Chapter 24
Cumulative impacts

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24 Cumulative impacts

This chapter summarises the cumulative impact assessment carried out for the upgrade of the Great Western Highway between Blackheath and Little Hartley (the project).

24.1 Cumulative impacts defined

Cumulative impacts have the potential to occur when benefits or impacts from a project overlap or interact with those of other projects, potentially resulting in a larger overall impact (positive or negative) on the environment or local communities. Cumulative impacts may occur when projects are constructed or operated concurrently or consecutively.

The extent to which another development or activity could interact with the construction and/or operation of the project would depend on its scale, location and/or timing of construction. Generally, cumulative impacts would be expected to occur where other long-duration or large magnitude construction activities are undertaken close to, and over a similar timescale to, construction activities for the project; or where consecutive construction occurs in the same area. Additionally, operation of the project could cause cumulative benefits when the project interacts with or possibly enhances the construction or operation of other projects.

24.2 Assessment approach

The cumulative impact assessment methodology for this project has been developed in accordance with the State Significant Infrastructure Guidelines (Department of Planning, Industry and Environment, 2022) and Cumulative Impact Assessment Guidelines for State Significant Projects (Department of Planning, Industry and Environment, 2021d). The methodology is illustrated in Figure 24-1 and described in more detail in the following sections.

Figure 24-1 Overview of cumulative impact assessment methodology

24.2.1 Identification of potential projects

Projects identified for consideration in the cumulative impact assessment included those that met the following screening criteria:

- spatially relevant (i.e., the development or activity overlaps with, is adjacent to or within 10 kilometres of the project)
- timing (i.e., the expected timing of its construction and/or operation overlaps or occurs consecutively to construction and/or operation of the project)
- scale (i.e., large-scale major development or infrastructure projects that have the potential to result in cumulative impacts with the project, as listed on the NSW Government Major Project website, the Transport for NSW project website and relevant council websites)
- status (i.e., projects in development with sufficient publicly available information to inform this environmental impact statement and with an adequate level of detail to assess the potential cumulative impacts).

24.2.2 Projects included in the cumulative impact assessment

Projects identified for consideration in the cumulative impact assessment are listed in Table 24-1. Projects identified for inclusion in the cumulative impact assessment have met the criteria listed above and are shown in Figure 24-2. Given the regional setting of the project within the Blue Mountains and Lithgow local government areas (LGAs), there are fewer major projects within the locality.

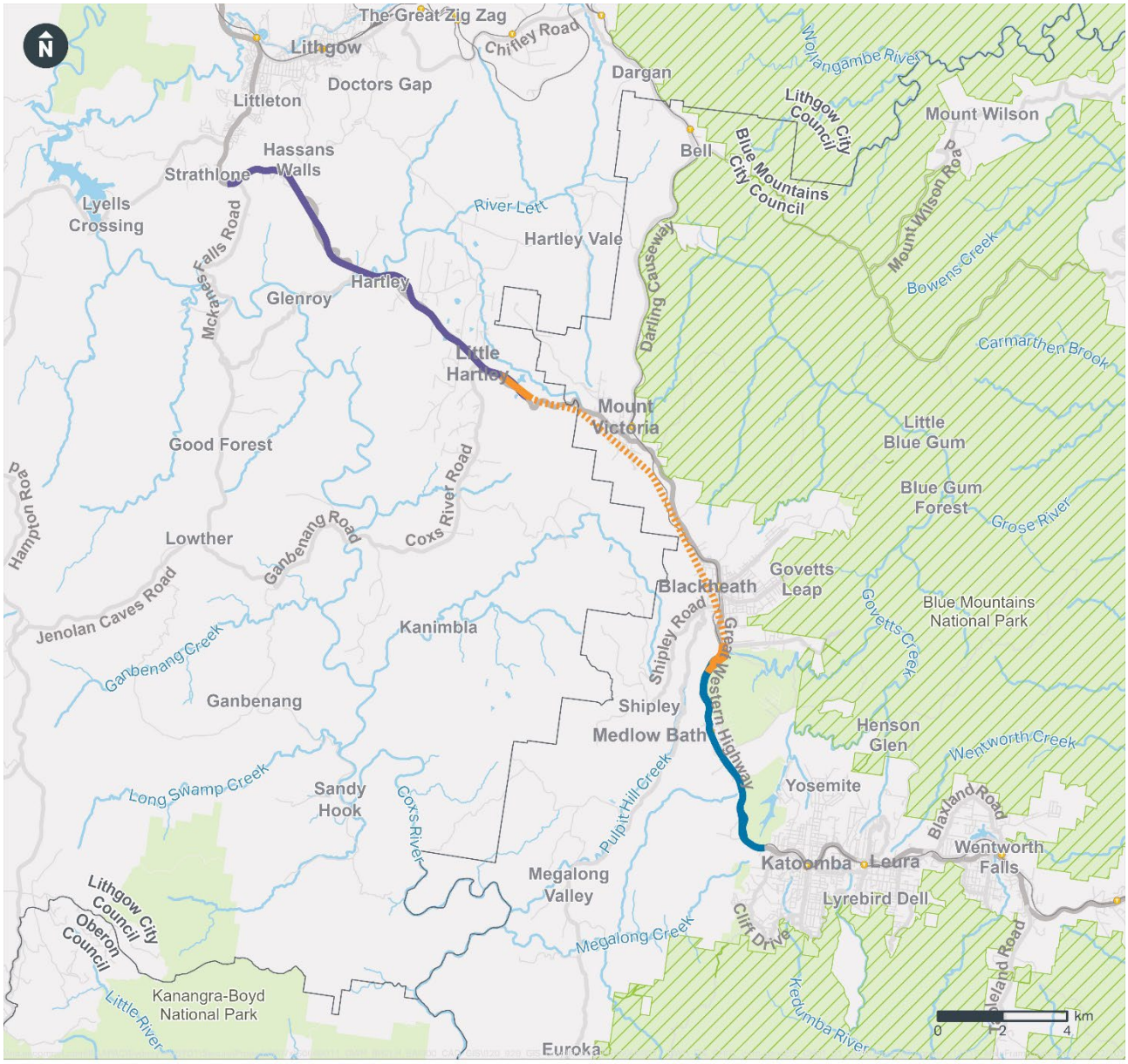
Figure 24-3 shows the construction and operational timeframes for each project considered in the cumulative impact assessment and how these overlap with the project. Subject to planning approval, construction is planned to commence in 2024 and continue until 2031. The project is expected to open to traffic by 2030.

Table 24-1 Projects considered for the cumulative impact assessment

Project and description	Spatial relevance	Timing	Scale	Status	Project included?
Great Western Highway Upgrade – Katoomba to Blackheath (Katoomba to Blackheath Upgrade) The Katoomba to Blackheath Upgrade involves widening of around 5.3 kilometres of the existing Great Western Highway between Rowan Lane, Katoomba and Tennyson Road, Blackheath from one to two lanes in each direction to be a four-lane divided carriageway.	Located immediately east of the project along the Great Western Highway	Katoomba to Blackheath Upgrade - construction expected to commence in 2023 and be completed in 2027.	Large-scale highway project	**Approved (2022)** Review of environmental factors (REF) and Submission Report publicly available	Yes
Great Western Highway Upgrade – Medlow Bath (Medlow Bath Upgrade) The Medlow Bath Upgrade involves upgrade of a 1.2 kilometre section of the existing Great Western Highway at Medlow Bath to a four-lane divided carriageway.	Located three kilometres east of the project along the Great Western Highway.	Medlow Bath Upgrade - construction has commenced and is expected to be completed by early 2024.	Large-scale highway project	**Approved (2022)** REF and Submission Reports publicly available	Yes

Project and description	Spatial relevance	Timing	Scale	Status	Project included?
Great Western Highway Upgrade Program – Little Hartley to Lithgow (West Section) (Little Hartley to Lithgow Upgrade) Upgrade of the Great Western Highway between Little Hartley and Lithgow. The project includes upgrade of about 14 kilometres of highway to a four lane divided highway.	Located immediately west of the project on the existing Great Western Highway alignment	Construction has commenced and is expected to be completed by 2026.	Large-scale highway project	**Approved (2022)** REF and concept design display for proposed modifications to the Little Hartley to Lithgow Upgrade publicly available.	Yes
Blackheath Village Centre Upgrade Blue Mountains City Council is planning improvements to the public domain of Blackheath over the coming 10 to 15 years including improvements to roads and active transport infrastructure, housing and community infrastructure.	Located within and surrounding Blackheath Town Centre, which is located around two kilometres north of the Blackheath portal	Work commenced in 2021	Localised urban amenity work	Limited publicly available information to inform a cumulative impact assessment	No This work comprises a number of small projects at Blackheath with relatively short construction timeframes that do not meet the scale criteria defined in Section 24.2.1. Transport for NSW would continue engagement with Blue Mountains City Council regarding the status of this work and potential interface with the project.

