Great Western Highway Upgrade Program – Little Hartley to Lithgow (West Section)

Review of Environmental Factors

Transport for NSW | November 2021

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Prepared by Jacobs and Arcadis Joint Venture and Transport for NSW

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Executive summary

The proposal

Transport for NSW (Transport) proposes to upgrade the Great Western Highway between Little Hartley and Lithgow, NSW (the proposal), located immediately to the west of the Blue Mountains within the Lithgow City local government area. The upgrade will reduce congestion, deliver safer, more efficient and reliable journeys for those travelling in, around and through the Blue Mountains, and better connect communities in the Central West.

Key features of the proposal include:

- Upgrade of about 14 kilometres of the Great Western Highway between Little Hartley and Lithgow to a four lane divided highway with two lanes in each direction
- Provision of service roads
- Provision of two rest areas, one eastbound and one westbound
- Provision of five new bridges
- Upgrade of the existing bridge over River Lett.

The proposal has been designed in four sections to allow flexibility in construction staging and delivery and includes:

- Little Hartley to River Lett Hill
- Coxs River Road
- River Lett Hill to Forty Bends
- Forty Bends to Lithgow.

Subject to planning approval, construction of the proposal is planned to commence in 2022 and the current program would take about three years to complete.

Need for the proposal

The Great Western Highway is the main road corridor between Central West NSW and the Sydney road network, and the major arterial road through the proposal area. The existing Great Western Highway between Little Hartley and Lithgow is mostly a two-way undivided carriageway with one lane in each direction. There are limited overtaking lanes or auxiliary lanes to help drivers overtake and negotiate steep grades.

The Great Western Highway services local, tourist, freight and general traffic, with varying traffic volumes from about 12,000 vehicles near Little Hartley and about 11,000 vehicles per day near Lithgow. A growth rate of about 0.4 per cent for light vehicles and 1.3 percent for heavy vehicles per annum is expected on the Great Western Highway at the proposal location. In particular, there is a relatively high proportion of heavy vehicles (between 12 and 24 per cent), reflective of the 18,000 tonnes of freight transported daily between the Central West and Sydney.

Without the proposal, travel times and intersection level of service would deteriorate to unacceptable levels. The proposed upgrade would improve network performance, safety, and resilience on the highway between Little Hartley and Lithgow, and as a result, drive economic development and productivity particularly for the Central West. The proposal is also intended to either maintain or improve the urban and rural amenity for townships along the route, which is constrained by the current performance of the Great Western Highway.

The proposal would increase the capacity of the Great Western Highway between Little Hartley and Lithgow, reduce congestion and improve intersection performance. Increasing the number of lanes on the

highway would allow traffic to flow smoothly and reduce travel time for motorists. This would lead to reduced travel time for motorists travelling along Great Western Highway. When considered with other upgrades to the Great Western Highway planned between Katoomba and Lithgow, it is expected that motorists would experience a reduction in travel time of up to 10 minutes.

Proposal objectives

The proposal primary objectives are:

- Improve travel time between Katoomba and Lithgow
- Improve road safety for all road users
- Improve road freight efficiency
- Support economic development in the Central West and Orana.

The secondary proposal objectives are:

- Provide landscape outcomes which complement the surrounding environment
- Minimise the social, environmental and heritage impact of the proposal
- Maximise the ability to manage incidents
- Minimise disruption to traffic during construction
- Avoid/minimise work, health and safety risk during construction and operation
- Provide a value for money solution.

Options considered

The NSW Government first announced an upgrade from Mount Victoria to Lithgow in May 2008. Four corridors were identified within the initial study area, along with the Newnes Plateau alternative corridor. The Newnes Plateau route was investigated and found not to be viable as the Department of Defence required the necessary land at Marangaroo. Routes to the north and south of the Department of Defence land were considered, but found not to be viable due to increased road length, steep grades, and travel time impacts. In addition, the Newnes Plateau option would not offer improved connectivity to Jenolan Caves Road and Oberon, from which a significant amount of tourism traffic is generated, as well as timber and quarry-related freight.

The preferred option corridor was selected as it would avoid potential environmental, social, and topographical constraints. The preferred option route would also pose the least issues from a constructability standpoint and provide the fastest travel times.

Statutory and planning framework

As the proposal is for a road and road infrastructure facilities and is to be carried out on behalf of Transport, it can therefore be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from Lithgow City Council is not required.

Transport is the determining authority for the proposal. This Review of Environmental Factors (REF) satisfies Transport's requirements under section 5.5 of the *Environmental Planning and Assessment Act 1979* to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity". The REF also fulfils the requirements of the strategic assessment approval granted by the Federal Government under the *Environment Protection and Biodiversity Conservation Act 1999* in September 2015, with respect to the impacts of Transport's road activities on nationally listed threatened species, ecological communities and migratory species.

A Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the Biodiversity Assessment Method (BAM) (2020), as required by *Biodiversity Conservation Act 2016*. The assessment found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. As the proposal would require the removal of native vegetation and potential fauna habitat from the subject land, Transport is required to offset these impacts on biodiversity.

The *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) applies to this proposal. Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. A portion of the proposal is on land currently reserved as national park. Transport has commenced a process to revoke a portion of the Hartley Historic Village to keep the alignment away from the village to avoid impacts to heritage buildings. If the revocation is passed by Parliament, Transport would be able to utilise clause 94 of ISEPP and the proposal would be permissible without consent.

The proposal is located within the boundary of the Sydney Drinking Water Catchment. Consequently, the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (SEPP) is applicable to the proposal. Clause 9 of the SEPP states that any development or activity within this catchment should incorporate the Sydney Catchment Authority's current recommended practices and performance standards that relate to the protection of water quality. Clause 12 of the SEPP states that: 'A public authority must, before it carries out any activity to which Part 5 of the Act applies, consider whether the activity would have a neutral or beneficial effect on water quality.' Water quality considerations and a qualitative Neutral or Beneficial Effect (NorBE) water quality assessment have been included as part of this REF.

The following permits and licenses as relevant would be obtained before commencing the proposal:

- Aboriginal Heritage Impact Permit(s) under the *National Parks and Wildlife Act 1974*
- Road Occupancy Licence/ Road Occupancy Permit under the *Roads Act 1993*
- Environment Protection Licence under the Protection of Environment Operations Act 1997
- Licenses/ leases under the Crown Land Management Act 2016
- A Water Supply Works approval under the *Water Management Act 2000*
- Permit(s) under the Part 7 of the *Fisheries Management Act 1994*
- Section 60, Section 140 and Section 139(4) permits under the *Heritage Act 1977.*

Community and stakeholder consultation

Transport has consulted with the community, and relevant agencies and stakeholders throughout the proposal planning and design process, which began in 2008. Transport has carried out a number of community consultation activities to increase public awareness of the proposal and seek community input and feedback. A community consultation and stakeholder engagement plan (communications plan) was developed and implemented to guide consultation activities.

The community consultation activities have included:

- Public exhibition of the Mount Victoria to Lithgow Background and Proposed Project Development Report (RTA, 2008) in June 2008
- Public exhibition of the Study Area Investigation and Corridor Identification Report (RTA, 2008) and the Strategic Evaluation of the Newnes Plateau Corridor Report (RTA, 2008) in November 2008 for community submission
- Public exhibition of the four modified corridors in the Submissions Report – corridors in which routes may be feasible (RTA, 2008) released in April 2009
- Public exhibition of the Route Options Report (RTA, 2009) and associated working papers in October 2009 for community submissions
- Public exhibition of the Preferred Route Report (RTA, 2010) in May 2010 for community submission

- Public exhibition of the strategic corridor for the Great Western Highway Upgrade Program between Katoomba and Lithgow in November 2019 for community submission
- Targeted consultation undertaken throughout 2021 with communities along the proposal alignment including the Hartley District Progress Association.

The community consultation has been accomplished through a proposal website, community meetings and displays, community newsletters, direct mail and email notifications, media releases and advertisements issued by Transport.

Transport has consulted with the Aboriginal community in accordance with the Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) and in accordance with Department of Planning, Industry and Environment (formerly DECCW) consultation guidelines.

Transport has consulted with government authorities and agencies including Lithgow City Council, National Parks and Wildlife Services, and State Emergency Services (SES) throughout the development of the proposal in accordance with the *State Environmental Planning Policy (Infrastructure) (ISEPP) 2007* framework. This has included regular meetings with key proposal stakeholders about the design and issues that may have arisen during proposal development. Stakeholders were also invited to participate in workshops across the development of the proposal.

Further information on consultation undertaken as part of the broader Great Western Highway Upgrade Program is available at ***nswroads.work/gwhd***

Transport will continue to work closely with the community and relevant stakeholders through all stages of the proposal.

Environmental impacts

Transport engaged the Jacobs/Arcadis Joint Venture to manage the environmental assessment process for the REF. A number of detailed technical investigations were completed to assess the potential impacts of the proposal and to identify safeguards and management measures to mitigate these impacts.

An overview of the key environmental impacts of the proposal is provided below. A summary of all the potential environmental impacts considered for the proposal are identified in Section 6 of this REF and supported by relevant technical working papers in the REF appendices.

Biodiversity

A Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the Biodiversity Assessment Method (BAM) (2020), as required by *Biodiversity Conservation Act 2016 (BC Act)*. The land in which biodiversity values have been assessed by this BDAR is known as the subject land.

The BAM credit calculator identified:

- Eighteen candidate threatened flora species credit species associated with the Plant Community Types (PCT) identified in the subject land. Of these, nine threatened flora species are considered to have the potential to occur within the subject land and have therefore been retained as candidate species for survey.
- Thirty-eight candidate threatened fauna ecosystem credit species and 17 candidate threatened fauna species credit species associated with the PCTs identified in the subject land.

Targeted surveys for threatened flora species will be undertaken in spring/summer 2021 to meet the recommended survey periods for the target flora species, to maximise the chance of detection. The survey results will be included in the Response to Submissions report.

Review of records within 10 kilometres of the subject land, paired with the presence of potential habitat, identified one additional threatened fauna species to be included in the assessment. Ten threatened fauna

species listed under the EPBC Act and/or BC Act were recorded in the subject land or immediately adjacent during surveys carried out for the proposal.

Additional targeted surveys for Purple Copper Butterfly and Booroolong Frog, and surveys to detect breeding of Gang-gang Cockatoo, will be carried out in spring 2021, and findings will be included in the Response to Submissions report.

Direct impacts of the proposal on biodiversity include:

- Removal of 75.19 hectares of native PCTs, of which
  - 17.59 hectares is consistent with Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as Endangered under the BC Act and
  - 5.82 hectares is consistent with White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as Critically Endangered under the BC Act
  - 3.6 hectares is consistent with White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as Critically Endangered under the EPBC Act
- Removal of 215.32 hectares of non-PCT vegetation comprising native and exotic plantings
- Removal of 75.19 hectares of potential habitat for threatened fauna species
- Mortality/injury of terrestrial fauna species, with potential mortality/injury of threatened fauna species. This should be minimised through pre-clearing procedures during construction and installation of fauna fencing during operation.

Biodiversity management measures would be implemented in accordance with Transport's Biodiversity Guidelines (RTA, 2011) to reduce any impacts due to the proposal.

Biodiversity offsets required for the proposal under the BC Act will be confirmed upon completion of remaining targeted spring/summer surveys.

The proposed culvert extension and scour protection would potentially impact in-stream habitat of several creeks mapped as Key Fish Habitat. Under the Policy and guidelines for fish habitat conservation and management (NSW DPI, 2013) this would require offsetting. Final offset calculations will be carried out following further design development.

Traffic and transport

Traffic modelling of future year periods indicates that the proposed upgrade would provide a safer, reliable and more efficient road corridor on the Great Western Highway between Little Hartley and Lithgow. The proposal would provide travel time savings of about 10 minutes between Katoomba and Lithgow from about 40 minutes without the proposal to about 29 minutes with the proposal. The proposal would also provide significant benefits with respect to increased safety and road network performance. Analysis indicates that the proposal is predicted to reduce the total crash rate on the highway between Little Hartley and Lithgow by 57 per cent.

Daily traffic volumes between Little Hartley and Lithgow are predicted to grow by 0.4 per cent per annum for light vehicles and about 1.3 per cent per annum for heavy vehicles between now and 2036. This would mean average weekday traffic volumes would grow from 11,100 vehicles per day in 2021 to 11,400 vehicles per day in 2026. In 2036, traffic volumes between Little Hartley and Lithgow are predicted to increase to an average 12,100 vehicles per day, equivalent to about 109 per cent of current (2021) traffic volumes. Traffic volume data between Little Hartley and River Lett Hill shows that heavy vehicles represent about 20 per cent of total traffic in 2021, or up to 2,380 heavy vehicles per day on an average weekday. The proportion of heavy vehicles is forecast to increase to 22 per cent in 2036, or up to 2,706 heavy vehicles per day on an average weekday.

Travel times and intersections level of service would also deteriorate to unacceptable levels without the proposal. By 2026, the level of service on the Great Western Highway near Little Hartley is predicted to reach operational capacity (level of service E). Future traffic growth would further increase delays at intersections on the Great Western Highway. Five intersections with the Great Western Highway are predicted to operate with an unsatisfactory level of service E or F during peak periods. This includes the Great Western Highway intersections with Coxs River Road/Ambermere Drive, Mid Hartley Road, Carroll Drive, Kelly Street, and Jenolan Caves Road/Blackmans Creek Road. With the proposal, the majority of intersections are predicted to operate at a level of service A during the AM peak and PM peak periods.

During the construction periods, there is potential for additional traffic to be generated. Construction traffic is expected to increase volumes between Little Hartley and Lithgow by between two per cent to eight per cent, depending on the package of works and locations. The increase in traffic volumes would be minor and would not impact the operational performance of the Great Western Highway. The construction staging design maintains one travel lane in each direction. However, there will be some instances during off peak times that lane closures or contraflow arrangements are required to complete works such as pavement resurfacing on the main carriageway. Throughout the construction period, haulage or traffic movements would be required to travel along the existing Great Western Highway and the connecting local road network. Traffic management plans and construction staging would be progressively developed and refined during construction to facilitate the safe and efficient movement of traffic through and around the proposal area and to and from construction locations and ancillary facilities.

Noise and vibration

Construction

Receivers in the study area are typically sparsely distributed rural residential properties with a small number of commercial properties at various points along the alignment. Receivers are relatively close to the alignment along the length of the proposal although they are generally few in number. The highest impacts are expected to occur when noise intensive equipment is being used, such as rockbreakers, concrete saws, chainsaws or chippers. These items of equipment would, however, be required occasionally and would be unlikely to be in use for long periods of time. Periodic blasting would be required for construction at River Lett Hill however, these blasts would be of short duration and undertaken during standard working hours (see below).

Impacts during the daytime are predicted to be ‘highly intrusive’ or ‘moderately intrusive’ within 10 of the 13 noise catchment areas during some of the noisier scenarios such as site establishment, earthworks, utility works and road works. The worst-case noise levels are predicted to be around 85 to 90 dBA at the nearest receivers when noise intensive equipment is being used close to receivers. When noise intensive equipment is not used the noise levels are expected to be substantially lower, with worst-case levels of around 70 dBA predicted at the closest receivers.

Residential receivers that are subject to noise levels of 75 dBA or greater are considered highly noise affected. Up to 12 receivers in NCA12 may be highly noise affected, up to six receivers in NCA12 and NCA13, and between one and four receivers in NCA01, NCA03, NCA04, NCA06, NCA07, NCA08, NCA09 and NCA10. The highest noise levels are conservative and would likely be apparent for relatively short periods.

Only certain work would be completed during the night-time, including transportation of bridge girders, asphalting and road tie-in work where connections to the existing road network are necessary. Worst-case noise levels may reach ‘highly intrusive’ levels in 9 of the 13 NCAs, however only a relatively small number of receivers are predicted to be impacted. Sleep disturbance screening criterion is also likely to be exceeded at these residential receivers when night work occurs. Where possible, noisy work would be completed as early as possible in each night work shift. Appropriate respite would also be provided to affected receivers in accordance with the Transport Construction Noise and Vibration Guideline (Roads and Maritime, 2016) (CNVG). Any work outside of standard construction hours would also be undertaken in accordance with the Interim Construction Noise Guideline (DECC, 2009) (ICNG).

