur within the development footprint. Around 11.02 hectares of the project's direct impact to vegetation is located in non-native vegetation, considered to provide negligible habitat beyond foraging opportunities for common kangaroo and wallaby species.
Habitat connectivity	Movement corridors are currently not restricted in width and availability as there are large tracts of intact vegetation adjacent to sections of the Great Western Highway.	The removal of vegetation for construction of the project is unlikely to fragment movement corridors for threatened fauna, as extensive remnant vegetation adjacent to the construction footprint would remain intact and not be fragmented.
Water bodies, water quality and hydrological processes	Reductions in water quality and increased flows can be detrimental to the natural environment as they can reduce available habitat for sensitive fauna, cause structural changes in creek lines, swamps and wetland ecosystems, and cause alterations in floristic diversity.	Groundwater seepage from tunnel excavation would be treated prior to discharge/re-use to avoid negative impacts to receiving environments. Surface water runoff would be managed via bioretention systems, flood retarding basins, flow spreaders and energy dissipation methods to limit potential impacts to receiving environments. Impacts to GDEs from groundwater drawdown are discussed in Section 12.3.6 and 12.3.7.

Prescribed biodiversity impact	Nature	Extent
Vehicle strikes	Increased vehicle movements, in particular heavy vehicles, have the potential to increase vehicle strikes with fauna species. Vehicle strikes on threatened fauna are of particular concern.	The potential for vehicle strikes would be reduced via construction of fauna exclusion fencing around the construction site, driver awareness training, and on-site measures such as reduced speed limits and signage.

12.3.6 Impacts on groundwater dependent ecosystems

Around 0.23 hectares of high priority GDEs and 3.92 hectares of medium priority GDEs occur within the assessment area at Little Hartley. As these areas are located outside of the development footprint there are no direct impacts to these areas.

However, indirect impacts have the potential to occur as a result of changes to water quality and hydrological processes, as outlined in Section 12.3.3. In particular, the increased runoff volumes from discharge locations are likely to result in increased inundation of the GDEs surrounding the largest of the three dams near the Little Hartley construction footprint. This has the potential to impact these communities as well as GDEs located downstream of the dam. Medium probability GDEs east of the Blackheath construction footprint would not be directly impacted but may also be subject to indirect impacts due to changes in surface water runoff volumes from discharge locations, and potential groundwater drawdown impacts.

Based on initial groundwater modelling (refer to Chapter 13 (Groundwater and geology)), potential reductions in baseflow are predicted at Greaves Creek from construction of the Blackheath portal, with the potential to impact medium probability GDEs to the east of the Blackheath construction footprint during dry periods. During design development and prior to construction, the numerical groundwater model will be updated and the existing groundwater monitoring network will be reviewed and maintained around the project to characterise the hydrogeological environment along and around Greaves Creek and associated GDEs. Subject to the outcomes of further consideration of potential impacts on GDEs, options to avoid and/ or minimise anticipated impacts will be identified and implemented if reasonable and feasible. Potential impacts to THPSS are discussed in Section 12.3.7.

12.3.7 Impacts on aquatic ecology

Impacts to aquatic ecology during construction are related to potential impacts on water quality and subsequent impacts on key fish habitat, and potential impacts to THPSS from groundwater drawdown.

As discussed in Chapter 14 (Surface water and flooding), the project would result in limited changes to the volume and quality of water discharged into receiving waterways. Populations of Macquarie Perch in the Cocks River and Grose River would therefore remain unaffected by the project.

As discussed in Section 12.3.6, potential dewatering and changes to baseflow are predicted within the Greaves Creek sub-catchment during construction of the project. During dry years, this could lead to impacts to THPSS mapped to the east of the Blackheath portal, including:

- the drying of swamp margins leading to a reduction in the area of the swamp
- changes to plant community type and structure
- increased susceptibility to erosion from surface water or stream flows
- increased susceptibility to bushfire.

As discussed in Section 12.3.6, a groundwater monitoring network will be established and maintained around the project to characterise the hydrogeological environment along and around Greaves Creek and associated GDEs, and options to avoid and/ or minimise anticipated impacts will be identified and implemented if reasonable and feasible.

12.3.8 Key threatening processes

A Key Threatening Process (KTP) is a process that threatens or may have the capability to threaten the survival or evolutionary development of species, populations or an ecological community. The direct impacts identified in Section 12.3.2 are likely to contribute to the KTPs identified in Table 12-8.