Project and description	Spatial relevance	Timing	Scale	Status	Project included?
Austen Quarry Stage 2 Extension Extension of the extraction area and overburden emplacement within the existing Austen Quarry of around 15.8 and 9.9 hectares respectively.	Located off Jenolan Caves Road over six kilometres west of the project	Unknown	Large-scale mining operations project	**Approved (2014)** Limited publicly available information to inform a cumulative impact assessment	No Located over six kilometres west of the project and does not meet the threshold to be considered in this assessment. Transport for NSW would continue engagement with Lithgow City Council regarding the status of the project and potential interface with the project.



Legend

Centreline
- Surface road
- Tunnel

Katoomba to Blackheath Upgrade (including Medlow Bath)
- Surface road

Little Hartley to Lithgow Upgrade
- Surface road

Existing enviroment
- Railway
- Main road
- Road
- Watercourse

Indicative only – subject to design development
- Greater Blue Mountains World Heritage Area
- National parks and reserves
- Local government area

Figure 24-2 Projects included in the cumulative impact assessment

Figure 24-3 Indicative construction duration for relevant projects

24.2.3 Type of assessment

Table 24-2 identifies relevant environmental aspects that may be subject to potential cumulative impacts during construction and operation from the included projects in Table 24-1. A description of these potential impacts is provided in Section 24.4 and Section 24.5.

Table 24-2 Nature of potential cumulative impacts

Key construction issues	Key operational issues
• transport and traffic • air quality • human health • noise and vibration • biodiversity • groundwater and geology • surface water and flooding • Aboriginal cultural heritage • Non-Aboriginal heritage • landscape and visual • social • business, land use and property • sustainability, climate change and greenhouse gas (GHG)	• transport and traffic • air quality • human health • noise and vibration • groundwater and geology • surface water and flooding • landscape and visual • social • business, land use and property • sustainability, climate change and GHG

Depending on the environmental aspect, the cumulative impact assessment may be quantitative, qualitative, or a combination of both. In most cases, a qualitative assessment has been undertaken for potential cumulative construction and operation impacts across key issues, as described in Section 24.4 and Section 24.5 respectively.

24.3 Baseline environment

The baseline environment for the cumulative impact assessment undertaken for the project comprises the road network and surrounding environment without any Upgrade Program infrastructure. The cumulative assessment assumes that construction of the Upgrade Program infrastructure has commenced at the time of project construction.

As shown in Figure 24-3, the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade adjoining the project to the east and west respectively would be under construction when construction of the project commences. To minimise environmental impacts, parts of the construction sites used for the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade would be used to support construction of the project.

The following activities would be carried out as part of the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade:

- vegetation would be cleared
- topsoil would be levelled and compacted
- site access tracks would be established
- water quality controls such as water quality and sediment basins would be installed.

These areas are shown in Figure 24-4 and Figure 24-5.

Limited overlap is anticipated with the Medlow Bath Upgrade as construction of the Medlow Bath Upgrade is anticipated to be completed by early 2024 before the peak construction year for the project (2026). Construction of the project would overlap with the construction activities associated with the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade which are due to be completed in 2027 and 2026 respectively, however peak construction years are not expected to overlap.

Further information related to the timing for the project, the Katoomba to Blackheath Upgrade (at Blackheath) and Little Hartley to Lithgow Upgrade (at Little Hartley) is shown in Table 24-3 and Table 24-4. The activities shown would not occur for the entire duration shown, however flexibility has been provided so that activities can be staged appropriately to minimise impacts and the interface with the adjacent projects.

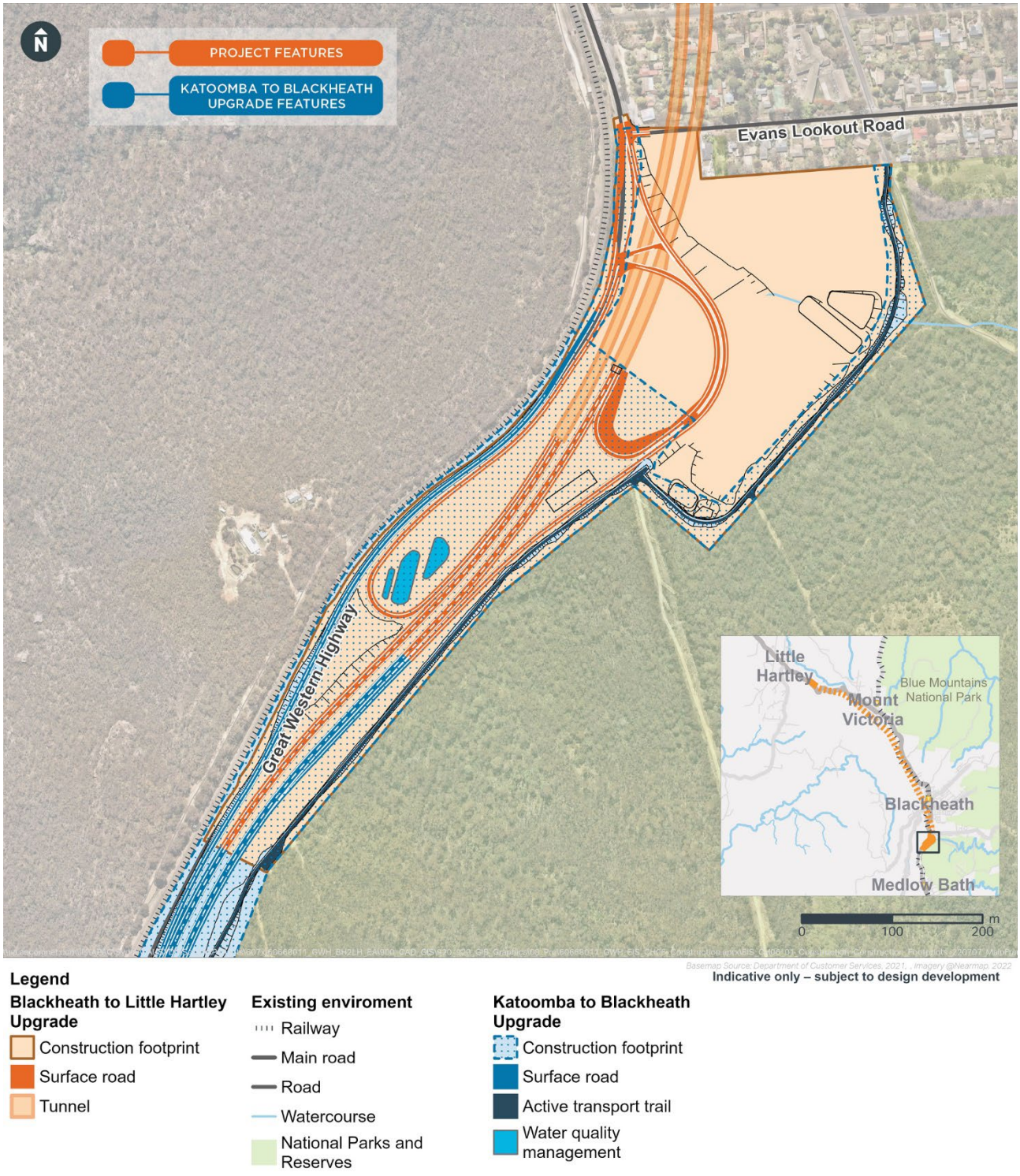


Figure 24-4 Indicative construction footprints and construction footprint overlap between the Katoomba to Blackheath Upgrade and the project at Blackheath