Occupants of affected buildings located within the human comfort minimum working distances may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby. Mitigation measures will be considered for receivers located near to the work within the minimum working distances for cosmetic damage.

A Construction Noise and Vibration Management Plan (CNVMP) would be prepared prior to work commencing which would detail the approach to providing noise and vibration mitigation during construction. The CNVG contains a number of 'standard mitigation measures' for mitigating and managing construction noise and vibration impacts. The measures would be applied to construction of the proposal, where feasible and reasonable. Where noise impacts remain after the use of 'standard mitigation measures', the CNVG requires the use of 'additional mitigation measures' where feasible and reasonable. The 'additional mitigation measures' are determined on the basis of the exceedance of the appropriate management levels and range from notifications, phone calls, individual briefings, respite periods, to in some cases alternative accommodation.

Blasting

Construction of the deep cut through River Lett Hill will require a significant amount of blasting to remove the large volume of hard rock. A blasting specialist has been engaged and would further inform the blasting methodology, including times, road closures and diversions, as detailed design progresses. Blasting would only occur during standard construction hours and each blast would be of a short duration.

Twenty-seven buildings are within 170 metres of the proposed blasting location and have the potential to be impacted by structural damage and human comfort associated with blasting. Thirteen heritage items or areas are within 340 metres of the proposed blasting location. A blast management plan will be prepared prior to the start of blasting and include trial blasting plans, monitoring and notification requirements and mitigation measures. Building condition surveys should be completed before and after the work where buildings or structures are within the minimum working distances and considered likely to exceed the cosmetic damage criteria during the use of blasting activities.

Operation

The proposal is predicted to alter operational road traffic noise levels for many receivers in the study area due to the revised alignment of the Great Western Highway. Noise levels are predicted to reduce in locations where the alignment is proposed to be moved away from receivers, however, the alignment is closer in some locations and noise levels are predicted to increase in these areas.

Exceedances of the relevant criteria are predicted at the nearest residential receivers. These exceedances are generally due to a mixture of increasing noise levels, exceedances of the cumulative limit criteria and acute road traffic noise levels.

For these areas, forty-seven sensitive receivers are considered eligible for consideration of additional noise mitigation. At property treatment is likely to be the most appropriate form of mitigation however, the final noise mitigation strategy would be determined during detailed design.

Aboriginal heritage

An Aboriginal Cultural Heritage Assessment Report (ACHAR) was prepared to provide an assessment of Aboriginal cultural values potentially impacted by the proposal.

Test excavations carried out for the proposal at 16 locations found repeated evidence of Aboriginal stone artefacts in the areas of River Lett Hill and Hartley, camping activity along River Lett at Jenolan Caves Road, and artefact scatters along tributaries associated with Whites Creek, Butlers Creek and Boxes Creek. Evidence of activities along minor watercourses and occupation at the western margin of the construction footprint were also confirmed.

Consultation with Aboriginal community members has confirmed that the entire proposal area is significant to Aboriginal people. A number of specific sites near to the proposal have been identified as having high cultural significance, with several falling within or partly within the proposal area.

Based on the results of the ACHAR and in consultation with registered Aboriginal parties (RAPs) it is considered that there are 20 Aboriginal sites within the construction footprint that would be directly impacted by the project. These direct impacts range from negligible to major. In addition, nine Aboriginal sites are located within the study area, but outside of the construction footprint, including two sites that will be subject to minor indirect impacts associated with vibration and settlement, and one site subject to moderate indirect impacts also associated with vibration and settlement.

Management recommendations have been developed in consultation with RAPs to avoid impacts where possible and where impacts are unavoidable, to effectively mitigate them. Management of Aboriginal sites would include protection and salvage measures, development of a curation policy for salvaged Aboriginal objects and procedures for unexpected discovery of Aboriginal objects. Site specific management measures would be described in an Aboriginal Heritage Management Plan (AHMP) that would form part of the construction environmental management plan (CEMP) that would be developed for the project.

Non-Aboriginal heritage

Construction activities associated with the proposal have the potential to directly and indirectly impact on heritage items within the study area including demolition/destruction of items, vibration impacts, and works within the heritage curtilage.

A review of previous heritage studies, aerial imagery, and a search of relevant heritage registers identified 36 listed heritage items and 14 locations of heritage potential (including archaeological potential) within the study area. Following the desktop assessment, 25 listed heritage items and six areas of heritage potential situated within or adjacent to the construction footprint were further assessed. One potential item, the causeway of Billesdene Grange has been considered as part of the listed heritage item.

The proposal would have a major impact to one listed heritage item, Lyndoch Orchard (LEP I019) that would experience major direct (physical) and indirect (visual) impacts.

The proposal would also have major impacts on three unlisted heritage items. The bridge over the River Lett (located on the Old Great Western Highway, over the River Lett) would experience major direct (physical) and indirect (visual and vibration) impacts. Archaeological potential on an unidentified Lot would experience major direct (physical) and archaeological impacts. The historic bullock track and creek crossing would experience major direct (physical) and indirect (visual) impacts.

The proposal would have a moderate impact to three heritage listed items. Billesdene Grange (LEP I023) would experience direct (physical), indirect (visual) and archaeological impacts. The state heritage listed Hartley Historic Village (SHR00992 and LEP I020) would experience direct (physical), indirect (visual and vibration) and archaeological impacts. The state heritage listed Fernhill (SHR00225 and LEP I043) would experience direct (physical) and indirect (visual and vibration) impacts. There would also be a moderate impact to one unlisted heritage item, Mitchell's Road.

The proposal would also have a negligible or minor impact to 23 heritage or potential heritage items.

Management and mitigation measures would be implemented to address these impacts based on the impact type and level, including but not limited to archival recording, archaeological test excavation, landscaping and sympathetic plantings, monitoring of ground disturbance works and engagement of subject matter experts (such as heritage structural engineer and an arborist) where appropriate.

Soils and surface water

Construction of the proposal will include earthworks along the proposed alignment, access tracks and site compounds. Earthworks have the potential to impact soil and surface water quality through erosion and sedimentation. Earthworks also have the potential to expose acid sulfate rock.

A Neutral or Beneficial Effect on water quality assessment has been conducted for the proposal. The assessment indicates that with the proposed mitigation measures, the proposal will have a beneficial effect on water quality with reduced pollutant loads compared to existing conditions.

Hydrology and flooding

Potential flooding impacts associated with the proposal would be confined to River Lett (including Boxes Creek) and Rosedale Creek. The results of the flooding analysis showed that most of the predicted impacts would be localised to waterways and pre-existing flooded areas. Flood level increases would be within the current industry accepted tolerances for the land uses surrounding the proposal.

Landscape character and visual impact

During construction, there would be temporary landscape character and visual impacts. These impacts would include views of large earthmoving and construction equipment, construction activities, stored materials and stockpiles, activities in and around ancillary facilities, vegetation clearing and excavation.

Construction, particularly out of hours work, would require lighting at ancillary facilities and work areas. These locations could result in light spill impact on adjoining properties. This may result in a temporary visual impact at night, particularly near residences. Safeguards and management measures have been identified for temporary construction works to manage landscape character and visual impacts. Impacts from lighting are anticipated to be minor as a majority of the works will be conducted during standard hours.

During operation, the proposal would result in a moderate to high impact on landscape character due to the intensification of road infrastructure in a sensitive rural landscape. There would be varied visual impacts as a result of the operation of the proposal. 27 viewpoints have been assessed that represent a range of directions, distances and sensitive receivers within the proposal area. 13 of the viewpoints are expected to have a visual impact considered greater than moderate with four viewpoints experiencing high visual impacts.

The landscape character and visual impacts associated with the proposal would generally be consistent with other similar projects, either completed or under construction along the Great Western Highway. A number of urban design principles have been developed for the proposal which take into account urban design and visual character of the surrounding area. These urban design principles would be incorporated into the detailed design to integrate the project within the surrounding rural landscape to minimise the visual impact of the proposal.

Socio-economic

During construction, potential impacts on communities, businesses, visitors and motorists in the study area would mainly be associated with disruptions for motorists and road users during construction, temporary changes to local amenity, noise and light spill during night works, and clearing of vegetation from bushland areas, rural properties and the road reserve.

Once operational, the proposal would have long term positive impacts on access and connectivity for local and regional communities, business, and industry. It would support faster, more reliable and safer regional connections and links to and from destinations within the study area and surrounding Blue Mountains, Lithgow, Central West, Orana and greater Sydney. Removal of through traffic, including heavy vehicles, within the Little Hartley village would support safer access and enhanced amenity for residents and businesses within the village.

Changes to the alignment of the highway, new access roads and widening of the existing highway will intensify road infrastructure at some locations and move the alignment closer to residential users. Traffic noise from the proposal has potential to impact on amenity for residents, including during the evening and night-time given the relatively low existing noise environment. The proposal would improve conditions for pedestrians and cyclists by providing a range of improvements to the existing active transport network and facilities as detailed in Section 6.2.3. Design development has considered the future development of shared

paths in the vicinity of the proposal. The alignment and structure of the future shared paths would be developed and finalised during future design development and in consultation with Lithgow City Council and other relevant stakeholders.

Property and land use

The proposal would require the partial or full acquisition of private property for the widening and realignment of the highway, local road changes and new access roads. Full acquisition of four lots owned by the National Parks and Wildlife Service, and one lot vested in Lithgow City Council would also be required. Temporary leases would be required over some properties for temporary construction facilities such as site compounds and stockpile sites.

Short term property impacts would potentially occur during construction as a result of activities such as land use changes and changes to property access, as well as leasing land for ancillary facilities and temporary sediment basins. Access to properties and businesses would be maintained for the full duration of construction. Alternative access arrangements would be provided where the proposal would impact access to residential and commercial properties.

Nine lots would be partially leased for the duration of construction. Consultation with landowners would be held in relation to leasing these properties (see Section 5 Consultation).

Contamination

A number of potential contamination sources (Areas of Environmental Interest) have been identified within the study area including groundwater contamination from underground fuel storage associated with a former service station, groundwater in vicinity of Hartley Cemetery, soil contamination from disturbance of waste dumping/burial, sheep/cattle dips, septic tanks and chemical or fuel use and ground storage areas. One contaminated site within the study area is listed on the EPA Contaminated Sites Record of Notices - a Shell Coles Express Service Station on the Great Western Highway in South Bowenfels. Further testing and investigation would be undertaken during detailed design to determine the likelihood and extent of any potential contamination on the proposal.

Justification and conclusion

The proposal to upgrade the Great Western Highway between Little Hartley and Lithgow forms part of the Great Western Highway Upgrade Program, which aims to reduce congestion and deliver safer, more efficient and reliable journeys for those travelling in, around and through the Blue Mountains, while also better connecting communities in the Central West.

Traffic modelling has indicated that the proposal will improve travel times along the Great Western Highway and is predicted to reduce the total crash rate by 57 per cent between Little Hartley and Lithgow. Reduction of through traffic, including heavy vehicles, within the Little Hartley village would support safer access and enhanced amenity for residents and businesses within the village.

The proposal would have some negative social impacts during the construction phase of the proposal, however once operational, there would be long term positive impacts on access and connectivity for local and regional communities, business, and industry. The proposal represents a cost-efficient investment in public infrastructure that would maximise the long-term social and economic benefits, while minimising the long-term negative impacts on communities and the environment. By improving local and regional transport facilities, the proposal would better enable movement of people, goods and services.

Measures to avoid, minimise or offset potential environmental impacts have been considered throughout the options development process for the proposal. An important consideration has been to minimise potential impacts on biodiversity and particularly the removal of native vegetation.

The proposal as described in the REF best meets the proposal objectives but would still result in some impacts such as construction noise and vibration, changes to access and traffic delays during construction, land acquisition and property adjustment, visual and landscape changes, loss of native vegetation, Aboriginal and non-Aboriginal heritage impacts. Safeguards and management measures as detailed in this REF would minimise these expected impacts. The proposal would cater for future population and traffic growth in the region. The proposal would benefit future generations by improving safety and helping to address the future increases in traffic volumes and traffic congestion associated with movement of traffic along the Great Western Highway. On balance the proposal is considered justified.

Display of the review of environmental factors

This REF is on display for comment between 22 November 2021 and 21 December 2021. You can access the documents in the following ways:

Internet

The documents are available as pdf files on the Transport website at **nswroads.work/gwhwestconsult**.

Printed copies

The documents can be viewed at the following locations:

Lithgow City Council Administration Centre

180 Mort Street, Lithgow NSW 2790

Hours of operation:

- Monday to Friday 8.30am–4.15pm

Lithgow Library Learning Centre

157 Main Street, Lithgow NSW 2790

Hours of operation:

- Monday to Friday 9am–6pm
- Saturday 9am–12pm

Copies by request

Printed and electronic copies are available by contacting the project team at 1800 953 777 or gwhd@transport.nsw.gov.au.

Public displays

The project team will be delivering a combination of online and face-to-face consultation sessions:

General online sessions

- Tuesday 30 November 6.30pm–8.00pm
- Saturday 11 December 12.30pm–2.00pm

Targeted online sessions

- Coxs River Road/Baaners Lane - Thursday 2 December 6.30pm–8.00pm
- Jenolan Caves Road/River Lett Hill – Thursday 9 December 6.30pm–8.00pm

Face-to-face sessions

- Saturday 4 December 1.00pm–3.15pm – Lithgow Civic Ballroom – Tony Luchetti Showgrounds, George Coates Avenue, Lithgow (book for a 45 minute session)
- Tuesday 7 December 5.30pm–7.45pm – Hartley Community Hall, Corner Great Western Highway and Mid Hartley Road, Hartley (book for a 45 minute session)

Register for a consultation session at **nswroads.work/gwhwestconsult.**

Bookings are essential for face-to-face sessions, which will be held pending COVID restrictions or the occurrence of local cases at the time of the events. QR code sign in and proof of double vaccination status will be required.

Contact the project team on 1800 953 777 or ***gwhd@transport.nsw.gov.au*** to book a personal phone consultation.

How can I make a submission?

To make a submission about this proposal, use the online submission form at **nswroads.work/gwhwestconsult**, email **gwhd@transport.nsw.gov.au** or send your written comments to

Great Western Highway Upgrade Program
Little Hartley to Lithgow REF and Concept Design
PO Box 334
Parkes NSW 2800

Submissions must be received or postmarked by midnight, Tuesday 21 December 2021.

Transport for NSW will collect information from your submission (including your name, contact details and comment) to use for the purpose of public consultation, including on the Great Western Highway Upgrade Program - Little Hartley to Lithgow ("the proposal"), and to contact you for feedback on our consultation process more generally.

Transport may release reports which outline how community feedback on the proposal has been considered but will not disclose any personal information provided as part of your submission in those reports. Providing personal information is voluntary, however we rely on your participation to ensure the accuracy and reliability of the information obtained and we may not be able to communicate with you directly if you do not provide your personal information. Your personal information will not be disclosed without your consent, except where required by law. Your personal information will be held and managed by Transport for NSW in accordance with the *Privacy and Personal Information Protection Act 1998 (NSW)*. For further information about how we manage your personal information, please see our Privacy Page at ***www.transport.nsw.gov.au/about-us/transport-privacy*** or contact us at ***privacy@transport.nsw.gov.au***

What happens next?

Transport will collate and consider the submissions received during public display of the REF.

After this consideration, Transport will determine whether or not the proposal should proceed as proposed and will inform the community and stakeholders of this decision.

If the proposal is determined to proceed, Transport will continue to consult with the community and stakeholders prior to and during construction.

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1. Introduction

This section introduces the proposal and provides the context of the environmental assessment. In introducing the proposal, the objectives and proposal development history are detailed and the purpose of the report provided.