Table 12-8 Relevant Key Threatening Processes

Relevant Key Threatening Process	Statutory listing	Likelihood of the project contributing to the KTP
Land clearance	EPBC Act	Clearing of land would occur
Bush rock removal	BC Act	Bush rock may be removed within the development footprint
Clearing of native vegetation	BC Act	Clearing of native vegetation would occur
Loss of hollow-bearing trees	BC Act	At least 20 hollow-bearing trees are expected to be removed
Removal of dead wood and dead trees	BC Act	Dead wood and dead trees may be removed as part of native vegetation clearing

12.3.9 Matters of national environmental significance

The project has the potential to directly impact the following MNES under the EPBC Act:

- six threatened fauna species, including Large-eared Pied Bat, Spotted-tailed Quoll, Broad-headed Snake, Purple Copper Butterfly, Greater Glider, and Koala
- a place nominated on the National Heritage List, namely the Greater Blue Mountains Area – Additional Values at Blackheath and Soldiers Pinch.

The following MNES have the potential to be indirectly impacted by the project:

- TECs, specifically potential changes in hydrology impacting THPSS (see Section 12.3.6 and 12.3.7)
- World Heritage areas, specifically potential changes in hydrology impacting the Greater Blue Mountains World Heritage Area (see Section 12.3.3).

Significant Impact Assessments have been completed for the threatened fauna species and TECs for which the project has the potential to impact. These assessments found that no significant impact is likely for these species, TECs and places as a result of the project. The project's potential impacts to threatened fauna is discussed in Section 12.3.2.

Biodiversity values related to the Greater Blue Mountains Area – Additional Values include high condition native vegetation. Given the areas of retained native vegetation near the project are known and predicted to support the same native vegetation, and no threatened flora or TECs have been identified in the development footprint, impacts to the Greater Blue Mountains Area – Additional Values are considered negligible.

12.4 Potential impacts – operation

The main impacts on biodiversity during operation would be:

- inadvertent impacts on adjacent vegetation and habitat during operation
- impacts on adjacent vegetation and habitat arising from a change in land-use patterns
- impacts on aquatic ecology due to changes in hydrology and water quality
- impacts on GDEs, including THPSS during operation
- prescribed biodiversity impacts during operation.

Operational impacts are considered likely to extend beyond the development footprint. Biodiversity impacts during operation are summarised in Table 12-9.

Table 12-9 Operational biodiversity impacts

Operational biodiversity impact	Nature	Extent
Inadvertent impacts on adjacent habitat or vegetation	Inadvertent impacts to adjacent vegetation have the potential to occur during the operation of the project as a result of non-targeted vegetation clearance.	Areas associated with retained vegetation adjacent the project. With the implementation of the environmental mitigation measures outlined in Section 12.5.2, impacts to adjacent habitat or vegetation as a result of the project can be minimised or prevented.
Reduced viability of adjacent habitat due to noise, dust or light spill	Habitats adjacent to the construction footprint are currently subject to a high degree of edge effects due to their close proximity to the existing Great Western Highway.	Areas associated with the use of lighting, and operational noise around tunnel portals. Given the project largely comprises subsurface infrastructure, habitat adjacent to the existing Great Western Highway may experience a decrease in noise, dust or light spill during operation. Potential noise, dust or light spill impacts near the portals would be managed with the implementation of the environmental mitigation measures outlined in Section 12.5.2.
Increase in predatory species populations	Lighting during operation of the project has the potential to attract predators and/or prey.	Areas associated with the use of lighting around tunnel portals and operational facilities. It is not expected that lighting from operation would attract predators and/or prey to a level that is detrimental. Indirect lighting during operation can be managed through the environmental mitigation measures outlined in Section 12.5.2.
Increased risk of fire	During operation of the project, the risk of fire may decrease adjacent to the project as use of underground tunnels increases, and surface traffic is reduced adjacent to retained vegetation.	Areas associated with retained vegetation adjacent to the project. The use of fire prevention and control systems during operation would minimise the risk of fire during operation.