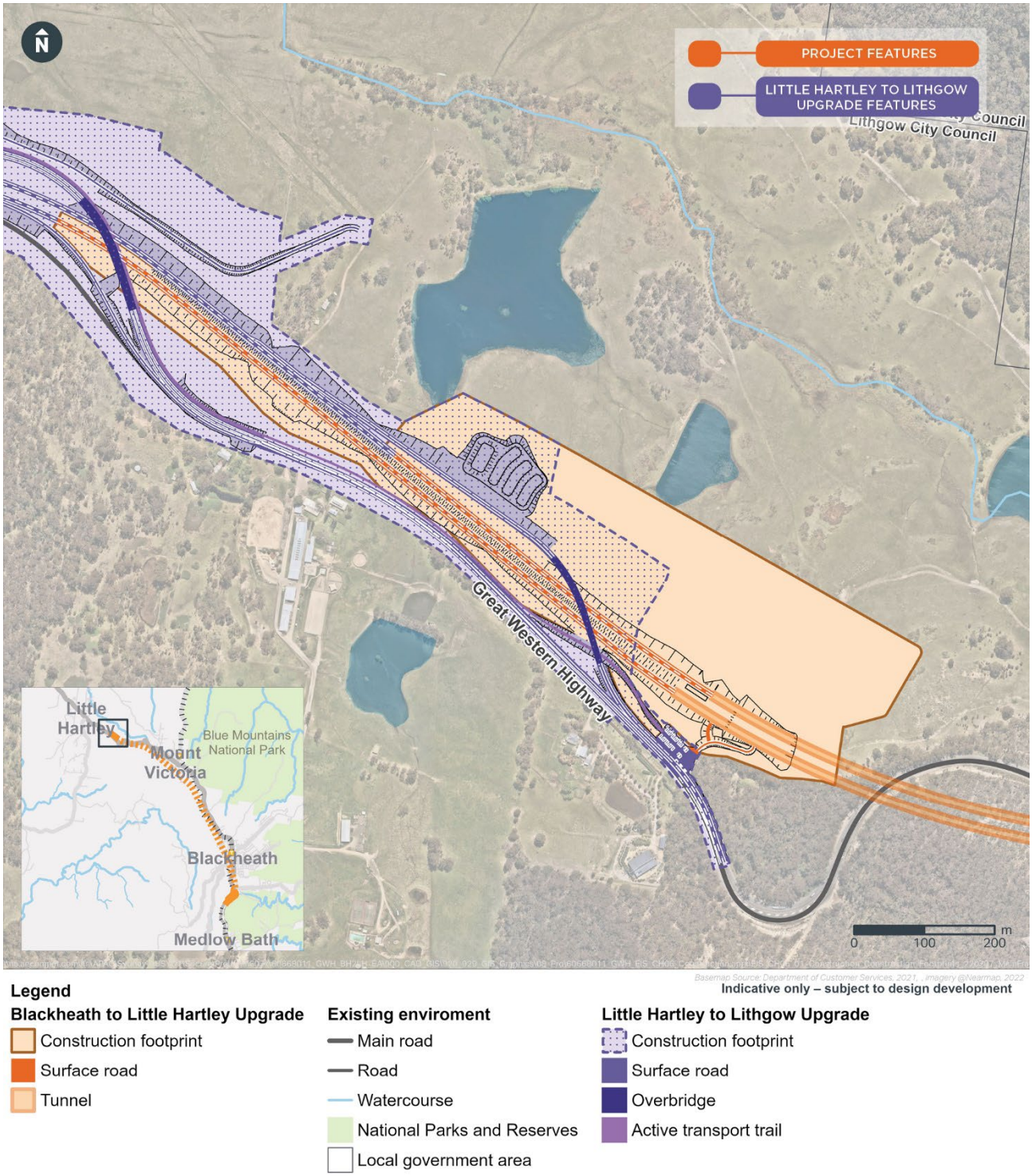


Figure 24-5 Indicative construction footprints and construction footprint overlap between the Little Hartley to Lithgow Upgrade and the project at Little Hartley

Table 24-3 Indicative construction program – Blackheath

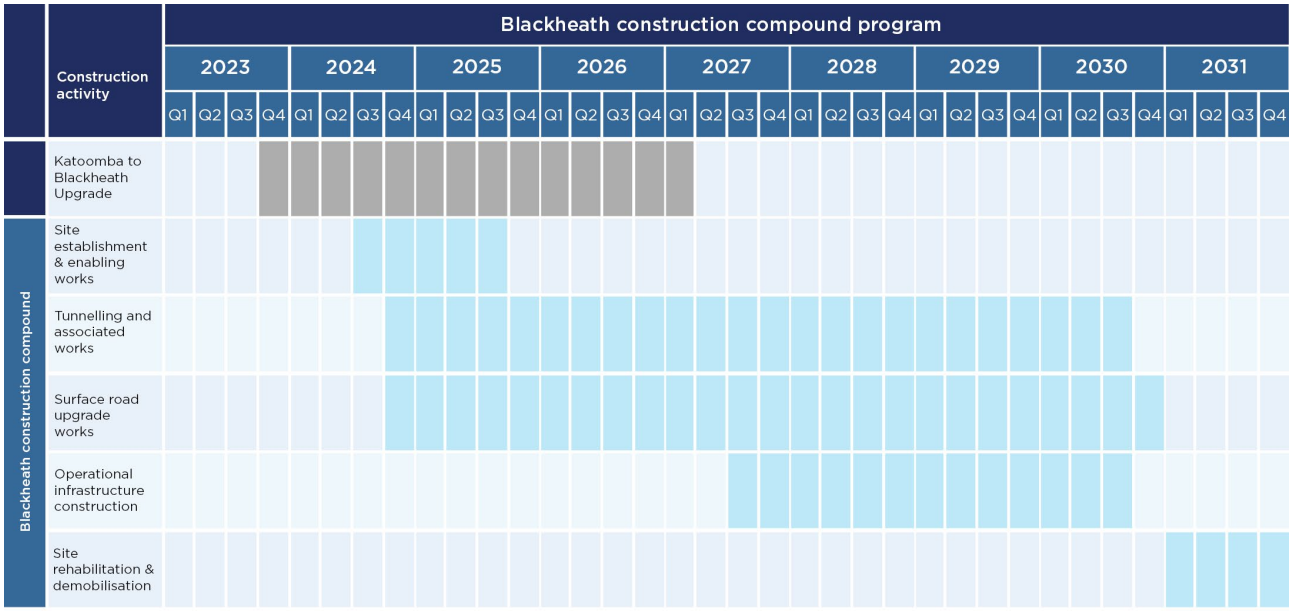
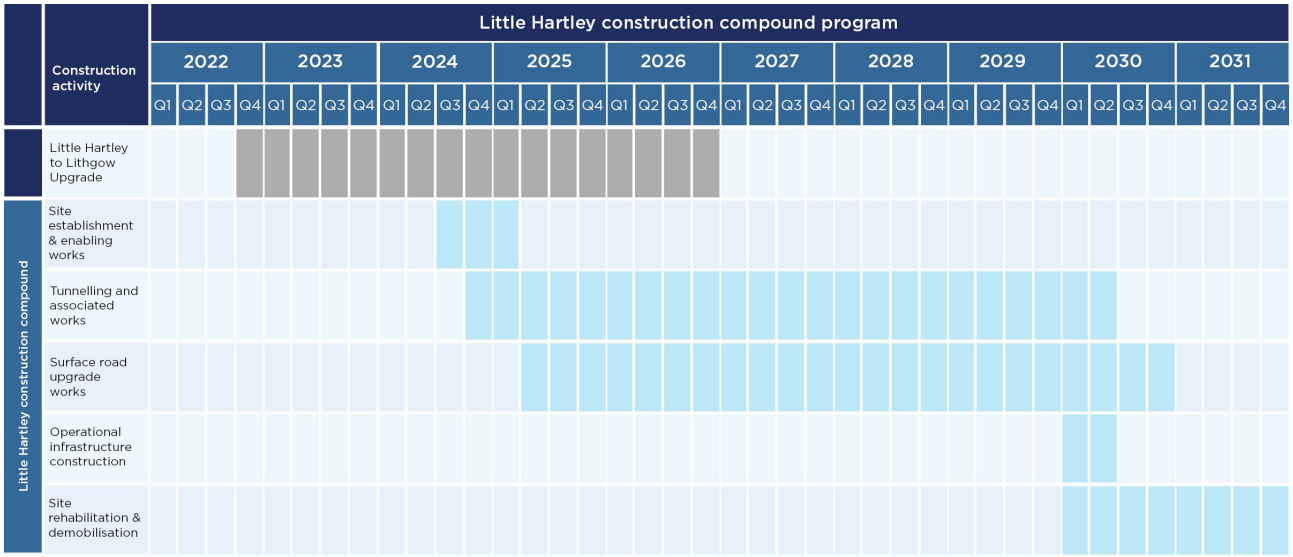