1.1 Proposal identification

Transport for NSW (Transport) proposes to upgrade the Great Western Highway between Little Hartley and Lithgow, NSW (the proposal), located about 96 kilometres west of the Sydney central business district within the Lithgow City local government area.

The Australian and NSW Governments are investing more than $4.5 billion towards upgrading the Great Western Highway between Katoomba and Lithgow. The proposal forms the 'West Section' of the Great Western Highway Upgrade Program.

The Great Western Highway is the main road corridor between Central West NSW and the Sydney road network. It services freight, tourist and general traffic, with varying traffic volumes from about 8,500 vehicles per day near Lithgow and up to 20,000 vehicles per day in the Blue Mountains. A growth rate of two per cent per annum is expected on the Great Western Highway at the proposal location. In particular, there is a relatively high proportion of heavy vehicles (between 12 and 24 per cent), reflective of the 18,000 tonnes of freight transported daily between the Central West and Sydney.

Without the proposed upgrade to the Great Western Highway, travel times and intersection level of service would deteriorate to unacceptable levels. The current performance of the Great Western Highway would constrain access between Sydney and proposed new freight infrastructure (and associated land use changes) in the Central West, including the Parkes National Logistics Hub and the Inland Rail Program.

The proposal forms part of the broader Greater Western Highway Upgrade Program that aims to reduce congestion and deliver safer, more efficient and reliable journeys for those travelling in, around and through the Blue Mountains, while also better connecting communities in the Central West. Provision of dual carriageway would provide travel time savings of about 10 minutes for light vehicles and for heavy vehicles between Katoomba and Lithgow, and would largely maintain those savings through to 2036 (for the modelled weekday).

Key features of the proposal would include:

- Upgrade of about 14 kilometres of the Great Western Highway between Little Hartley and Lithgow to a four lane divided highway
- Provision of service roads
- Provision of two rest areas, one eastbound and one westbound
- Provision of five new bridges
- Upgrade of the existing bridge over River Lett.

The proposal would provide improved facilities for the movement of freight between the Central West and Sydney while enhancing accessibility and improving road safety in the area.

The location of the proposal is shown in Figure 1-1 and an overview of the proposal is provided in Figure 1-2. Section 3 describes the proposal in more detail.

Figure 1-1 Location of the proposal

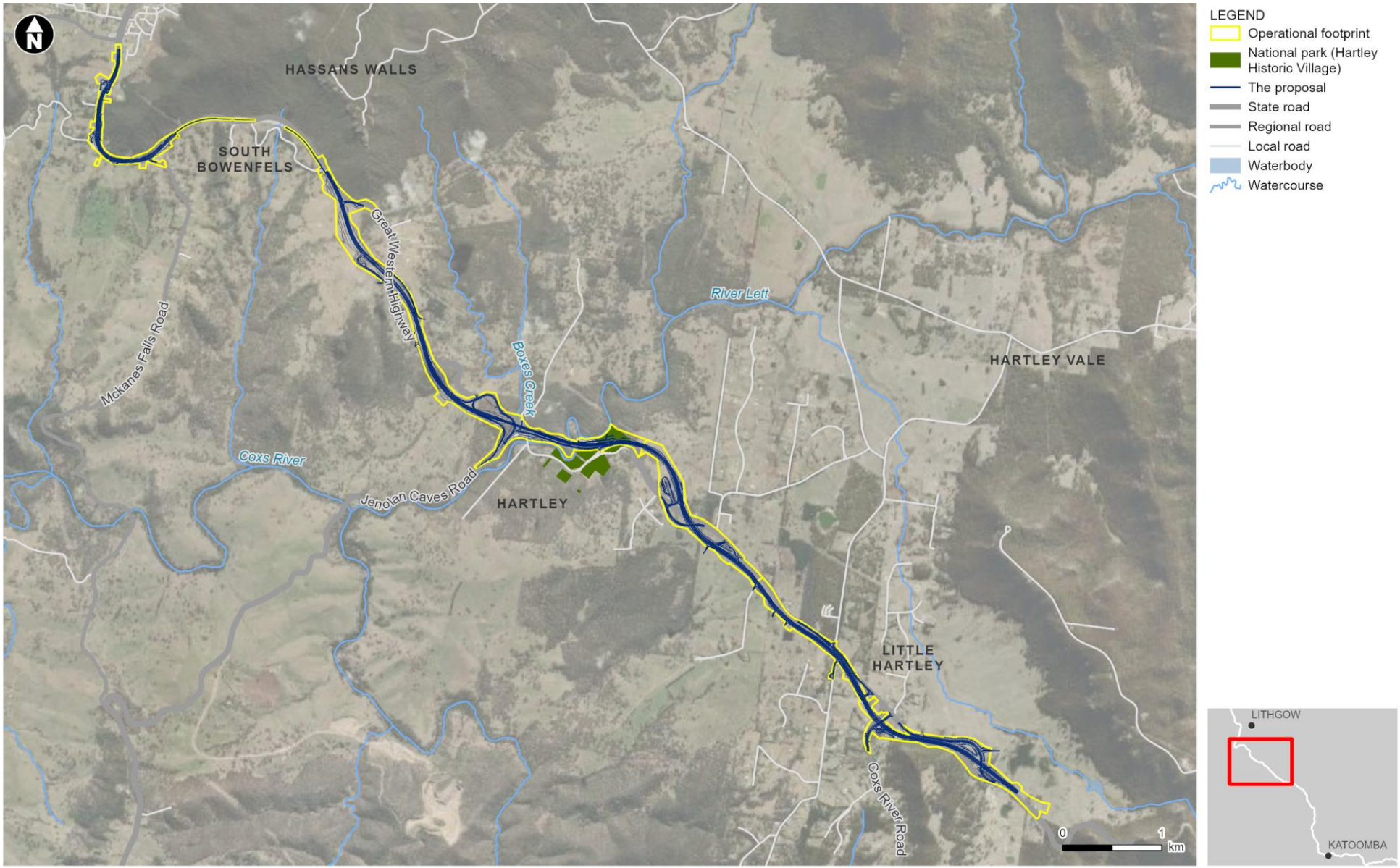


Figure 1-2 Overview of the proposal operational features

1.2 Purpose of the report

This review of environmental factors (REF) has been prepared by Jacobs/Arcadis Joint Venture on behalf of Transport. For the purposes of these works, Transport is the proponent and the determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in *Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Is an EIS required? guidelines) (DUAP, 1995/1996), *Roads and Related Facilities EIS Guideline (DUAP 1996)*, the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Refer to Section 4 Statutory planning and framework for more information on statutory considerations.

In doing so, the REF helps to fulfil the requirements of:

- Section 5.5 of the EP&A Act including that Transport examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity
- The strategic assessment approval granted by the Federal Government under the EPBC Act in September 2015, with respect to the impacts of Transport's road activities on nationally listed threatened species, ecological communities and migratory species.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in Section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of Agriculture, Water and the Environment for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

2. Need and options considered

This section describes the need for the proposal in terms of its strategic setting and operational need. It identifies the various options considered and the selection of the preferred option for the proposal.

2.1 Strategic need for the proposal

2.1.1 NSW State Infrastructure Strategy 2018-2038

The State Infrastructure Strategy 2018-2038 (the State Infrastructure Strategy) (Infrastructure NSW, 2018) sets the strategic vision for infrastructure across NSW over 20 years and combined with the Future Transport Strategy 2056 and the Regional Development Framework (NSW Government, 2018), brings together infrastructure investment and land-use planning for cities and regions within NSW.

The State Infrastructure Strategy outlines Infrastructure NSW's recommendations for priority transport infrastructure projects and initiatives for NSW to 2038, to ensure the transport system creates opportunities for people and businesses to access the services and support they need.

The State Infrastructure Strategy aligns with the benefits of the proposal, such as improving travel times and improving road safety within the proposal area. The Great Western Highway is identified as the main road freight corridor connecting Western NSW with Sydney and its ports. The Strategy identifies that the Great Western Highway suffers from constraints that limit freight movement, particularly for longer vehicles. The proposal is consistent with the Strategy as it would provide improved facilities for the movement of freight between Western NSW and Sydney.

The proposal would support key recommendations made for the transport sector as it would increase freight capacity and efficiency of the road network (Recommendations 41 and 42) to support the mass transit system while enhancing accessibility and improving road safety in the area (Recommendations 50 and 51).

2.1.2 Future Transport 2056

The NSW Future Transport Strategy 2056 (Transport for NSW, 2018) outlines a clear framework to address transport challenges in NSW over the next 40 years and is an update of the NSW Long Term Transport Master Plan released in 2012. It integrates planning for roads, freight and all other modes of transport and sets out initiatives, solutions and actions to meet NSW transport challenges.

Future Transport 2056 outlines six state-wide outcomes to guide investment, policy and reform and service provision. They provide a framework for planning and investment aimed at harnessing rapid change and innovation to support a modern, innovative transport network. The proposal directly aligns with the following state-wide outcomes:

- A strong economy – The transport system powers NSW's future $1.3 trillion economy and enables economic activity across the state. The proposal supports this outcome enabling growth in economic activity, including the movement of freight
- Safety and performance – Every customer enjoys safe travel across a high performing, efficient network. The proposal supports this outcome through the separation of carriageways and the implementation of contemporary design standards
- Sustainability – Making the best use of available resources and assets.

The proposal would also provide an opportunity to directly support the following regional transport customer outcomes:

- Customer Outcome 3 – The appropriate movement and place balance is established enabling people and goods to move efficiently through the network whilst ensuring local access and vibrant places – The movement and place framework is discussed further in Section 2.1.3.
- Customer Outcome 4 – Supporting centres with appropriate transport services and infrastructure – The proposal would support the access between Sydney and the Central West of NSW, including the various towns and urban centres along the alignment
- Customer Outcome 7 – A safe transport system for every customer with the aim for zero deaths or serious injuries on the network by 2056 – The proposal would improve safety via the separation of carriageways and the implementation of contemporary design standards.

2.1.3 Movement and place framework

Future Transport Strategy 2056 introduces the movement and place framework which aims to allocate road space in a way that improves the liveability of places.

The framework identifies the need to prioritise different customer groups, depending which street environment they are travelling. These environments are described in Figure 2-1.

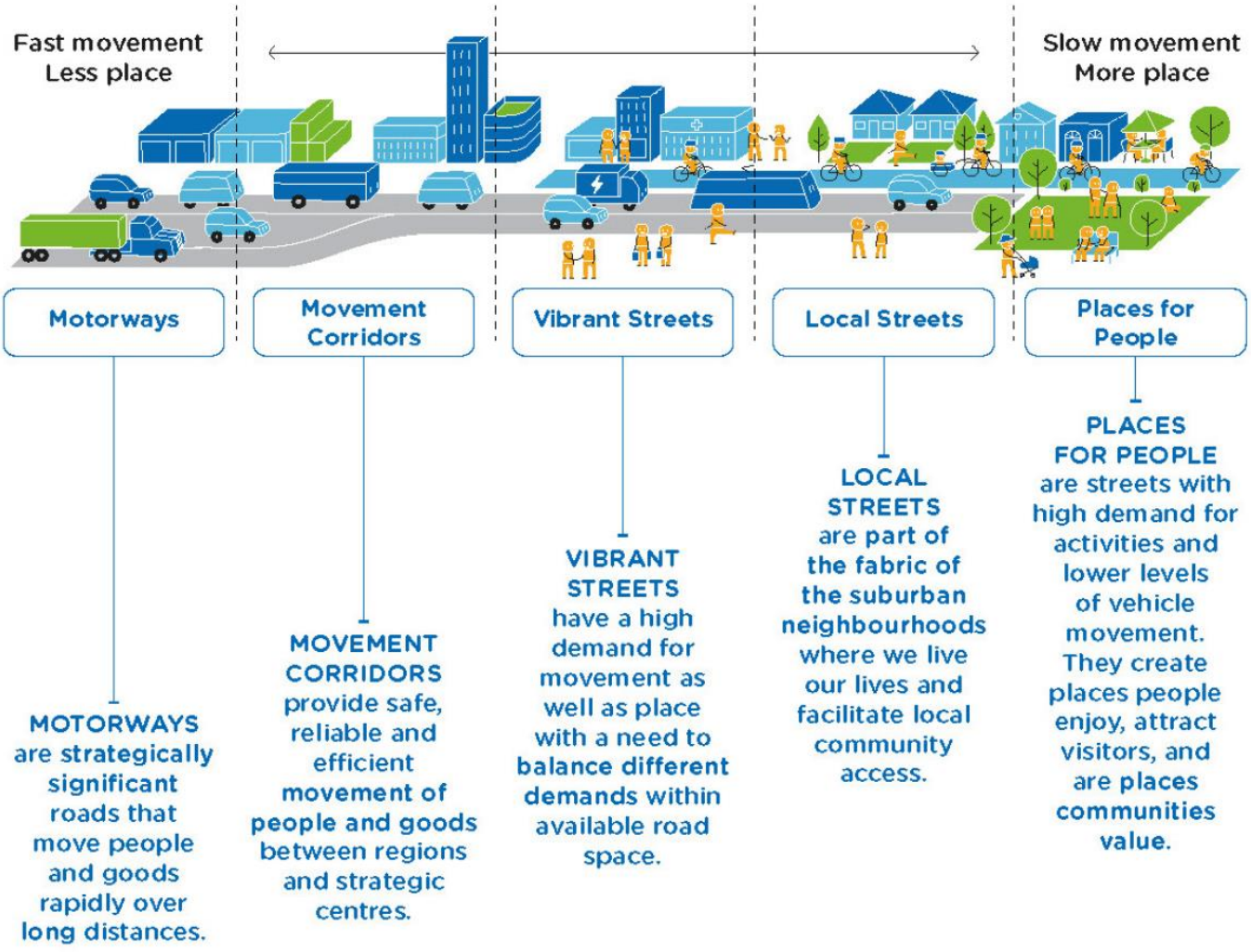


Figure 2-1 Movement and place framework

The proposal would provide an opportunity, through options selection and the design development process, to balance the movement function of the Great Western Highway with the place functions of the various towns and urban centres along the alignment.

2.1.4 Regional NSW Services and Infrastructure

The Regional NSW Services and Infrastructure Plan (Transport for NSW, 2018) supports Future Transport Strategy 2056 and is the NSW Government's blueprint for transport in regional NSW from now until 2056. The plan outlines the vision and customer outcomes that the government will use to go about its detailed transport planning in each region and also support its future decision making.

The Regional NSW Services and Infrastructure Plan aims to produce a modern multi-modal freight transport network and identify the need to lift freight productivity above previous results as a key objective. The identified vision for regional NSW is a safe, efficient and reliable network of transport services and infrastructure that recognises and reinforces the vital role of regional cities as hubs for services, employment and social interaction for their surrounding communities.

The regional customer outcomes outlined in the Regional NSW Services and Infrastructure Plan are the same as those identified in NSW Future Transport Strategy 2056, and as noted in Section 2.1.2 above, the proposal directly supports several of these customer outcomes.

The plan includes the following initiatives that are directly relevant to the proposal:

- 0 to 10 years for investigation – Great Dividing Range long term solution study
- 0 to 10 years for investigation – Great Dividing Range long term solution corridor preservation
- 20 years plus initiative – Delivery of Great Dividing Range long term solution – Delivery of solution to improve freight connectivity across the Great Dividing Range in order to connect inland areas to Sydney/Wollongong/Newcastle.

2.1.5 Road Safety Plan 2021

The Road Safety Plan 2021 (Transport for NSW, 2018) details the NSW Government's commitment to improving safety on NSW roads. It outlines how the NSW Government will work towards the State Priority Target of reducing fatalities by 30 per cent by 2021 (compared to average annual fatalities over 2008–2010). It also aligns the Towards Zero vision with Future Transport 2056, which aims to have a NSW transport network with zero trauma by 2056.