Operational biodiversity impact	Nature	Extent
Water bodies, water quality and hydrological processes	Reductions in water quality and increased flows can be detrimental to the natural environment as they can reduce available habitat for sensitive fauna, cause structural changes in creek lines, swamps and wetland ecosystems, and cause alterations in floristic diversity.	Areas associated with waterways and water bodies. Groundwater seepage from tunnel operation would be treated prior to discharge to minimise impacts to receiving environments. Surface water runoff would be managed via bioretention systems, flood retarding basins, flow spreaders and energy dissipation methods to limit potential impacts to receiving environments.
	Groundwater drawdown can be detrimental to the natural environment as reduced groundwater availability may lead to the drying out of the fringes of waterways or swamps which can alter the plant community type extent and floristic structure and associated aquatic habitat.	Based on initial groundwater modelling (refer to Chapter 13 (Groundwater and geology)), the majority of groundwater dependent ecosystems are at low risk of experiencing impacts associated with operational groundwater drawdown. The majority of THPSS locations are not predicted to be affected by groundwater drawdown during operation. Drawdown at GDEs from construction (see Section 12.3.6) are predicted to decline during operation due to tanking of the tunnels and cross passages. The numerical groundwater model will be updated as part of ongoing design development. Where updated groundwater modelling confirms the likelihood of material impacts on Greaves Creek baseflows, then further consideration should be given to design-related mitigation measures with a focus on reducing groundwater drawdown around the Blackheath portals.
Vehicle strikes	Increased vehicle movements, in particular heavy vehicles, have the potential to increase vehicle strikes with fauna species.	The potential for vehicle strikes is likely to decrease during operation as traffic volumes on the existing Great Western Highway through Blackheath and Mount Victoria are projected to decrease due to operation of the tunnel.

12.5 Environmental mitigation measures

12.5.1 Performance outcomes

Performance outcomes for the project in relation to biodiversity are listed in Table 12-10 and identify measurable performance-based standards for environmental management.

Table 12-10 Biodiversity performance outcomes

SEARs desired performance outcome	Project performance outcome	Timing
The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity.	Design the project to minimise adverse impacts on native terrestrial and aquatic flora and fauna.	Design
The offsets and/or biodiversity conservation actions are assured and are equivalent to any residual impacts of project construction and operation.	Secure a biodiversity offset and/ or carry out a conservation action equivalent to no less than the impacts of the detailed design of the project on biodiversity as assessed using the NSW Biodiversity Assessment Method (BAM) (2020).	Construction and operation

12.5.2 Mitigation measures

Mitigation measures to avoid, minimise or manage potential biodiversity impacts as a result of the project are outlined in Table 12-11. A full list of environmental mitigation measures for the project is provided in Appendix R (Compilation of environmental mitigation measures).

Table 12-11 Environmental mitigation measures – biodiversity

ID	Mitigation measure	Timing
B1	The project will be designed and implemented to minimise the removal of native vegetation and to minimise impacts to threatened species and their habitats.	Design and construction
B2	The project will be designed and constructed to minimise disturbance and impacts, including indirect impacts, to watercourses, riparian areas, aquatic habitats and threatened aquatic species, where feasible and reasonable.	Design and construction
B3	<p>A Construction Flora and Fauna Management Plan (CFFMP) will be prepared as part of the Construction Environmental Management Plan (CEMP) in consultation with DPE. The CFFMP will be prepared in accordance with Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects (RMS 2011b) and Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 (DPI, 2013), including:</p> <ul style="list-style-type: none"> • a procedure for planning and carrying out clearing, including preclearance surveys, management of vegetation clearance, removal of bush rock and other habitat features, and a specific protocol for the identification and removal of hollow-bearing trees • delineation of the construction footprint and areas within it where vegetation will be retained in accordance with Guide 2 of the Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects (RMS, 2011b) • procedures for establishing and maintaining tree protection zones, including with reference to Australian Standard 4970-2009 Protection of Trees on Development Sites 	Construction