Table 24-4 Indicative construction program – Little Hartley



24.4 Potential impacts – construction

Potential cumulative impacts during construction are related to:

- transport and traffic
- air quality
- human health
- noise and vibration
- biodiversity
- groundwater and geology
- surface water and flooding
- Aboriginal cultural heritage
- non-Aboriginal heritage

- landscape and visual
- social
- business, land use and property
- sustainability, climate change and GHG.

These impacts are summarised in Sections 24.4.1 to Section 24.4.13. Further details on the potential cumulative impacts during construction are presented in the respective technical reports.

24.4.1 Transport and traffic

Table 24-5 presents the estimated peak cumulative heavy vehicle volumes generated by the Upgrade Program along the Great Western Highway during construction. It is estimated that the Upgrade Program would result in around an additional:

- 2,600 heavy vehicles per day along the Great Western Highway, which is 45 per cent more than the project alone
- 3,315 light vehicles per day along the Great Western Highway, which is 40 per cent more than the project alone.

It is anticipated that vehicles associated with the Katoomba to Blackheath Upgrade and Medlow Bath Upgrade would mostly travel between the project and the east via the Great Western Highway and similarly, the vehicles associated with the Little Hartley to Lithgow Upgrade would mostly travel between the project and the west via the Great Western Highway.

The project's heavy vehicles would most likely travel to and from the west and the project's light vehicles would likely travel to and from the east. As a result of the likely directional split of traffic, the total vehicle movements shown in Table 24-5 would not be experienced at any one location along the Great Western Highway.

Table 24-5 Indicative peak cumulative traffic volumes along the Great Western Highway[1]

Upgrade Program	Daily light vehicle movements	Daily heavy vehicle movements	Total vehicle movements
Blackheath to Little Hartley (the project)	2,355	1,805	4,160
Medlow Bath Upgrade	360	200	560
Katoomba to Blackheath Upgrade	200	140	340
Little Hartley to Lithgow Upgrade	400	450	850
Total	**3,315**	**2,595**	**5,910**

Table notes:

1. Vehicle movement refers to each movement that a vehicle makes e.g. one vehicle would usually make two movements (in and out) per day.

Cumulative construction traffic impacts associated with the Upgrade Program may include localised increased congestion, poor intersection performance and reduced travel speeds around Blackheath and Little Hartley resulting from the combined construction traffic generation and more extensive speed limit reductions associated with these projects. In addition, multiple traffic switches, lane reductions and speed limit reductions would be active across the Upgrade Program. The cumulative impacts of these traffic management measures would likely result in lower travel speeds and longer travel times (in the order of 10 minutes) along the Great Western Highway between Katoomba and Lithgow, particularly at night or off-peak periods when these are most likely to occur.

Work across the Upgrade Program would be staged appropriately to minimise these impacts. In particular, the Katoomba to Blackheath and Little Hartley to Lithgow Upgrade would have completed work in the vicinity of the project prior to peak activities associated with the project commencing. Construction worker shift changeover for the project which would account for a large proportion of total light vehicle movements would be scheduled to occur outside peak hour travel times. In addition, upgraded sections of the Great Western Highway would be opened to traffic sequentially, providing additional mid-block capacity and grade separated or upgraded intersections along the corridor as works are completed.

24.4.2 Air quality

The highest potential for cumulative air quality impacts is where construction of the project would overlap with construction of the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade. This would potentially result in receivers at Blackheath and Little Hartley experiencing greater air quality impacts for a longer duration given the concurrent and consecutive nature of the Upgrade Program components. Potential cumulative air quality construction impacts would largely be attributed to:

- dust from demolition, earthworks, stockpiling and mobilisation of dust from vehicles and/or machinery leaving construction sites
- emissions from construction vehicles and mobile and stationary equipment.

The Medlow Bath Upgrade is located around three kilometres east of the project and construction is expected to be completed by early-2024 which would have limited overlap with the project. Therefore, cumulative air quality impacts with the Medlow Bath Upgrade are not anticipated during construction.

Parts of the construction sites used for the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade would be used to support construction of the project. As outlined in Section 24.3, construction activities for the Upgrade Program would be staged appropriately to minimise the interface with the adjacent projects and avoid concurrent construction activities in the same localities. With the implementation of appropriate dust mitigation during construction, potential cumulative air quality impacts would be minor.

24.4.3 Human health

The human health assessment has focused on health-related impacts associated with air quality, noise and vibration and social impacts of the Upgrade Program. Where there is the potential for cumulative construction impacts on air quality (particularly from dust) and noise (see Section 24.4.2 and 24.4.4 respectively), there is also potential for related cumulative human health impacts. Extended exposure to construction related impacts from a prolonged construction duration may increase levels of stress and anxiety in some individuals located close to where projects overlap at Blackheath and Little Hartley.

With the implementation of air quality and noise mitigation measures (refer to Appendix R (Compilation of environmental mitigation measures)), the potential for cumulative human health impacts is considered low (for air quality) to moderate (for noise). These mitigation measures would adequately address construction related impacts such that the levels are not of concern to community health.

24.4.4 Noise and vibration

Sensitive receivers located in areas where the project overlaps spatially with the Katoomba to Blackheath Upgrade (at Blackheath) and the Little Hartley to Lithgow Upgrade (at Little Hartley) may be affected by cumulative construction noise. Cumulative construction noise could potentially increase noise levels at one particular receiver by up to 3 dBA above the highest noise level predicted for a particular project (assuming that at any one location equal noise levels from two stages of work are experienced). An overview of the noise sensitive receivers most likely to be impacted by cumulative construction noise is shown in Figure 24-4 and at Badgerys Creek in Figure 24-5. (see Figure 24-6). Cumulative impacts are likely to be restricted to standard hours

only as utility works for the adjacent projects would be undertaken before commencement of the project and not be undertaken concurrently.

Parts of the construction sites used for the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade would be used to support the construction of the project. While works would be staged to minimise concurrent activities occurring within the same localities, identification of sensitive receivers subject to increased noise levels from projects under concurrent construction would be determined during design development and detailed construction planning when further construction programming information is available. At Blackheath and Little Hartley construction sites, it is likely that noise mitigation measures confirmed during design development and implemented for the project (e.g. such as acoustic sheds) would also reduce the impact of cumulative noise from adjoining projects.

Provided the minimum working distances provided in Section 4.7 of Appendix G (Technical report – Noise and vibration) are implemented, it is highly unlikely that cumulative vibration would impact receivers near the boundaries between neighbouring projects.

Although there would be minimum concurrent impacts from cumulative construction noise, there is potential for receivers to experience construction noise fatigue due to the consecutive nature and increased duration of the cumulative construction period. Receivers at Little Hartley are expected to be particularly impacted as they would be impacted by noise generated from the Little Hartley to Lithgow surface works, as well as tunnelling support activities at the Little Hartley construction site for the project. Construction fatigue would predominantly be managed through stakeholder notification and engagement. Where practicable, respite would be provided and the total duration of works would be minimised as far as practicable.