The proposal is consistent with the directions set out in Road Safety Plan 2021 because it would improve safety through the separation of carriageways and the implementation of contemporary design standards. The traffic analysis indicates that the proposal is predicted to reduce the total crash rate on the Great Western Highway by 57 per cent compared to the base case/'Do nothing' option.

2.1.6 Tourism and Transport Plan

The total number of visitors to regional NSW grew by 23 per cent from December 2010 to December 2017 or three per cent each year in compound annual growth terms. The Tourism and Transport Plan (Transport for NSW, 2018) (a companion document to Future Transport Strategy 2056) recognises the connection between transport and tourism and identifies the potential to support and enhance existing tourism as well as create new economic development opportunities.

The plan includes the following four customer outcomes:

- Customer Outcome 1: Enhancing the Visitor Experience

- Customer Outcome 2: Greater access to more of NSW
- Customer Outcome 3: Making transport the attraction
- Customer Outcome 4: A seamless experience.

By improving transport infrastructure on the main route to the Central West, the proposal aligns with Customer Outcome 2. There may also be opportunities to contribute to Customer Outcomes 1 and 3 as the proposal development process moves forward.

2.1.7 Central West and Orana Regional Plan 2036

The Central West and Orana Regional Plan 2036 (Department of Planning and Environment, 2017) provides an overarching framework to guide subsequent and more detailed land use plans, development proposals and infrastructure funding decisions for the region. The proposal is consistent with the following directions under Goal 3: Quality freight, transport and infrastructure networks:

- Direction 18: Improve freight connections to markets and global gateways
- Direction 19: Enhance road and rail freight links.

2.1.8 NSW Freight and Ports Strategy

The NSW Freight and Ports Strategy (NSW Government, 2013) targets specific challenges associated with the forecast doubling of the NSW freight task by 2031. It recognises that providing a network that minimises congestion will support economic growth and productivity and encourage regional development. In this context the strategy identifies the need to develop and maintain capacity for freight on the road network.

Objectives of the NSW Freight and Ports Strategy relevant to the proposal include:

- Delivery of a freight network that efficiently supports the projected growth of the NSW economy
- Balancing freight needs with those of the broader community and the environment.

Actions of the strategy and task actions relevant to the proposal include:

- Action 2B – Develop and maintain capacity for freight on the road network
  - Task 2B-2 Prioritise road infrastructure investments
- Action 3B – Manage congestion, noise and emission impacts of freight transport
  - Task 3B-1 Recognise costs of congestion.

The proposal is considered consistent with the objectives, actions and tasks referenced above. It would help address growth in freight demand and would enhance safety for all road users.

2.1.9 NSW Freight and Ports Plan 2018-2023

The NSW Freight and Ports Plan (NSW Government, 2018) is aligned with NSW Future Transport Strategy 2056 and has the aim of providing a network to move goods in an efficient, safe and environmentally sustainable manner, providing successful outcomes for communities and industry. One of the objectives of the plan is to ensure safe, efficient and sustainable freight access to places. The proposal is consistent with this objective because it would assist safe and efficient freight movements and provide new access for high productivity vehicles.

Another objective of the plan is to increase infrastructure and land use capacity to accommodate growth. This objective is supported by the goal to increase road freight capacity and improve safety across the

Great Dividing Range. The specific NSW Government Action relevant to this proposal is to provide capacity enhancements crossing the Blue Mountains.

2.1.10 Australian Infrastructure Plan and Priority List

The Australian Infrastructure Plan (the Plan) (Infrastructure Australia, 2016) sets out the infrastructure challenges and opportunities that Australia faces over the next 15 years and the solutions required. The plan was informed by a comprehensive review of existing and required infrastructure over the coming decades. The plan has four main themes:

- Productive cities, productive regions
- Efficient infrastructure markets
- Sustainable and equitable infrastructure
- Better decisions and better delivery.

The Infrastructure Priority List (Infrastructure Australia, 2020), which is part of the Plan, is designed to give guidance to decision makers and provide transparency for industry and the community. It is a 'rolling' list that is updated periodically as proposals move through development and delivery and in response to emerging challenges and opportunities.

The 2020 Infrastructure Priority List identifies the regional NSW road network safety improvements as a high priority initiative. The proposal would address this initiative by improving traffic flow, lane modifications that will decrease lane change crashes and improving the cycle network. The priority list provided an indicative timeframe for this initiative as 0-5 years.

The 2020 Infrastructure Priority List is available on the Infrastructure Australian website: https://www.infrastructureaustralia.gov.au/publications/infrastructure-priority-list-2020-august **.**

2.1.11 National Freight and Supply Chain Strategy

The National Freight and Supply Chain Strategy (Transport and Infrastructure Council, 2019) is the national approach to Australia's freight and supply chains. This strategy builds on the foundation laid through the National Ports Strategy (Australian Government, 2012) and National Land Freight Strategy (Australian Government, 2013), and expands freight and supply chain networks as an integrated whole. The Strategy sets an agenda for government and industry action across all freight modes over the next 20 years and beyond and is supported by the National Action Plan which details key actions to be delivered by government to achieve goals of the Strategy. The Strategy commits to action in four critical areas:

- Smarter and targeted infrastructure
- Enable improved supply chain efficiency
- Better planning, coordination, and regulation
- Better freight location and performance data.

The proposal would improve access to major freight gateways to support the critical area of smarter and targeted infrastructure investment. The proposal has been designed to accommodate heavy vehicles and will increase efficiency in freight movements.

2.1.12 National Road Safety Strategy 2021-2030

A new National Road Safety Strategy for the decade 2021-2030 is currently being developed and is expected to be finalised and approved in the first half of 2021. This new Strategy will recognise that road safety is achieved by three key themes: Safe Roads, Safe Vehicles and Safe Road Use.

The current strategy, the National Road Safety Strategy 2011–2020, represents the commitment of federal, state and territory governments to road safety by setting out an agreed set of national goals, objectives and action priorities to reduce fatal and serious injury crashes on Australian roads.

The proposal would provide the opportunity to reduce crashes, as it would improve the design of the Great Western Highway through improved curves and gradients of the highway alignment, intersection upgrades with local roads, and provision of additional local access and service roads. The design provides for two lanes in each direction, with an additional climbing lane on River Lett Hill to separate slower trucks and other vehicles and allow for safer overtaking. By improving road safety, the proposal would directly support the aims of the current National Road Safety Strategy 2011–2020.

2.1.13 Beyond the Pavement

Beyond the Pavement (Transport, 2020) is the overarching Transport policy guiding urban design on all of its projects. The following four physical design objectives have been adopted to achieve Transports commitment to providing 'successful places' with the 'liveability, amenity and economic success of communities and places enhanced by transport':

- Projects should fit sensitively into the built, natural, and cultural environment in both urban and rural locations
- Projects should contribute to the accessibility and connectivity of communities and a general permeability of movement through areas by all modes of movement
- The design and management of projects should contribute to the overall design quality of the public domain for the community, including transport users
- Projects should help revitalise areas and contribute to the local and broader economy.

An integrated design approach was taken for landscape and urban design, and road design for the proposal to integrate with the immediate and surrounding context, minimise impacts on heritage and cultural values, whilst enhancing and benefiting the community of the Hartley Valley and surrounds.

The urban design objectives for the proposal are to:

- Develop an integrated design that fits with the existing high visual qualities, ecology and character of the Hartley Valley and its setting
- Minimise impacts to the integrity of heritage sites, significant trees and cultural values of the community within the proposal
- Create a road corridor that responds to the natural and cultural environment, enhancing local and regional connectivity to evoke the underlying character of the Hartley Valley and surrounds
- Apply the principles stipulated in Transports urban design and other policies, and design principles outlined in Beyond the Pavement.

2.2 Limitations of existing infrastructure

2.2.1 Great Western Highway

The Great Western Highway is the major arterial road through the proposal area, carrying local, intra-regional and inter-regional travel. The general alignment of the Great Western Highway between Little Hartley and Lithgow is mostly a two-way undivided carriageway with one lane in each direction. There are limited overtaking lanes and sections of auxiliary lanes to facilitate overtaking and negotiation of adverse grades.

The Great Western Highway services freight, tourist, and general traffic, with varying traffic volumes from about 12,000 vehicles near Little Hartley and about 11,000 vehicles per day near Lithgow. and up to 20,000 vehicles per day in the Blue Mountains. In particular, there is a relatively high proportion of heavy vehicles (between 12 per cent and 24 per cent), reflective of the 18,000 tonnes of freight transported daily between the Central West and Sydney.

Traffic growth is expected on the Great Western Highway through the proposal area. Without the proposal, the performance of the Great Western Highway is expected to deteriorate over the next fifteen years and would approach operational capacity. Motorists travelling along Great Western Highway would experience congestion with little opportunities to overtake. Intersections would perform at levels below satisfaction resulting in delays.

The proposal would increase the capacity of the Great Western Highway which would reduce congestion and improve intersection performance. The proposal would increase the number of lanes on Great Western Highway allowing traffic to flow smoothly. This would lead to reduced travel time for motorists travelling along Great Western Highway. When considered with other upgrades to the Great Western Highway planned between Katoomba and Lithgow, it is expected that motorists would experience a reduction in travel time of up to 10 minutes.

Crashes

Table 2-1 summarises crash data recorded between January 2014 and June 2020 (six-year period) on Great Western Highway between Little Hartley and Lithgow. A total of 89 crashes were recorded of which 61 per cent resulted in a casualty. No fatal crashes were recorded.

Table 2-1 Recorded crashes on Great Western Highway (Little Hartley to Lithgow) by severity between January 2014 and June 2020

Severity of crash	Number of crashes	Per cent of crashes
Fatal	0	0 per cent
Serious injury	11	12 per cent
Moderate injury	32	36 per cent
Minor injury	8	9 per cent
Uncategorised injury	3	3 per cent
Non-casualty (towaway)	35	39 per cent
Total	89	100 per cent

Crash reduction analysis was undertaken on the Great Western Highway by comparing conditions with and without the proposal to estimate potential crash reductions based on the crash data presented above.

Analysis indicates that the proposal would reduce the total number of crashes on the Great Western Highway between Little Hartley and Lithgow by 57 per cent.

2.2.2 Local roads and intersections

Local roads connection with the Great Western Highway between Little Hartley and Lithgow include:

- Coxs River Road
- Ambermere Drive
- Baaners Lane
- Browns Gap Road
- Mid Hartley Road
- Carroll Drive
- Old Great Western Highway
- Kelly Street
- Jenolan Caves Road
- Blackmans Creek Road
- Forty Bends Road
- Daintree Close
- McKanes Fall Road
- Old Bathurst Road
- Mudgee Street

These roads are generally two-way undivided roads with one lane in each direction that provides access to local residential properties. The post speed limits range between 40 and 80 kilometers per hour.

Currently, there are 14 sign-controlled intersections with the Great Western Highway between Little Hartley and Lithgow:

- Coxs River Road / Ambermere Drive
- Baaners Lane
- Browns Gap Road (I-3)
- Mid Hartley Road
- Carroll Drive
- Kelly Street
- Old Great Western Highway
- Jenolan Caves Road / Blackmans Creek Road
- Forty Bends Road
- Daintree Close
- McKanes Falls Road
- Old Bathurst Road
- Mudgee Street
- Quarry Place.

Currently (2021), only two of the 14 intersections perform at a level considered to be below satisfactory. Intersections delays average between seven and 36 seconds per vehicle which is primarily attributed to traffic on local road connecting to the Great Western Highway. However, modelling of intersection performance indicates that level of service will continue to deteriorate and by 2036 ten of the 14 intersections would experience unsatisfactory performance with delays of over a minute per vehicle at most intersections and over three minutes per vehicle at one intersections.

The proposal would provide new intersection layouts and control measures which would operate with only minor delays at all intersections. Traffic modelling good operational performance levels and hence the proposal would provide a reliable and efficient road network between Little Hartley and Lithgow.

2.2.3 Pedestrian and cyclists

Currently active transport movements along and across the Great Western Highway between Little Hartley and Lithgow are limited by a lack of dedicated cycle and pedestrian paths with narrow should lanes restricting the use of the Great Western Highway for cycling.

The proposal would improve conditions for pedestrians and cyclists by providing a range of improvements to the existing network and facilities, including:

- A 2.5 metre nearside sealed shoulder would be provided on Great Western Highway. It is anticipated that the sealed shoulders would be sufficient to accommodate on road cyclists on both sides of each carriageway of Great Western Highway
- A two metre nearside sealed shoulder would be provided on Service Road 2 and Coxs River Road for on road cyclists
- A two metre nearside sealed shoulder would be provided on Service Roads 1 and 3 for on road cyclists
- Design development has considered the future development of shared paths in the vicinity of the proposal. The alignment and structure of the future shared paths would be developed and finalised during future design development and in consultation with Lithgow City Council and other relevant stakeholders

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

The proposal objectives are summarised in Figure 2-2.

Service need themes	Program objectives	Sub-objectives
Economic development / productivity / recovery	Improve economic development, productivity and freight accessibility in and through the Blue Mountains, Central West and Orana regions	• Support economic recovery in the short term, economic development in the medium term and economic sustainability in the long term within the Blue Mountains, Central West and Orana regions through better transport connectivity • Improve the efficiency and safety of freight movement through the Blue Mountains to better link Central West and Orana region economies with domestic and international markets • Improve access and connections to tourism facilities in the Blue Mountains, Central West and Orana region
Resilience / future proofing	Improve the resilience of the corridor between Katoomba and Lithgow to ensure continuity and safety of transport and essential services	• Enable continuity of services along the corridor between Katoomba and Lithgow including during events that disrupt regular network operations • Provide capacity to meet future population growth in the Blue Mountains, Central West and Orana regions • Futureproof the corridor for emerging transport technologies and innovative solutions
Network performance	Improve transport network performance and efficiency along the corridor between Katoomba and Lithgow to meet the needs of all our customers	• Blue Mountains, Central West and Orana regional centres, social infrastructure and other services and for all customers • Improve the overall reliability and capacity of the transport network between Greater Sydney, and the Central West and Orana • Minimise peak period congestion through the Blue Mountains • Build on and maximise the efficiency of existing infrastructure
Safety	Improve the overall safety of the corridor for all transport users between Katoomba and Lithgow	• Reduce road crashes via safer physical infrastructure • Keep all our transport users safe by minimising potential conflicts between light and heavy vehicles, pedestrians, cyclists and local traffic • Improve road infrastructure that contributes to the safety and welfare of heavy vehicle drivers and the community
Movement & place / amenity	Enhance the liveability and be sensitive to the unique environmental and cultural assets along the corridor between Katoomba and Lithgow	• Better balance of local and through traffic along the Katoomba and Lithgow corridor to provide a better overall customer experience • Improve the liveability of town centres west of Katoomba and through to the Central West and Orana region • Minimise potential impacts to the unique environmental, cultural and social value of the Blue Mountains

Figure 2-2 Proposal Objectives

2.3.2 Development criteria

The key design criteria for the proposal are summarised in

Table 2-2.