ID	Mitigation measure	Timing
	<ul style="list-style-type: none"> procedures for managing and appropriately handling fauna that may be located within the construction footprint or affected by construction activities, and protocols for managing injured fauna in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RMS, 2011b) requirements for the installation of traffic signage and construction driver education on the risk of fauna related vehicle strikes, and procedures for removal of road carrion measures for managing the presence of unexpected threatened species procedures for re-establishing native vegetation, taking into account ecological values, opportunities to enhance habitat connectivity and landscaping requirements of the project, and replacing or re-installing habitat features such as woody debris, bushrock, and tree hollows protocols for managing weeds and pathogens in accordance with Guide 6: Weed management and Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RMS, 2011b) measures to protect aquatic habitat and riparian areas, including runoff and water quality management (refer to measure SW1), in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RMS, 2011b) and section 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management (DPI, 2013). 	
B4	Rehabilitation and landscaping of the construction footprint following completion of construction will seek to maximise the use of locally endemic native species and to enhance habitat connectivity across the Great Western Highway corridor where feasible and reasonable, consistent with the landscape plan for the project.	Design and construction
B5	Consideration will be given to the design of culverts under surface roads to act as potential fauna crossing points and habitat resources for microbat species.	Design
B6	Native vegetation cleared from the construction footprint will be mulched and reused in site rehabilitation, stabilisation and landscaping where appropriate.	Construction
B7	<p>Potential lighting/ overshadowing effects from the project on flora and fauna will be minimised where reasonable and feasible, including design and implementation of lighting during construction and operation taking into account:</p> <ul style="list-style-type: none"> minimum lighting requirements and design standards to maintain safety during construction and safety for operational traffic guidance on the management of obtrusive lighting effects in AS4282-1997: Control of the Obtrusive Effects of Outdoor Lighting guidance on good lighting principles provided in Part 4 of Dark Sky Planning Guideline (DPE, 2016a). 	Design and construction

ID	Mitigation measure	Timing
B8	Opportunities to minimise the risk of fauna strikes during construction and operation of the project will be considered during further design development and construction planning. This may include the installation of temporary fencing or other barriers near construction sites.	Design and construction
B9	The Biodiversity Assessment Method (BAM) will be used to review and update biodiversity offset requirements based on the final detailed design for the project. Biodiversity offsets for the project will be secured in accordance with the NSW Biodiversity Offset Scheme (BOS).	Design
B10	Based on the updated numerical groundwater model for the project (refer to environmental mitigation measure GW1), and groundwater and surface water monitoring data (refer to environmental mitigation measures GW2 and SW2), further consideration of the potential impacts of the project on groundwater dependent ecosystems along Greaves Creek as a consequence of groundwater drawdown and/ or reduction in watercourse baseflow will be carried out during further design development. Subject to the outcomes, options to avoid and/ or minimise anticipated impacts will be identified, and implemented if reasonable and feasible.	Design
B11	Swamp extent and PCT mapping will be carried out for the <i>Biodiversity Conservation Act 2016</i> (NSW) and <i>Environmental Protection and Biodiversity Conservation Act 1999</i> listed peat swamps (GDEs) on Greaves Creek and Butlers Creek prior to the commencement of construction, followed by seasonal swamp extent mapping and species composition assessment to assess change in swamp dynamics for a period of two years post-construction.	Design and operation
B12	Ground settlement predictions will be considered based on further design development. If cliff top areas are identified as potentially experiencing settlement of 20 millimetres or more, monitoring and management measures will be identified based on a Before After Control Impact (BACI) approach.	Design, construction and operation
B13	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through the use of design features such as bioretention systems and flow spreaders.	Design
B14	Bioretention systems will be unlined to allow infiltration of treated stormwater directly into the surrounding soils and will also include usage of engineered filter media augmented with organic carbon to provide appropriate pH buffering. The bioretention system will be planted with native flora species that are representative of the surrounding PCTs.	Design

12.5.3 Biodiversity offset requirements

Residual impacts that are not able to be avoided or managed through mitigation measures would be offset in accordance with the BAM based on the BAM calculator calculations for both TECs (ecosystem credits) and threatened species (species credits). Further detail on the calculations for the project's offset obligation is provided in Appendix H (Technical report – Biodiversity).

The project offset obligation has been calculated to require the following biodiversity credits:

- 279 ecosystem credits
- 510 species credits.

The biodiversity offset strategy for the project comprises three options:

- identifying the required 'like for like' credits in the market through the biodiversity offset scheme public registers, then purchasing the appropriate number of credits using biodiversity offset scheme transaction forms
- generating the required number of credits from a suitable Biodiversity Stewardship Site
- utilising the offsets payment calculator to determine the cost of the credit obligation, and paying this amount into the Biodiversity Conservation Fund. The Biodiversity Conservation Trust is then responsible for identifying and securing the credit obligation.

The obligation may be refined as further field work is undertaken and design development reduces the impacts of the project.