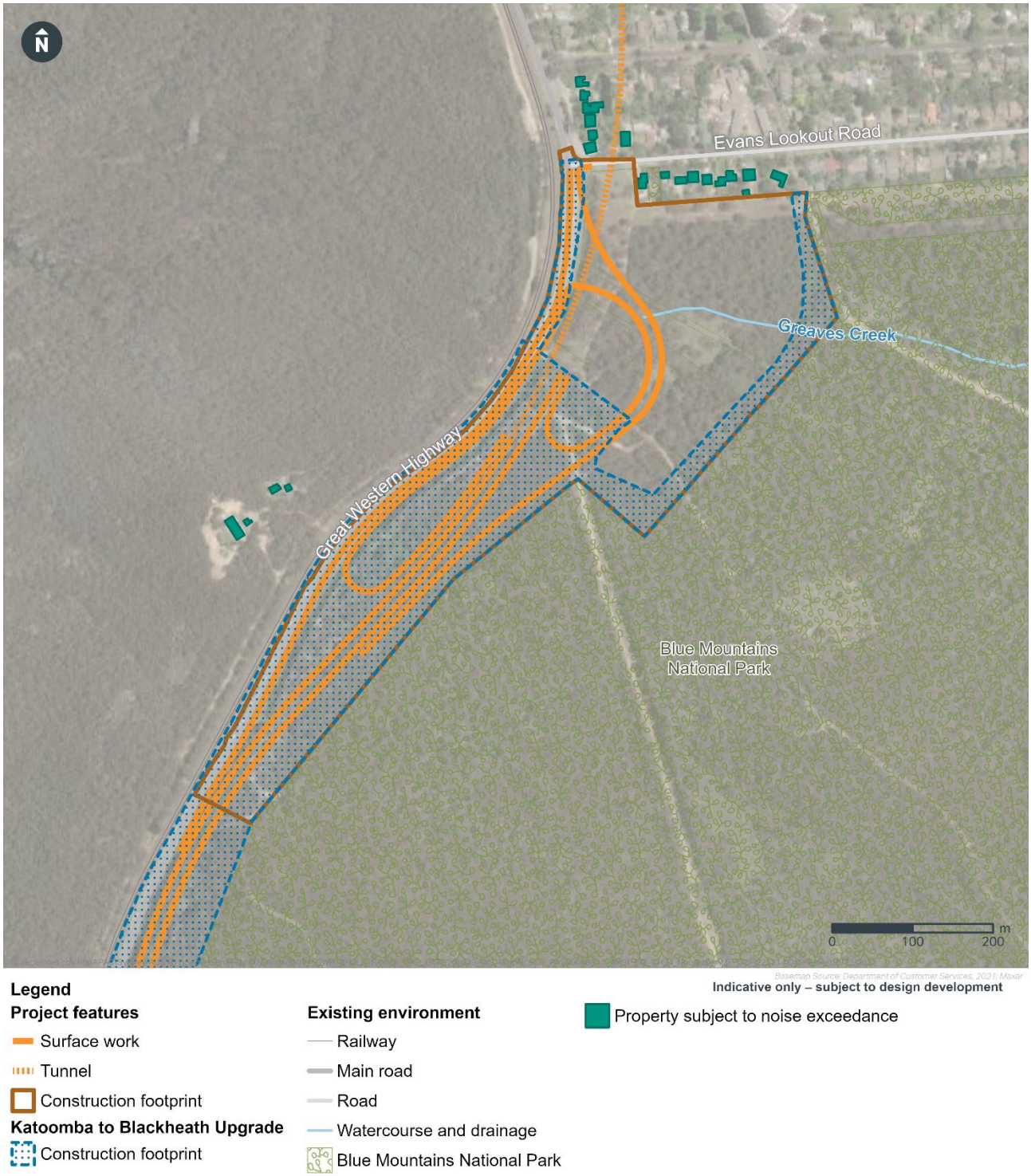


Figure 24-6 Receivers potentially impacted by cumulative noise at Blackheath

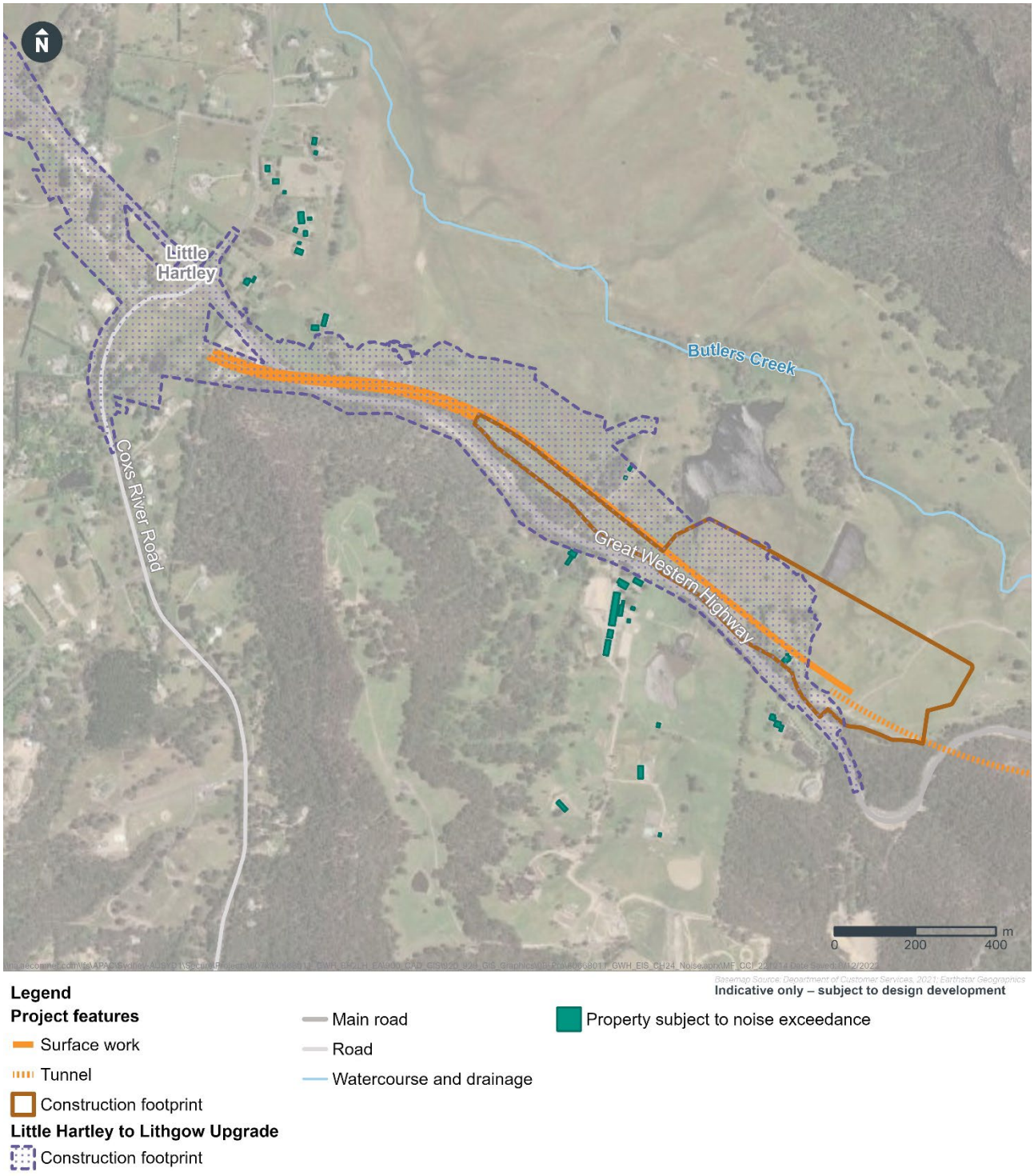


Figure 24-7 Receivers potentially impacted by cumulative noise at Little Hartley

24.4.5 Biodiversity

Parts of the construction sites for the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade would be used to support construction of the project, minimising the amount of vegetation to be removed for the Upgrade Program.

Potential cumulative biodiversity impacts from the Upgrade Program would include:

- increased removal of native vegetation
- increased removal of hollow-bearing trees.

These impacts are presented in Table 24-6 and Table 24-7 respectively. The project would comprise around 7.6 per cent of cumulative native vegetation impacts and around 5.6 percent of hollow-bearing tree cumulative impacts from the Upgrade Program.