Table 2-2 Design criteria

Design element	Criteria
Great Western Highway	
Design speed	• 80 to 110 kilometres per hour
Posted speed	• 80 to 100 kilometres per hour
Lane width	• 3.5 metres
Turn auxiliary lane width	• 3.5 metres
Nearside (outside) shoulder width	• 2.5 metres
Offside (median) shoulder width	• 0.5 to 1 metre
Maximum grade	• 6 per cent
Design vehicle	• 26 metre B-double • (Checking vehicle 36.5 metre A-double (12 axle))
Vertical clearance to overpass	• 5.4 metres
Flood immunity	• 1 in 100 year annual recurrence interval (ARI)
Service Roads	
Posted speed limit	• Service Road 1, 3, 6 and 8: 60 kilometres per hour • Service Road 2: 80 kilometres per hour during construction, 60 kilometres per hour during operation • Service Road 9, 10, 11, 12 and 13: 50 kilometres per hour
Lane widths	• Service Road 1, 11, 12 and 13: 3 metres • Service Road 2, 3, 6, 8 and 10: 3.5 metres • Service Road 9: 2 metres
Nearside (outside) shoulder width	• Service Road 1 and 3: 2 to 3 metres • Service Road 2, 6, 8 and 10: 2 metres • Service Road 9: 0.5 metres • Service Road 11, 12 and 13: 1.5 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)
Connecting Roads	
Posted speed limit	• 50 kilometres per hour

Design element	Criteria
Lane widths	• Connecting Road 1 and 4: 3.5 metres • Connecting Road 2: 4.5 metres • Connecting Road 3 and 5: 3 metres
Nearside (outside) shoulder width	• Connecting Road 1: 1 to 1.5 metres • Connecting Road 2: 2 metres • Connecting Road 3, 4 and 5: 3 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)
Local Roads	
Posted speed limit	• Baaners Lane and Coxs River Road: 60 kilometres per hour • Blackmans Creek Road: 40 kilometres per hour • Browns Gap Road, Jenolan Caves Road and McKanes Falls Road: 80 kilometres per hour • Forty Bends Road, Kelly Street, Mudgee Street and Old Bathurst Road: 50 kilometres per hour
Lane widths	• Baaners Lane, Browns Gap Road, Coxs River Road, Forty Bends Road, Jenolan Caves Road and McKanes Falls Road: 3.5 metres • Blackmans Creek Road Mudgee Street and Old Bathurst Road: 3 metres • Kelly Street: 2 metres
Nearside (outside) shoulder width	• Baaners Lane, Blackmans Creek Road, Browns Gap Road and Forty Bends Road: 1 metres • Coxs River Road and Jenolan Caves Road: 2 metres • Kelly Street: 0.5 metres • McKanes Falls Road: 2 metres • Mudgee Street: 1.5 metres • Old Bathurst Road: 0.5 to 1.5 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)
Coxs River Road on and off ramps	
Posted speed limit	• 60 kilometres per hour
Lane widths	• 3.5 metres
Nearside (outside) shoulder width	• 1 metre

2.3.3 Urban design objectives

Urban design objectives for the proposal include:

- Develop an integrated design that fits with the existing high visual qualities, ecology and character of the Hartley Valley and its setting
- Minimise impacts to the integrity of heritage sites, significant trees and cultural values of the community within the proposal
- Create a road corridor that responds to the natural and cultural environment, enhancing local and regional connectivity to evoke the underlying character of the Hartley value and surrounds
- Apply the principles stipulated in Transports urban design and other policies, and design principles outlined in Beyond the Pavement (Transport, 2020)

Further details including design principles are outlined in Appendix L Urban Design and Landscape Character Impact Assessment.

2.4 Alternatives and options considered

2.4.1 Overview of the proposal development process

The proposal development process undertaken to date has involved seven main stages and is summarised in Table 2-3.

Table 2-3 Proposal development process – key milestones

Key milestone	Description
Proposal announcement (October 2007 and May 2008)	The upgrade proposal began in May 2008 when the Australian and NSW governments announced the location of the initial study area. In June 2008 the community consultation process was initiated with the release of the Mount Victoria to Lithgow Background and Proposed Project Development Report (RTA, 2008c).
Study area investigations (May 2008)	Study area investigations aimed at facilitating the identification of potential corridors were initiated in May 2008. Following suggestions by community members, Transport agreed to investigate the feasibility of the Newnes Plateau as an alternative corridor.
Initial corridor development leading to the selection of five corridors in which routes may be feasible (November 2008)	Based on the outcomes of the aforementioned investigations, five potential corridors in which routes might be feasible were announced in November 2008. The Study Area Investigations and Corridor Identification Report (RTA, 2008b) and Strategic Evaluation of the Newnes Plateau Corridor Report (RTA, 2008c), which outlined the development of these corridors, were released in November 2008.
Corridor modification and confirmation (November 2008 to April 2009)	Following a review of the initial corridors, four modified corridors were confirmed and placed on display in April 2009, together with the Submissions Report – corridors in which routes may be feasible (RTA, 2009e). As part of the corridor confirmation process, the Transport determined that the Newnes Plateau corridor would not be taken forward for further consideration.

Key milestone	Description
Preferred corridor announcement (August 2009)	In August 2009, the NSW Minister for Roads announced that the plans for the upgrade of the Great Western Highway between Mount Victoria and Lithgow would concentrate solely on the corridor along the existing highway, known as the modified orange corridor.
Route options development (May to October 2009)	The development of route options within the modified orange corridor included community submissions and involvement in workshops, field investigations and engineering design, and culminated in the announcement of various route options and sub-options in October 2009. The Route Options Report (RTA, 2009a) and associated working papers (RTA, 2009f to r), which summarise the development of the route options were released in October 2009.
Preferred route selection (October 2009 to May 2010)	Following further community consultation and a technical workshop was held in November 2009 in which the route options were assessed based on a previously established evaluation criteria considering business impacts, residential impacts, visual impacts, heritage, ecology, sense of place and value for money. During the workshop, further refinements were identified for the routes to minimise potential environmental impacts. Finally a preferred route option was selected. The Preferred Route Report (RTA, 2010) which summarises this process was released in May 2010.
Further design refinements	The Preferred Route was used as a basis for the development of the Concept Design. A limited options development phase was undertaken prior to the development of the Concept Design. This was to ensure the most effective option that best met the proposal objectives was taken forward into design development.

2.4.2 Refinements to the concept design

The reference design developed by Transport formed the basis for the development of the concept design. This section outlines refinements made to the reference design during the development of the concept design.

Baaners Lane / Browns Gap Road Connectivity

Connectivity between Baaners Lane and Browns Gap Road and the location of the Baaners Lane and Great Western Highway intersection was raised as a key concern in the community feedback received by Transport in previous phases of the proposal. As such, a review was undertaken at a workshop held in March 2021 between Transport and its consultants to investigate alternative options around this connection. The options reviewed at the value management workshop were:

- Option 1: Right Turns in and out of Baaners Lane across the Great Western Highway (at grade intersection). Residents along Baaners Lane travelling to Browns Gap Road will need to travel via Great Western Highway.
- Option 2: Bridge across the Great Western Highway and staggered T-intersection with grade separation.
- Option 3: New service road along Great Western Highway for connection to Coxs River Road (at grade intersection).

A paired comparison and option assessment was undertaken during the workshop which resulted in both Option 1 and Option 2 having merit, and that further consultation with the community would be required.

Transport met with the Hartley District Progress Association in March 2021. Based on feedback from this meeting, it was determined that Option 1 would be developed in the concept design.

Climbing lane on River Lett Hill

A truck speed assessment for the westbound approach to River Lett Hill was carried out during design development and reviewed at a workshop held in March 2021 between Transport and its consultants. This assessment determined that truck speeds would be significantly affected by the prolonged length of steep grade necessary to traverse River Lett Hill. Trucks would reduce to below 40km/h for approximately 2km, commencing immediately west of the Twin Bridges Over Jenolan Caves Road and would not increase to the posted speed until west of Forty Bends Road, where the speed limit is reduced from 100km/h to 90km/h.

Further assessment was also carried out to determine if the truck speed reduction would significantly affect the traffic flow. The assessment was carried out using predicted traffic levels for 2026 and 2036. This assessment identified a decrease of at least two levels of service on River Lett Hill.

In accordance with Austroads Guide to Road Design (AGRD), a climbing lane is warranted if either:

- Truck speed falls to 40 km/h or less, or
- The level of service on the grade falls two levels below that on the approach to the upgrade or to level of service ‘E’.

The two warrants above are met and therefore, a climbing lane has been introduced on River Lett Hill.

Other refinements

It is recognised that substantial design effort, options analysis and independent reviews have been undertaken by Transport in the development of the Transport reference design for the proposal, including extensive consultation with the local community and key stakeholders. This has resulted in a balance between providing a high standard design incorporating wider lanes and medians and minimising impacts to the surrounding property accesses and environmentally sensitive areas. Refinements to the reference design during the development of the concept design have sought to avoid compromising that balance. Refinements have generally comprised minor adjustments to:

- The design speeds along sections of the Great Western Highway to reduce the number of speed changes
- Median and shoulder widths
- Property access and intersections
- Land acquisition extents
- Exit and entry ramps
- Road geometry, alignment and connections.

3. Description of the proposal

This section describes the proposal and provides descriptions of existing conditions, the design parameters including major design features, the construction method and associated infrastructure and activities.

3.1 The proposal

Transport proposes to upgrade the Great Western Highway between Little Hartley and Lithgow, NSW (the proposal). The proposal forms part of the broader Greater Western Highway Upgrade Program that aims to reduce congestion and deliver safer, more efficient and reliable journeys for those travelling in, around and through the Blue Mountains, while also better connecting communities in the Central West to Sydney.

The Great Western Highway Upgrade Program is packaged into separate East, Central and West Sections. The West Section (ie this proposal), has been developed based on the concept design publicly displayed in 2012 and its further refinement. It would include:

- Upgrade of about 14 kilometres of the Great Western Highway between Little Hartley and Lithgow to a four lane divided highway
- Embankment work and median adjustment in the Forty Bends section (upgraded in 2017) to provide a fourth lane
- Provision of service roads, where feasible and reasonable, to minimise direct access to the Great Western Highway from adjacent properties
- Upgrade and/or adjustment of existing intersections at local roads
- Provision of two vehicle rest areas, one eastbound and one westbound, near Mid Hartley Road and Carroll Drive
- Temporary and permanent water quality treatment basins
- Provision of five new bridges, including twin bridges over River Lett and Jenolan Caves Road
- Upgrade of the existing bridge over River Lett as part of a local service road network
- Extension of existing drainage culverts at Rosedale Creek and Boxes Creek
- Provision of three combined drainage and fauna crossing culverts
- Establishment and use of temporary ancillary facilities during construction
- Property works including acquisition, demolition and adjustments to accesses
- Adjustment of existing utility infrastructure, including overhead powerlines, poles and underground communications cables
- Rehabilitation of disturbed areas and landscaping, where required.

The proposal has been designed in four sections to allow flexibility in construction staging and delivery and includes:

- Little Hartley to River Lett Hill
- Coxs River Road
- River Lett Hill to Forty Bends
- Forty Bends to Lithgow.

A description of the key features of each section is provided below and are shown in Figure 3-1, along with the proposed construction footprint.

3.1.1 Little Hartley to River Lett Hill

The Little Hartley to River Lett Hill section involves the realignment of about three kilometres of the Great Western Highway with two lanes in each direction from the base of Victoria Pass, where it would tie into the Great Western Highway Upgrade – Central Section, to east of the River Lett, excluding the Coxs River Road Section (see Section 3.1.2). Key features include:

- Two span 'Super T' bridges over the new Great Western Highway east of Coxs River Road and west of Mid Hartley Road to maintain the local road connection
- Realignment of the highway to improve alignment and provide two lanes in each direction. The existing highway would become a local service road
- Upgrade at the intersection of the Great Western Highway and Carroll Drive
- Eleven temporary construction sediment basins and three permanent operational water quality control basins (noting three of the temporary basins would be converted to permanent basins at completion for construction)
- Adjustment, protection and/or relocation of overhead distribution powerlines and underground communications assets
- Construction of two Hartley Valley rest areas near Mid Hartley Road and Carroll Drive, connected by a service road.

3.1.2 Coxs River Road

The Coxs River Road section involves the realignment of about 2.4 kilometres of the Great Western Highway with two lanes in each direction from east of the Coxs River Road to near the Hartley Cemetery. Key features include:

- A grade separated interchange at Coxs River Road, supplemented by new sections of connecting roadway to create a local service road network
- Realignment of the existing highway near Browns Gap Road to create a local service road
- Upgrades to the intersections at Browns Gap Road and Baaners Lane, including a vehicle turning facility on Baaners Lane
- Six temporary construction sediment basins and four permanent operational water quality control basins (noting two of the temporary basins would be converted to permanent basins at completion of construction)
- Adjustment, protection and/or relocation of overhead distribution powerlines, underground communications assets and water utility infrastructure
- Retaining walls on the Great Western Highway eastbound adjacent to the Lolly Bug.

3.1.3 River Lett Hill to Forty Bends

The River Lett Hill to Forty Bends section involves the realignment and/or widening of about four kilometres of the Great Western Highway to at least two lanes in each direction between the River Lett and Forty Bends Road (eastern junction). Key features include:

- Twin bridges over Jenolan Caves Road (about 370 metres long) to form a grade separated interchange
- Twin Bridges over River Lett (about 80 metres long)
- Retention of the existing bridge over River Lett on the existing Great Western Highway as part of a local road connection from the new highway, including barrier upgrade works.

- Realignment of the existing highway from Jenolan Caves Road to about 250 metres south of Forty Bends Road (eastern junction) to reduce the gradient of the road on River Lett Hill and provide for an climbing (third) lane westbound. The existing highway in this section would be converted to a local service road where feasible
- Upgrade to the intersection at Blackmans Creek Road and Kelly Street, including a realignment of Kelly Street
- Five temporary construction sediment basins and seven permanent operational water quality control basins (noting four of the temporary basins would be converted to permanent basins at completion of construction)
- Construction of retaining walls at Off Ramp 1 and between River Lett twin bridges and Jenolan Caves Road intersection
- Extension of the existing box culverts at Boxes Creek
- Extensive cuts and fills at River Lett Hill, the abutments for the bridge over Jenolan Caves Road and between Service Road 8 and Forty Bends Road (eastern junction)
- Adjustment, protection and/or relocation of overhead transmission powerlines and underground communications assets
- Three 3.3 meter wide x 3.3 metre high box culverts providing both drainage and a fauna crossing.

3.1.4 Forty Bends to Lithgow

The Forty Bends to Lithgow section involves widening about 4.5 kilometres of the Great Western Highway to two lanes in each direction from Forty Bends Road (eastern junction) to Magpie Hollow Road. Key features include:

- Embankment work and median adjustment in the existing Forty Bends Section of the highway (upgraded in 2017) to provide a fourth lane
- Upgrades to intersections at McKanes Falls Road, Old Bathurst Road and Mudgee Street
- Modifications to the intersection at Forty Bends Road (western junction)
- Two temporary construction sediment basins and five permanent operational water quality control basins (noting the two temporary basins would be converted to permanent basins at completion of construction)
- Four retaining structures on the eastbound alignment and one westbound
- Six drainage culverts traversing under the proposed highway, as well as additional minor culverts under local service roads and/or property access.

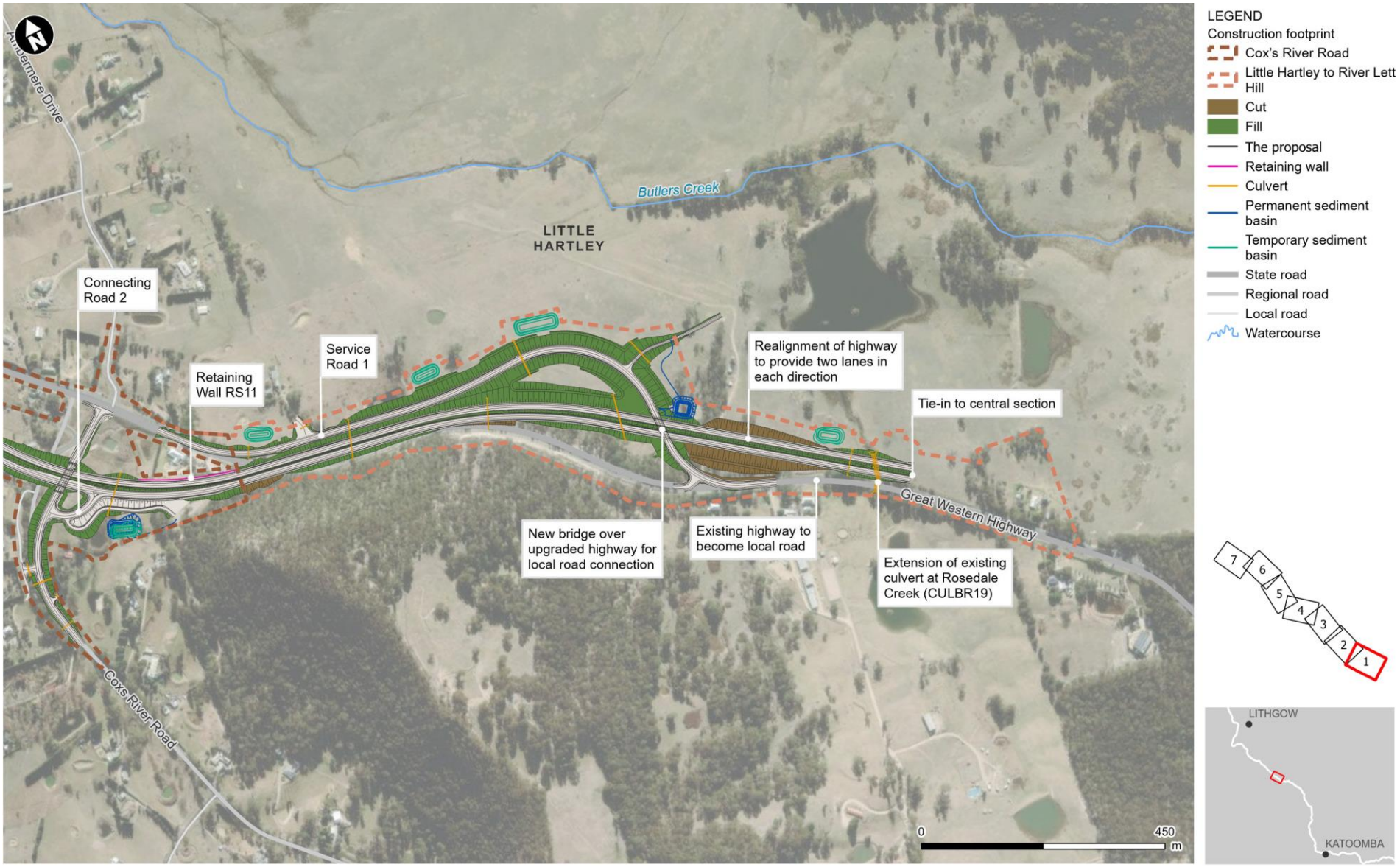


Figure 3-1 a Key features of the proposal

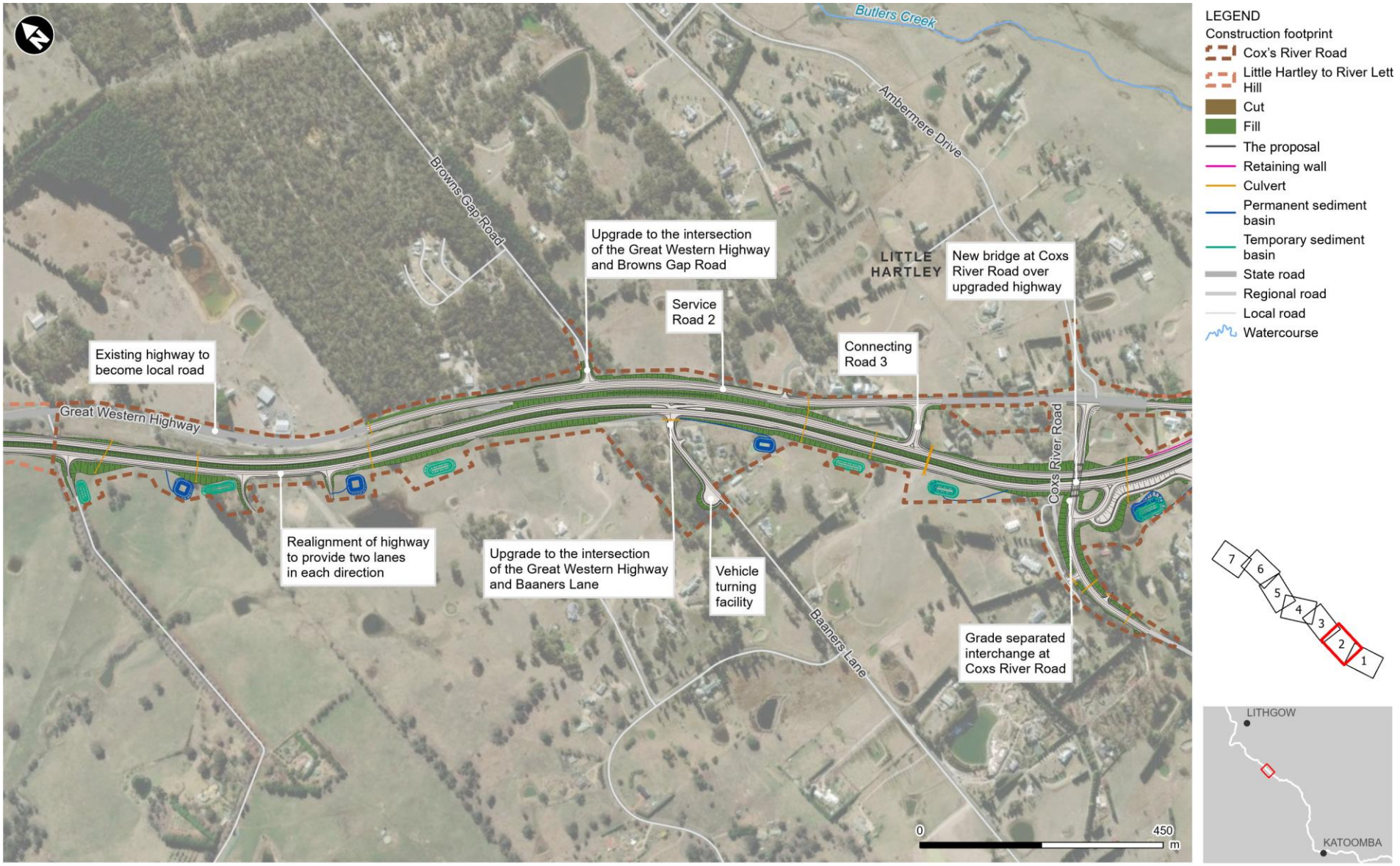


Figure 3-1 b Key features of the proposal

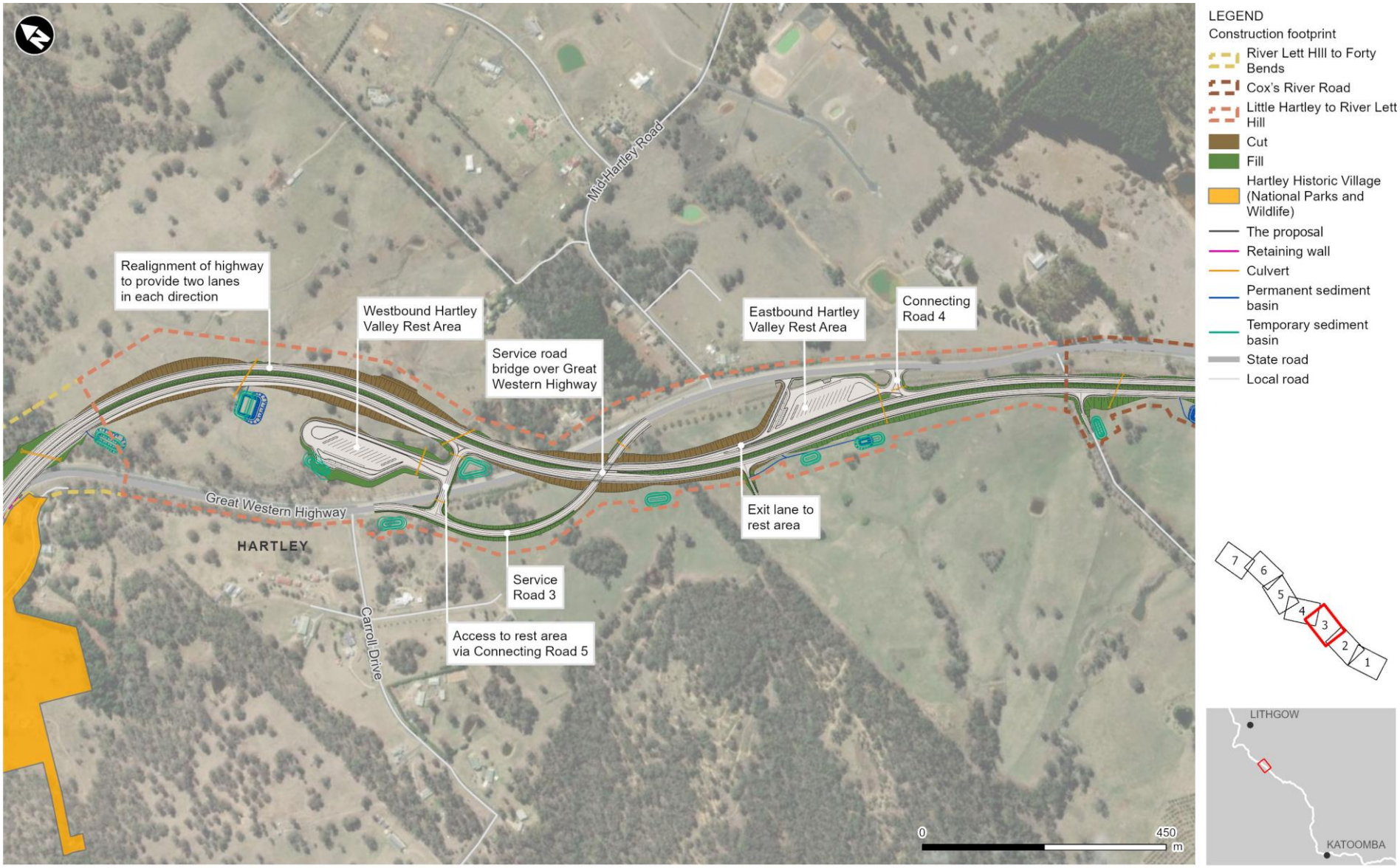


Figure 3-1 c Key features of the proposal

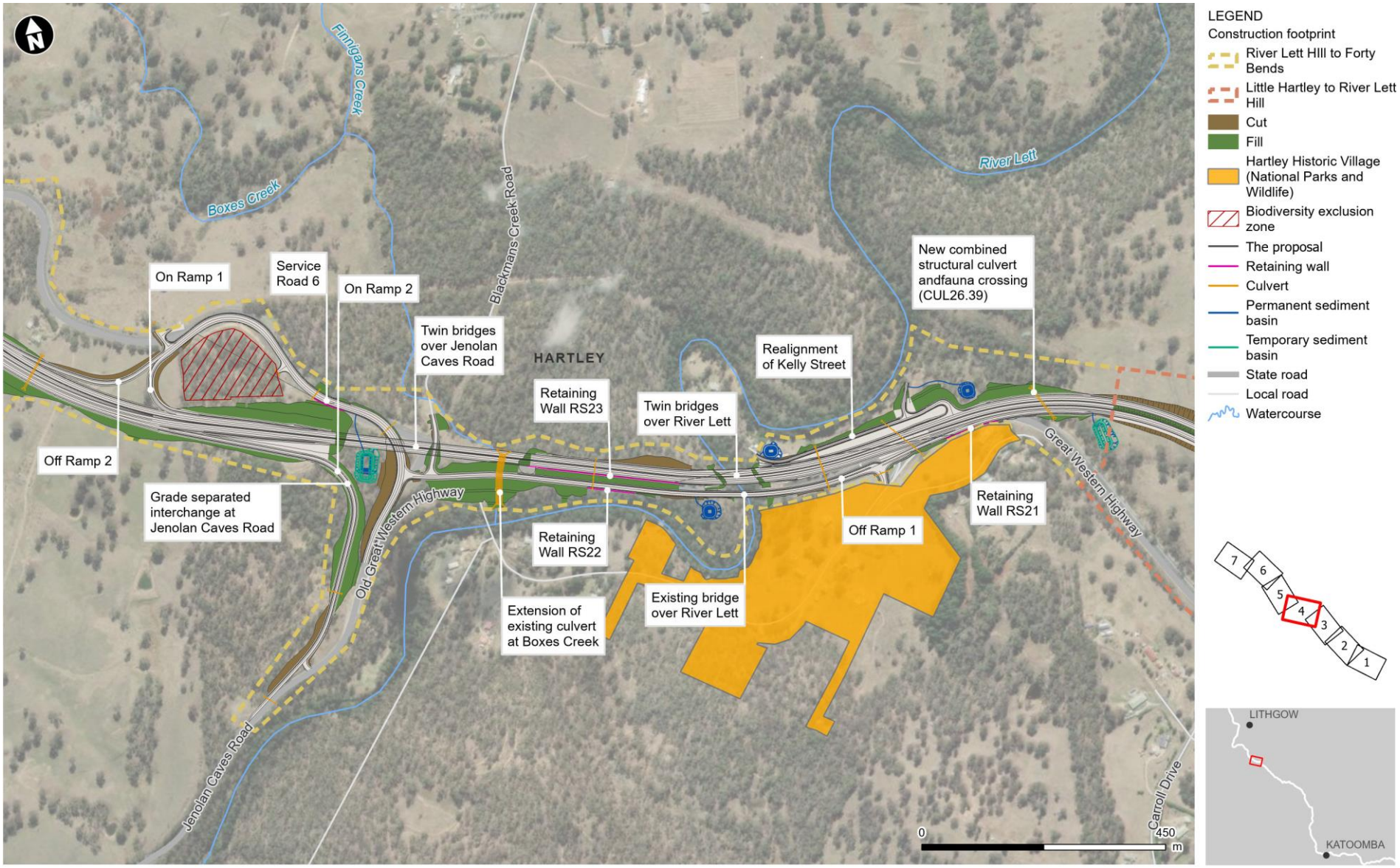


Figure 3-1 d Key features of the proposal

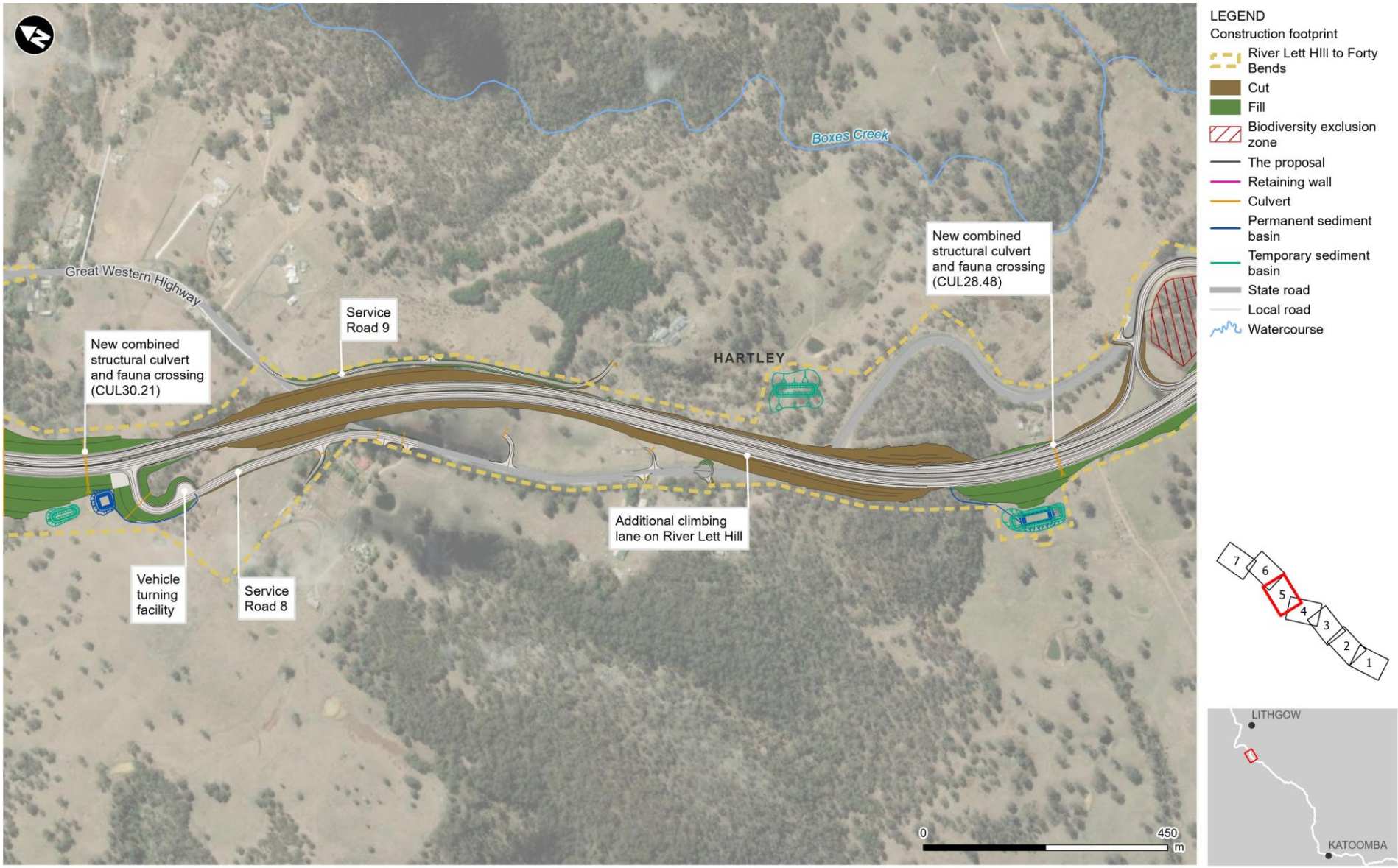


Figure 3-1 e Key features of the proposal

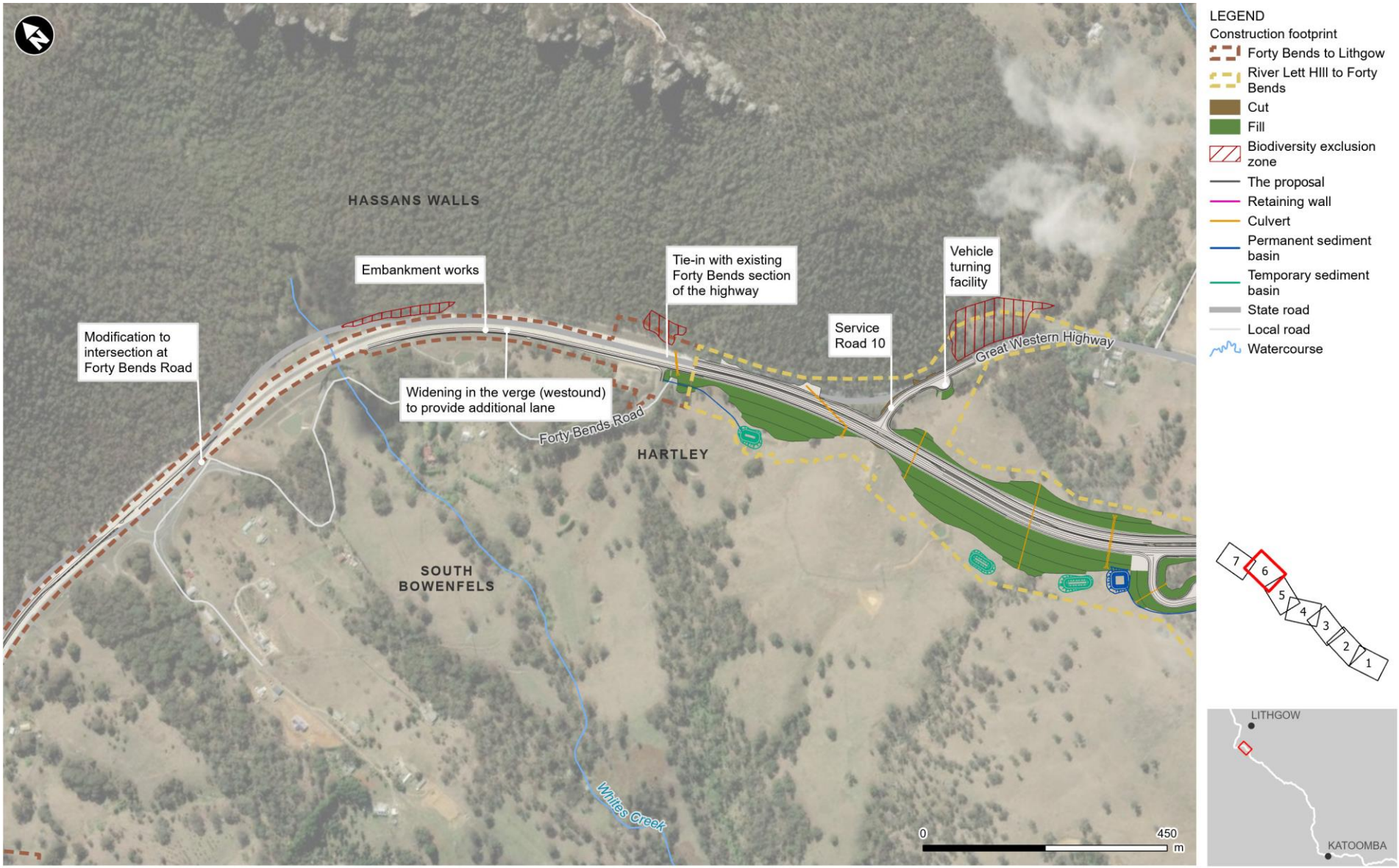


Figure 3-1 f Key features of the proposal

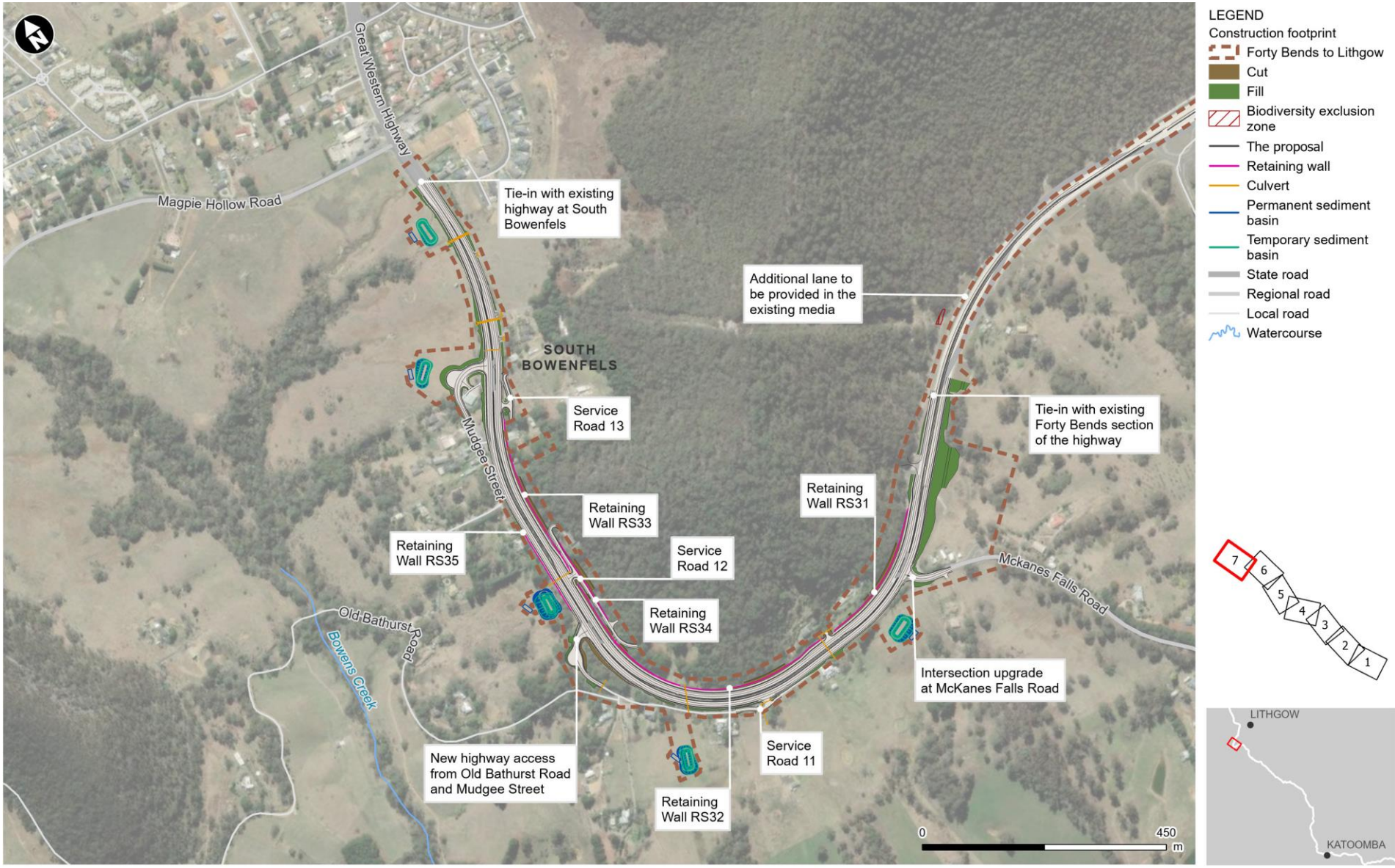


Figure 3-1 g Key features of the proposal

3.2 Design

The design is being prepared in accordance with Transport's project specifications and design standards and guidelines as follows:

- Austroads Guides
- Australian Standards
- Transport supplements to Austroads Guides and Australian Standards
- Technical directions and quality alerts
- Other current Transport publications.

3.2.1 Design criteria

The key design criteria for the proposal are summarised in Table 3-1. The infrastructure design life is provided in Table 3-2.Typical cross sections for the proposal are presented in Figure 3-2.

Table 3-1 Design criteria

Design element	Criteria
Great Western Highway	
Design speed	• 80 to 110 kilometres per hour
Posted speed	• 80 to 100 kilometres per hour
Lane width	• 3.5 metres
Turn auxiliary lane width	• 3.5 metres
Nearside (outside) shoulder width	• 2.5 metres
Offside (median) shoulder width	• 0.5 to 1 metre
Maximum grade	• 6 per cent for the overall proposal. This criterion could not be achieved on River lettt Hill and a grade of 6.75 per cent has been adopted for this design element.
Design vehicle	• 26 metre B-double • (Checking vehicle 36.5 metre A-double (12 axle))
Vertical clearance to overpass	• 5.4 metres
Flood immunity	• 1 in 100 year annual recurrence interval (ARI)
Service Roads	
Posted speed limit	• Service Road 1, 3, 6 and 8: 60 kilometres per hour

Design element	Criteria
	• Service Road 2: 80 kilometres per hour during construction, 60 kilometres per hour during operation • Service Road 9, 10, 11, 12 and 13: 50 kilometres per hour
Lane widths	• Service Road 11, 12 and 13: 3 metres • Service Road 1, 2, 3, 6, 8 and 10: 3.5 metres • Service Road 9: 2 metres
Nearside (outside) shoulder width	• Service Road 1 and 3: 2 to 3 metres • Service Road 2, 6, 8 and 10: 2 metres • Service Road 9: 0.5 metres • Service Road 11, 12 and 13: 1.5 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)