As shown in Table 24-6, the project would specifically contribute to the cumulative impact to PCT 1248 (Sydney Peppermint – Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains, Sydney Basin Bioregion). This PCT is not associated with any threatened ecological communities listed under the *Biodiversity Conservation Act 2016* (NSW) or the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Given the context of the retained vegetation within the Blue Mountains National Park (more than 200,000 hectares), the removal of a relatively small amount of vegetation across the Upgrade Program is unlikely to substantially impact or reduce the availability of habitat critical to the survival of threatened flora or fauna. In the context of native vegetation retained and impacts to the Greater Blue Mountains World Heritage Area avoided, cumulative impacts to native vegetation are considered minor.

The Upgrade Program is largely located within an existing road corridor and native vegetation adjacent the Great Western Highway is already subject to a high degree of edge effects. As parts of the Great Western Highway corridor would be widened as result of the Upgrade Program, a slight cumulative increase in edge effects is expected. The implementation of standard mitigation measures consistently across the Upgrade Program would mean that cumulative impacts on biodiversity would not be substantial.

Table 24-6 Cumulative impacts to native vegetation

Plant Community Type (PCT) and condition	Area impacted (ha)				
	The project	Katoomba to Blackheath Upgrade	Medlow Bath Upgrade	Little Hartley to Lithgow Upgrade	Total cumulative impact
PCT 708 Moderate	0.50	-	-	-	**0.50**
PCT 708 High	1.30	-	-	-	**1.30**
PCT 731 Good	-	-	-	12.44	**12.44**
PCT 731 Variant – good	-	-	-	3.08	**3.08**
PCT 731 Moderate	-	-	-	14.61	**14.61**
PCT 732 Moderate	-	-	-	6.42	**6.42**
PCT 766 Low	0.43	-	-	-	**0.43**
PCT 963 Good	-	-	-	1.20	**1.20**
PCT 967 Low	-	0.70	-	-	**0.70**
PCT 967 Moderate	-	0.06	-	-	**0.06**
PCT 1103 Disturbed	-	-	-	1.71	**1.71**
PCT 1103 Low-Moderate	-	-	-	4.79	**4.79**
PCT 1103 Moderate	-	-	-	6.2	**6.2**
PCT 1103 Good	-	-	-	10.72	**10.72**
PCT 1155 Moderate	-	-	-	9.72	**9.72**
PCT 1248 Poor	-	-	0.02	-	**0.02**
PCT 1248 Low	0.33	19.06	-	-	**19.39**
PCT 1248 Moderate	0.86	27.74	0.34	-	**28.94**
PCT 1248 High	6.10	-	-	-	**6.10**
PCT 1615 Low	0.01	-	-	-	**0.01**
PCT 1615 Moderate	0.18	-	-	-	**0.18**
Total native vegetation	**9.71**	**47.56**	**0.36**	**70.89**	**128.52**

Table 24-7 Cumulative impacts to hollow-bearing trees

Biodiversity value impacted	Total count				
	The project	Katoomba to Blackheath Upgrade	Medlow Bath Upgrade	Little Hartley to Lithgow Upgrade	Total cumulative impact
Hollow-bearing trees	20	207	0	142	**369**

24.4.6 Groundwater and geology

The project may result in potential impacts to groundwater flow rates and drawdown near the portals and mid-tunnel access shaft, adit and cavern due to tunnelling and the construction of these items. Localised excavations (cuts) for the Upgrade Program have the potential to result in cumulative impacts to groundwater level and flow. This is likely to occur where excavation would be deeper than the water table. The closest cut for the Little Hartley to Lithgow Upgrade is around four metres west of the Little Hartley portal. The maximum depth of the cut is about 5.5 metres, above the water table depth of six metres below ground level and therefore is unlikely to impact groundwater levels at this location. Proposed cuts for the Katoomba to Blackheath Upgrade are less than five metres in depth in the vicinity of the project and are not anticipated to intercept groundwater. Potential impacts to sensitive receivers and groundwater users due to the long-term cumulative groundwater drawdown during construction of the Upgrade Program is therefore considered to be low.

24.4.7 Surface water and flooding

The project construction activities have the potential to temporarily impact the water quality of surrounding waterways, however these would be appropriately managed and would be minor.

The project and the Little Hartley to Lithgow Upgrade are both located in the Sydney Drinking Water Catchment and would implement guidelines and principles from the Blue Book to demonstrate a neutral effect on water quality (NorBE), therefore there would be no cumulative impacts expected to surface water quality at Blackheath and Little Hartley. The following potential cumulative surface water impacts were considered:

- overland flow from the Katoomba to Blackheath Upgrade construction footprint could wash construction materials, fuels and chemicals into the natural drainage line at Blackheath if not adequately managed leading to detrimental impacts to surface water quality in the receiving waterways prior to commencement of the project. Construction basins are proposed along the Katoomba to Blackheath Upgrade to capture runoff and manage these impacts in accordance with the Blue Book (Landcom, 2004)
- Little Hartley to Lithgow Upgrade construction works may lead to water quality impacts such as increased turbidity in receiving waterways including Rosedale Creek, from erosion and scour and increased nutrients which can lead to algal blooms. To mitigate these impacts at Rosedale Creek, proposed erosion and sediment control measures and the sizing of temporary sediment basins used during construction would meet the requirements of the Blue Book (Landcom, 2004) for both projects. With the implementation mitigation measures, the Little Hartley to Lithgow Upgrade would have a minimal impact on existing water quality and therefore there would be no cumulative impacts on surface water quality at Rosedale Creek.

There is potential for inundation under a five per cent annual exceedance probability event at Little Hartley during construction of the project, however no cumulative impacts on flood behaviour are expected during construction.

24.4.8 Aboriginal cultural heritage

No direct Aboriginal cultural heritage impacts are anticipated as a result of the project.

When considering the potential cumulative impacts of the Upgrade Program, Aboriginal sites do not exist in isolation and rather are associated with particular landforms and natural features. For example, a single site assessment identifying an artefact scatter in association with a rock shelter may find this site type common and typical. However, this site type and association may be rare within the region and therefore its context would have significance at a regional level and result in cumulative impacts if it were to be impacted. Likewise, the relative rarity of a site type needs to be considered when assessing the cumulative impacts of a project for a region's archaeology.

Construction of the Upgrade Program would result in potential direct impacts to 22 Aboriginal sites. These sites are of increased significance due to their rarity in an increasingly developed environment. The Aboriginal cultural heritage values across the Upgrade Program would be reduced if complete loss of these sites was to occur. Potential negligible or indirect impacts to a site are not considered to be a risk for cumulative impacts to the region's Aboriginal cultural heritage.

A preliminary Aboriginal Narrative Report and Body of Story Report has been prepared for the Upgrade Program to assist with the interpretation and integration of intangible Aboriginal cultural values collected during Aboriginal consultation and exploratory workshops by giving Aboriginal communities a voice in the design of the Upgrade Program. Examples of how some of the cultural values identified in the Aboriginal cultural heritage assessment for the project would be considered in the project design are discussed in Section 5.6 of Appendix N (Technical report – Urban design, landscape and visual). Consultation with Aboriginal stakeholders is further discussed in Chapter 16 (Aboriginal cultural heritage).

24.4.9 Non-Aboriginal heritage

Construction of the project has the potential to result in cumulative impacts to three heritage items and conservation areas identified in the non-Aboriginal heritage assessment.

Depending on the precise location of this archaeological site, the site of the Plough Inn could be subject to major direct impact from either the Little Hartley to Lithgow Upgrade or the project, whichever is constructed first. Currently, the Little Hartley to Lithgow Upgrade is expected to be constructed and affect the archaeological site prior to commencement of construction of the project. Overall, the site of the Plough Inn has been assessed as being potentially subject to a major direct cumulative impact. Cumulative vibration and visual impacts from construction of the Little Hartley to Lithgow Upgrade and the project also has the potential to result in moderate indirect impacts to the Rosedale local heritage item.

Construction of the project and the Katoomba to Blackheath Upgrade would result in direct cumulative impacts to the Greater Blue Mountains Area – Additional Values (a nominated National Heritage List item) of which native vegetation is an important feature. Given that the areas of retained native vegetation near the project are known and predicted to support the same native vegetation, these direct impacts are considered minor.

24.4.10 Landscape and visual

Construction of the Upgrade Program would result in potential visual and landscape character impacts at Blackheath and Little Hartley associated with increased construction footprints and the length of time construction activity would occur at these locations. In comparison to the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade, the construction footprint for the project is relatively small and predominantly in areas already impacted by the adjacent projects as most of the project alignment is in the tunnel.

Landscape character

At Blackheath, the Great Western Highway corridor would be widened between Medlow Bath and the Blackheath tunnel portals, with the removal of stands of bushland vegetation to the east of

Great Western Highway to accommodate the widening. This would substantially open up views east across the valley. This impact would occur to support construction of the Katoomba to Blackheath Upgrade and the project construction footprint at Blackheath. Similarly, the cumulative construction footprint at Little Hartley for the project and the Little Hartley to Lithgow Upgrade would be an uncharacteristic addition to the existing quiet, rural valley setting.

Visual impact

Visual receptors within the Little Hartley valley (predominantly residents), at lookouts along the Mount York escarpment (typically hikers and tourists), and receivers travelling along the Great Western Highway are sensitive due to the relationship of these receptors to the views seen from their properties or while engaging in recreational activities and the potential change to these views.

The Upgrade Program would result in the increased presence of construction-related infrastructure and an extended construction footprint and duration which would increase the magnitude of change experienced at most viewpoints during construction.

24.4.11 Social

Cumulative social impacts during construction would be predominantly experienced at Blackheath and Little Hartley, where the project interfaces with the Katoomba to Blackheath Upgrade and Little Hartley to Lithgow Upgrade. Communities around these particular areas would be subject to sequential construction impacts from the Upgrade Program over an extended period of time (up to around eight to nine years). Cumulative social impacts during construction include:

- increased stress and impacts to people's way of life and their ability to move around the social locality, from cumulative increased congestion, poor intersection performance and reduced travel speeds at Blackheath and Little Hartley
- additional impacts to people's sense of place and wellbeing from cumulative construction noise, vibration and dust changing the amenity of nearby properties and social infrastructure
- potential decline in the way people experience their surroundings from cumulative landscape character impacts
- additional impacts to the natural landscape, which is valued by the community, due to cumulative removal of native vegetation
- potential construction fatigue due to the cumulative extended construction period and associated traffic, noise, air quality and amenity impacts
- improvements to people's capacity to earn an income and associated benefits to livelihood as some retail and construction businesses would experience higher levels of spending across the Upgrade Program.

The overall unmitigated social significance of potential cumulative construction impacts would be a medium (negative) impact (refer to Chapter 19 (Social impacts) for rating definitions). Opportunities to minimise and manage cumulative impacts across the Great Western Highway Upgrade Program will be identified in consultation with other projects in the Upgrade Program, and implemented where reasonable and feasible.

24.4.12 Business, land use and property

The cumulative capital expenditure and number of workers associated with construction of the Upgrade Program would result in additional economic benefits, including increased output and jobs created for the Lithgow and Blue Mountains LGAs compared to the project in isolation. An increased proportion of construction related jobs located in these regions would also be expected during construction of the Upgrade Program, which is expected to span for around nine years.

The economic benefits of the Upgrade Program are likely to include higher levels of spending at local accommodation and retail businesses over the duration of construction compared to the project in isolation. While the increase in the number of workers in the area may put pressure on

accommodation supply and result in shortages in accommodation in the short-term, this impact is expected to be partially mitigated by the sourcing of local workers who already live in the area.

The Upgrade Program has avoided the requirement for property acquisition that would result in the loss of businesses.

24.4.13 Sustainability, climate change and greenhouse gas

Construction of the project would result in around 0.09 mega tonnes of carbon dioxide equivalent (Mt CO_2e) per year of construction.

Construction of the Little Hartley to Lithgow Upgrade in combination with the project would result in 0.127 mega tonnes of Mt CO_2e per year of construction. This is equivalent to 0.096 per cent of total NSW annual emissions in 2020.

While the Katoomba to Blackheath Upgrade and Medlow Bath Upgrade greenhouse gas emissions haven't been quantified, these would be of a similar order of magnitude as the Little Hartley to Lithgow Upgrade.

24.5 Potential impacts – operation

Potential cumulative impacts during operation are related to:

- transport and traffic
- air quality
- human health
- noise and vibration
- groundwater and geology
- surface water and flooding
- landscape and visual
- social
- business, land use and property
- sustainability, climate change and GHG.

These impacts are summarised in Sections 24.5.1 to Section 24.5.10. Further details on the potential cumulative impacts during operation are presented in the respective technical reports.

24.5.1 Transport and traffic

The Upgrade Program would provide a new connection for higher productivity freight vehicles longer than 20 metres for 34 kilometres between Katoomba and Lithgow.

Following the completion of the Upgrade Program, average travel times along the Great Western Highway between Katoomba and Lithgow would reduce by up to 13 minutes in 2030 and 15 minutes in 2040. The total trip would take less than 30 minutes.

Following the completion of the Upgrade Program, average vehicle speeds on the Great Western Highway between Katoomba and Lithgow would increase from an average of:

- 57 kilometres per hour to 77 kilometres per hour in 2030
- 54 kilometres per hour to 76 kilometres per hour in 2040.

The travel times demonstrate that the Upgrade Program would result in a 10 to 15 minute (20 to 35 per cent) travel time saving for heavy vehicles travelling between Katoomba and Lithgow during the weekday AM and PM peak hours.

The vehicle speeds demonstrate that the Upgrade Program would result in improved heavy vehicle speeds including 15 to 20 kilometres per hour (30 to 40 per cent) in the eastbound direction and 12 to 16 kilometres per hour (25 to 30 per cent) in the westbound direction.

These improved travel speeds and travel time savings would provide substantial benefits for regional freight transport.

24.5.2 Air quality

The operational air quality impact assessment carried out for the project (Appendix E (Technical report – Air quality)) included all components of the Upgrade Program and has therefore considered the potential cumulative impacts of the Upgrade Program.

Operational air quality impacts were assessed for both tunnel ventilation design options currently being investigated for the project (emissions via ventilation outlets or portals). In both ventilation outlet and portal emissions scenarios, predicted total ground level concentrations were below the NSW Environment Protection Authority's criteria for all pollutants and all modelled scenarios at the worst affected receptors. This assessment is further summarised in Section 9.6 of Chapter 9 (Air quality).

24.5.3 Human health

During operation, the Upgrade Program would result in community health benefits associated with reduced levels of traffic congestion, improved connectivity between Sydney and Central West NSW, reduced travel times, and improved air quality and traffic noise (for receivers between Blackheath and Little Hartley).

24.5.4 Noise and vibration

The operational traffic noise assessment carried out for the project (Appendix G (Technical report – Noise and vibration)) included all components of the Upgrade Program and has therefore considered the potential cumulative impacts of the Upgrade Program.

Operation of the Upgrade Program is expected to result in reduced noise levels at around 2,000 residential receivers where the tunnel provides a bypass to the existing surface road between Blackheath and Little Hartley. By providing an improved gradient and alignment, the project would also reduce maximum noise levels and events associated with truck engine braking, exhausts and horns. Some receivers located adjacent to where new and upgraded sections of surface road are proposed may experience elevated levels of operational road traffic noise. Where predicted cumulative traffic noise levels exceed criteria, mitigation options for noise affected receivers will be considered. This assessment is further summarised in Section 11.4 of Chapter 11 (Noise and vibration).

24.5.5 Groundwater and geology

As discussed in Section 24.4.6, proposed cuts for the Katoomba to Blackheath Upgrade are less than five metres in depth within the vicinity of the project, and are not anticipated to intercept groundwater. Groundwater drawdown from the tunnels during operation is expected to be limited. The maximum simulated spatial extent of water table drawdown during operation of the project at the Little Hartley portals is expected to be less than 500 metres from the portals. Given the closest cut that intercepts groundwater from the Little Hartley to Lithgow Upgrade is around 1.2 kilometres west of the Little Hartley portals, the estimated groundwater drawdown contours are not anticipated to overlap and therefore no cumulative impact to groundwater level or flow is expected. Potential impacts to sensitive receivers and groundwater users due to the long-term cumulative groundwater drawdown during operation of the Upgrade Program is considered to be low.