Connecting Roads	
Posted speed limit	• 50 kilometres per hour
Lane widths	• Connecting Road 1, 2 and 4: 4.5 metres • Connecting Road 3, 4 and 5: 3 metres
Nearside (outside) shoulder width	• Connecting Road 1: 1 to 1.5 metres • Connecting Road 2: 2 metres • Connecting Road 3, 4 and 5: 3 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)
Local Roads	
Posted speed limit	• Baaners Lane and Coxs River Road: 60 kilometres per hour • Blackmans Creek Road: 40 kilometres per hour • Browns Gap Road, Jenolan Caves Road and McKanes Falls Road: 80 kilometres per hour • Forty Bends Road, Kelly Street, Mudgee Street and Old Bathurst Road: 50 kilometres per hour
Lane widths	• Baaners Lane, Browns Gap Road, Coxs River Road, Forty Bends Road, Jenolan Caves Road and McKanes Falls Road: 3.5 metres • Blackmans Creek Road Mudgee Street and Old Bathurst Road: 3 metres • Kelly Street: 2 metres

Design element	Criteria
Nearside (outside) shoulder width	• Baaners Lane, Blackmans Creek Road, Browns Gap Road and Forty Bends Road: 1 metres • Coxs River Road and Jenolan Caves Road: 2 metres • Kelly Street: 0.5 metres • McKanes Falls Road: 2 metres • Mudgee Street: 1.5 metres • Old Bathurst Road: 0.5 to 1.5 metres
Design vehicle	• 19 metre semi-trailer • (Checking vehicle 26 metre B-double)

Table 3-2 Design life

Design Element	Design Life
Inaccessible drainage elements	100 years
Drainage elements that are accessible for refurbishment and maintenance including sedimentation and detention basins	40 years
Sign faces	10 years
Sign support structures and other roadside furniture	40 years
Fences included fauna fences	20 years
Lighting and electrical equipment	20 years
Bridge and tunnel structures, including underpasses, overpasses and wildlife tunnels	100 years
Retaining walls including reinforced soil walls	100 years
Noise barriers, noise attenuation devices and headlight screens	50 years
Pavements – main carriageway including ramps	40 years
Pavements – local roads	20 years
Local road embankment and support structures	100 years
Embankments, including reinforced embankments	100 years
Cut batters, including batter treatments	100 years
Timber furniture	30 years
Intersection capacity improvements	10 years

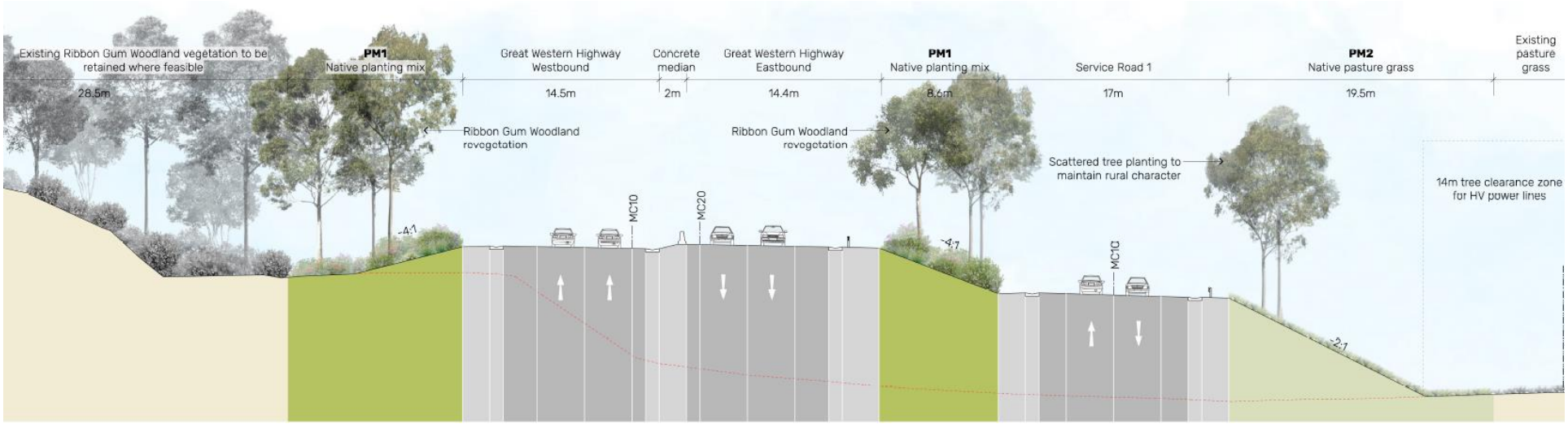


Figure 3-2 a Typical cross section of the Great Western Highway near Service Road 1