24.5.6 Surface water and flooding

The Katoomba to Blackheath and Little Hartley to Lithgow Upgrade would drain to the Sydney Drinking Water Catchment and surface runoff treatment for both of these projects would meet the requirements for a NorBE. As such cumulative water quality impacts during operation of the project

to the receiving waterways including tributaries of Grose River and Coxs River catchments is neutral and would not contribute to cumulative impacts with other projects.

At Little Hartley, existing conditions include a potential localised flood level increase at the upstream end of the Rosedale Creek culvert beneath the existing Great Western Highway. During operation of both projects at Little Hartley, flood modelling indicates that a flood level increase would no longer be expected due to the proposed culvert upgrade as part of this project. Therefore, there is expected to be a cumulative benefit on flood behaviour during operation at Little Hartley.

24.5.7 Landscape and visual

The Upgrade Program would result in substantial changes both to landscape character and views. The scale of the widened road corridor and the larger pieces of infrastructure that would be added to the landscape, particularly the operational ancillary facilities, divided carriageways, bridges, tunnel portals, and lighting, would be uncharacteristic with the existing landscape setting.

Landscape character

During operation, the narrow, winding Great Western Highway embedded within the landscape would increase in prominence, with the widened road corridor and large scale of the operational infrastructure enforcing more of a presence on the surrounding landscape. Tree planting, particularly within and around the surface works at Blackheath and Little Hartley would assist in reducing the cumulative visual impacts within the landscape over time.

The overall combined impact of the Upgrade Program on landscape character is considered to be high (adverse). A Place Design and Landscape Plan (PDLP) will be prepared to minimise landscape character and visual impacts, and detail and guide the implementation of landscape features to be installed as part of the project. The PDLP will be prepared in accordance with applicable guidelines, be consistent with the project identity in the EIS and relevant urban design objectives and principles for the project including consideration of implementation of Crime Prevention Through Environmental Design principles, and in consultation with the relevant councils.

Visual impact

Visual receptors within the Little Hartley valley (predominantly residents), at lookouts along the Mount York escarpment (typically hikers and tourists), and receivers travelling along the Great Western Highway are sensitive due to the relationship of these receptors to the views seen from their properties or while engaging in recreational activities and the potential change to these views.

The cumulative impact of the Upgrade Program would be the substantial widening of the Great Western Highway corridor with the addition of uncharacteristically large operational infrastructure. At Little Hartley for example, cumulatively, the view would be characterised by bridges, tunnel portals and batters, a water treatment plant, substation and ventilation outlet (if this ventilation option is selected) increasing the magnitude of change experienced at most viewpoints. Tree planting, particularly within and around the surface works at Blackheath and Little Hartley would reduce the impact of these structures over time, particularly when seen from the Mount York escarpment and from residences within the Little Hartley valley. Urban design principles and objectives that would guide design development to ensure the project design integrates with the existing setting are outlined in Appendix N (Technical report – Urban design, landscape and visual).

The overall combined impact of the Upgrade Program on views is considered to be high (adverse).

24.5.8 Social

Cumulative social impacts during operation primarily consist of social benefits as a result of substantial travel time improvements and decreases in congestion on the existing Great Western Highway as a result of the Upgrade Program.

These social benefits include:

- improved accessibility within the social locality and the broader region, and improved access to local businesses, facilities, jobs and social infrastructure
- substantial improvements in amenity and road user safety in bypassed town centres, contributing to an improved sense of place, as well as potentially attracting additional tourists and visitors
- enhanced wellbeing and decreased stress from the reduction in travel times and congestion experienced by road users
- the accessibility and safety benefits delivered by the project would be enhanced by additional active transport and safety initiatives, including active transport trails to the east and west of the project (provided as part of the Katoomba to Blackheath Upgrade and the Little Hartley to Lithgow Upgrade), and the formalisation of the informal Berghofer's Pass car park to improve the safety and amenity of the car park for visitors (as part of the Little Hartley to Lithgow Upgrade).

There is some potential for adverse changes to how local residents and visitors experience their surroundings and sense of place, particularly in relation to visual amenity, associated with the collective presence of surface infrastructure in Blackheath and Little Hartley. A Place Design and Landscape Plan would be implemented to provide consistency in design, and landscaping provided for screening, to manage this impact (refer to Chapter 18 (Landscape and visual)).

The overall unmitigated social significance of cumulative operation impacts would be a high (positive) impact (refer to Chapter 19 (Social impacts) for rating definitions).

24.5.9 Business, land use and property

During operation, the cumulative impacts of the project and the Katoomba to Blackheath Upgrade (including the Medlow Bath Upgrade) and Little Hartley to Lithgow Upgrade would include large travel time reductions, increased vehicle speeds, increased capacity for freight traffic volumes and improved road safety for drivers travelling through the Blue Mountains. For communities in the Blue Mountains it is anticipated that this would result in increased productivity for local workers, as well as further improving the accessibility and attractiveness of local tourist attractions, with the impacts resulting from the Upgrade Program likely to be greater than changes by the project in isolation.

The cumulative impact from the Upgrade Program is also likely to result in greater changes to passing trade activity across the Lithgow and Blue Mountains LGAs. Depending on the nature of the business – specifically the type of industry, location and reliance on passing trade – the actual impact of these impacts would vary, however retail trade businesses are likely to be most severely impacted.

24.5.10 Sustainability, climate change and greenhouse gas

Cumulative climate change impacts associated with operation of the Upgrade Program would occur as a result of interdependencies with the surrounding environment, with the potential to increase climate change risks for the receiving environment. These interdependencies include:

- increased overland flow and changes to drainage lines resulting in increased risk of localised flooding and/or increase flows to receiving environments
- increase in impervious surfaces, however given that the majority of the project would be below the surface in tunnels, this increase is not anticipated to result in substantial cumulative impacts
- interactions with existing drainage systems. The project drainage infrastructure has been designed to account for the capacity of existing drainage systems, such that it would meet or improve current drainage flows
- project infrastructure providing additional options for access and evacuation during extreme events including for emergency management and response.

The mitigation measures identified in Chapter 23 (Sustainability, climate change and greenhouse gas) would improve project's resilience to climate change and reduce potential interdependencies and cumulative climate change risks. The implementation of adaptation measures to address climate change risks provides opportunities to improve the resilience of infrastructure within the region.

The Little Hartley to Lithgow Upgrade is predicted to result in around 0.001 Mt CO_2e per year during operation. Combined with the Blackheath to Little Hartley Upgrade and the project, this would result in a combined 0.036 Mt CO_2e under the ventilation outlet option, and 0.015 Mt CO_2e under the portal emissions option. These are equivalent to 0.027 and 0.011 per cent of total NSW annual emissions in 2020 for the ventilation outlet and portal emissions options respectively.

24.6 Environmental mitigation measures

Mitigation measures to avoid, minimise or manage potential cumulative impacts as a result of the project are outlined in Table 24-8. A full list of performance outcomes and environmental mitigation measures for the project is provided in Appendix R (Compilation of environmental mitigation measures).

Table 24-8 Environmental mitigation measures – cumulative impacts

ID	Mitigation measure	Timing
CI1	Opportunities to minimise and manage cumulative impacts across the Great Western Highway Upgrade Program will be identified in consultation with the other projects in the Upgrade Program, and implemented where reasonable and feasible. Key focus areas for the minimisation and management of potential cumulative impacts will include: • construction planning and staging, including coordination of construction activities and provision of respite periods to manage construction fatigue • coordination of stakeholder notification and engagement requirements and activities across the Upgrade Program to manage consultation fatigue • construction phase amenity, particularly in relation to traffic, dust, noise and vibration • avoidance and minimisation of impacts on biodiversity, Aboriginal heritage and non-Aboriginal heritage • coordination of waste and resource management, including spoil/ cut-and-fill balances, surface water management and water supply requirements, recycling and sustainability initiatives.	Design