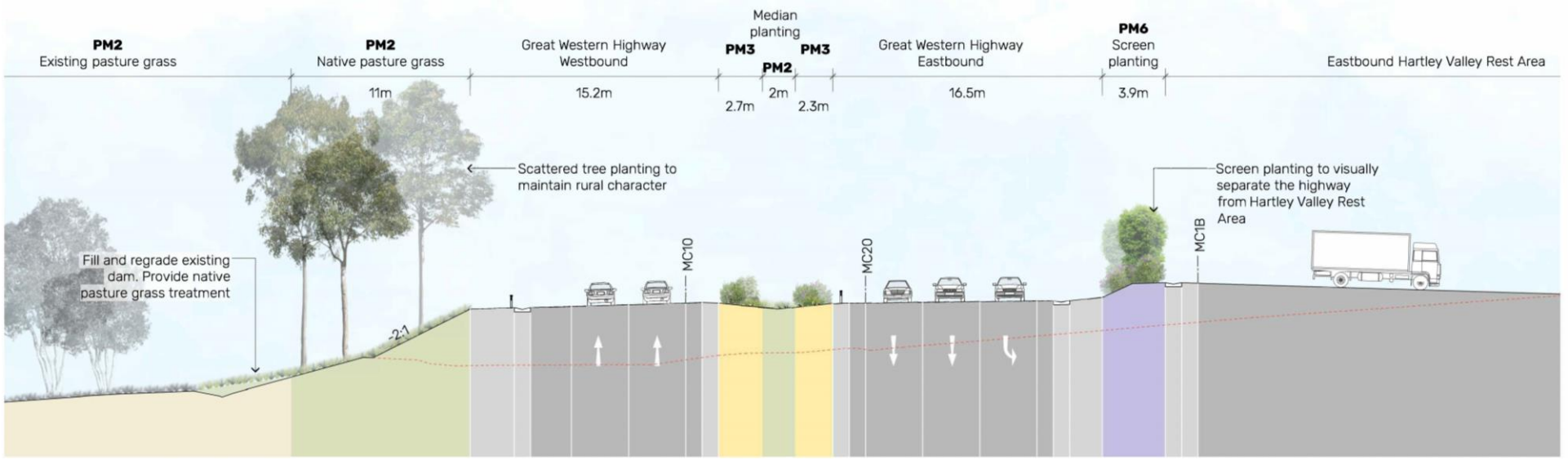


Figure 3-2 b Typical cross section of the Great Western Highway near Eastbound Hartley Valley rest area

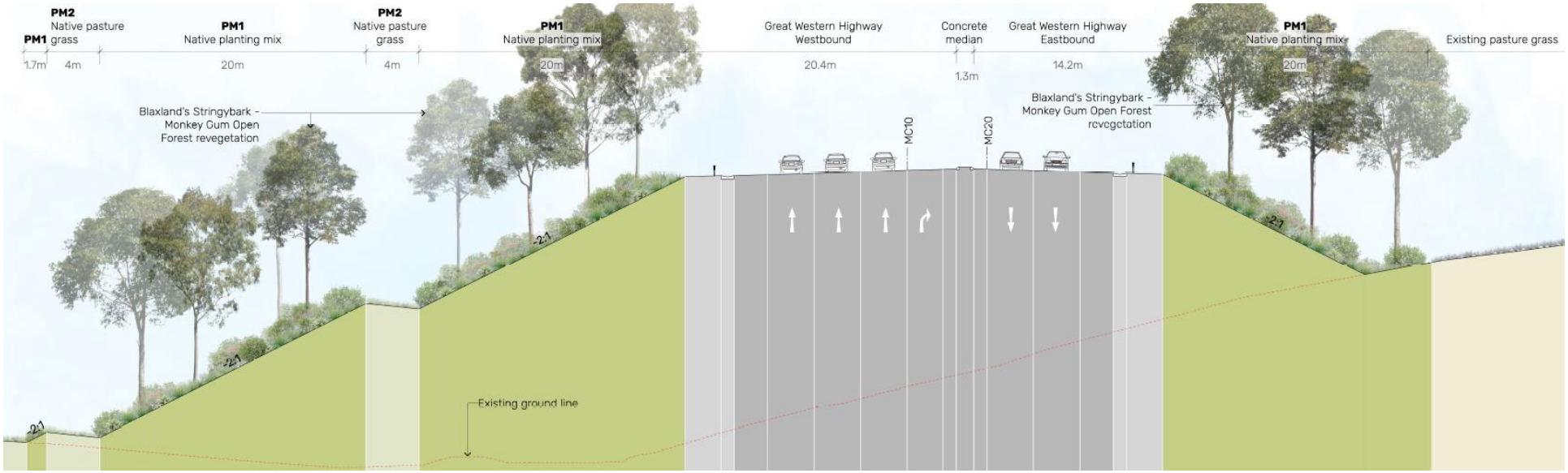


Figure 3-2 c Typical cross section of Great Western Highway requiring deep fill

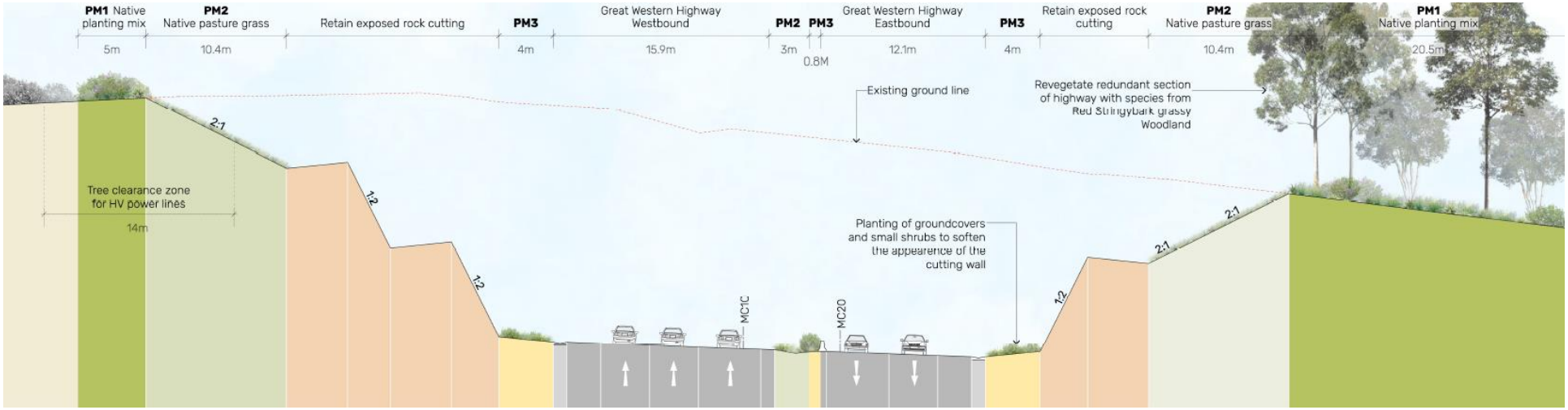


Figure 3-2 d Typical cross section of Great Western Highway requiring deep cut

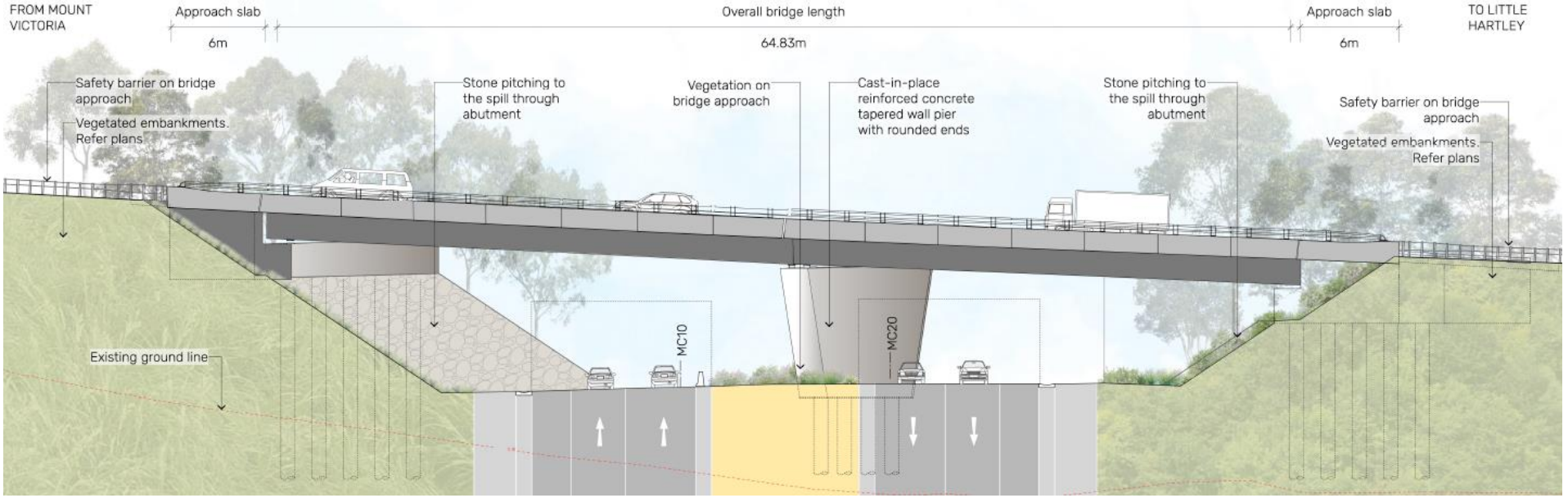


Figure 3-2 e Long section of Service Road 1 bridge over the Great Western Highway

Figure 3-2 f Long section of the Great Western Highway twin bridges over River Lett

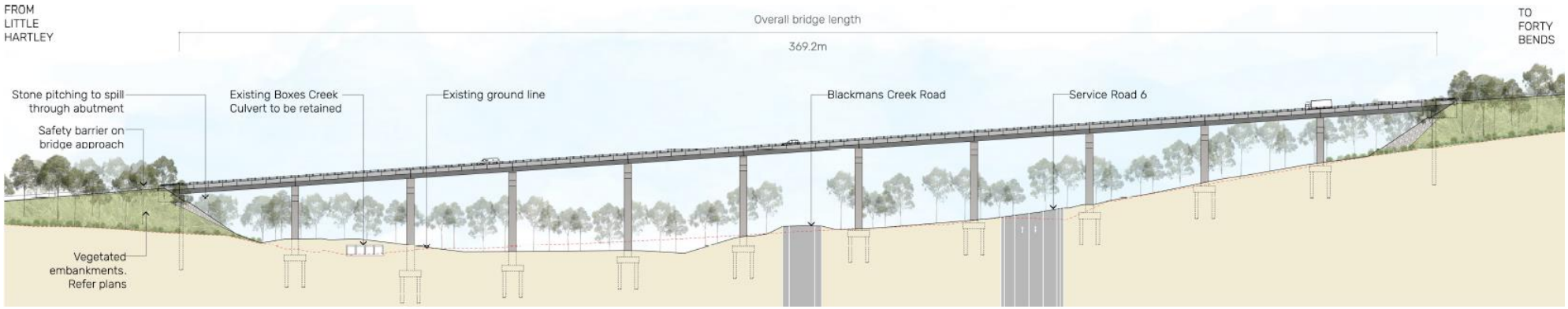


Figure 3-2 g Long section of the Great Western Highway twin bridges over Jenolan Caves Road

3.2.2 Engineering constraints

Engineering constraints have been identified for the proposal. The key constraints include:

- Existing natural features, including topography (steep and varying terrain) and existing watercourses/drainage lines and associated flood levels (in particular River Lett). Large cuts and fills would be required to construct the proposal in accordance with the design criteria
- Tie-ins. There are multiple tie-in requirements for the proposal, including tie-ins to:
  - The existing highway, in particular at the eastern extent of the proposal adjoining future highway upgrades that are subject to separate environmental assessment and approval
  - Existing local road intersections. There are 12 local road intersections that would require modification or tie-in to the proposal, including Coxs River Road, Baaners Lane, Browns Gap Road, Carroll Drive, Old Great Western Highway, Kelly Street, Jenolan Caves Road, Blackmans Creek Road, Forty Bends Road, McKanes Falls Road, Old Bathurst Road and Mudgee Street
  - Existing properties. There are multiple properties that would require property access adjustments or upgrades as a result of the proposal
- Construction staging. The proposal construction staging strategy needs to be structured to be feasible and meet proposal needs, with particular consideration of managing earthworks across the project and maintaining existing highway traffic flows in both directions
- Geotechnical issues and risks within the proposal construction footprint. There are geological risks, including presence of Acid Sulfate Rock, and slope failure risks associated with the Forty Bends to Lithgow Section and the eastern end of the Little Hartley to River Lett Section. The risks primarily include remobilisation of small to large boulders residing on steep slopes as a result of erosion, slump failures and debris flows
- Formation of black ice. Black ice formation, largely due to cold air flowing down from Hassans Walls, has been identified as a hazard along the highway at Forty Bends.
- Key environmental constraints, including:
  - Avoiding impacts to the existing non-Aboriginal heritage items within or adjacent to the proposal construction footprint, in particular impacts to the Lolly Bug and the Harp of Erin properties
  - Avoiding impacts to the number of known Aboriginal heritage sites and potential archaeological deposits
- Avoiding and/or minimising impacts native vegetation and threatened fauna habitat, in particular threatened ecological communities listed under the BC Act and/or EPBC ActProperty acquisition. The proposal has minimised local property acquisition where feasible, including impacts to private properties, National Park and to Crown land subject to an Aboriginal land claim
- The presence of existing utility infrastructure. The proposal would require the protection and/or relocation of electricity, telecommunications and water infrastructure
- Visual impact of the proposal, in particular bridge structures associated with the Coxs River Road Section and Jenolan Caves Road.

3.2.3 Major design features

Great Western Highway realignment and widening

The proposed alignment would follow the general alignment and grade of the existing highway, however would diverge in places to ease tightly curved sections. It also provides new junctions and retains sections of the existing highway as service roads to property accesses.

The main points of divergence from the existing road alignment would include:

- Coxs River Road. This section of about 850 metres would allow for the intersection to be constructed predominantly offline and traffic flow along the highway to be maintained. The proposed divergence would also avoid impacts to hreeheritage listed/potential buildings, the Lolly Bug, the Harp of Erin and Ambermere
- Coxs River Road to Hartley. This section would follow adjacent to the highway on the southern side for about 1.5 kilometres, allowing space for the eastbound rest area and for the existing highway to be used as a service road for access to properties and Mid Hartley Road. The following 1.2 kilometres would diverge to the north, allowing space for the westbound rest area and for the turning curve to be increased
- Jenolan Caves Road intersection. The proposed alignment would diverge to allow the existing highway to be used as a service road to access Jenolan Caves Road, Old Bathurst Road and Blackmans Creek Road
- Jenolan Caves Road to Forty Bends. This section of about three kilometres would reduce the number of and ease thecurves as well as reduce the steep grades on a new alignment, allowing the existing highway to be used as a service road for access to properties.

The proposed alignment would be constructed to a design speed of 110 kilometres per hour from Little Hartley to about 750 metres east of the Service Road 8 connection, then 100 kilometres per hour to McKanes Falls Road and 80 kilometres per hour to Lithgow. The posted speed limit would be 100 kilometres per hour from Little Hartley to about Forty Bends Road (eastern junction), then 90 kilometres per hour to McKanes Falls Road and 80 kilometres per hour from McKanes Falls Road to Lithgow.

The proposed alignment would have 3.5 metre wide lanes, with shoulders of about 2.5 metres and a maximum grade of 6.75 per cent. The central median would be of varying widths from three to 11 metres, and would consist of both pavement or vegetated areas along the alignment.

Bridges

The proposal would require the construction of seven bridges structures and the upgrading of one bridge, as summarised in Table 3-3.

Table 3-3 Proposed bridges

Bridge	Description
Little Hartley to River Lett Hill	
Service Road 1 bridge	The bridge is located where the proposed Service Road 1 crosses over the proposed new highway. The bridge would be about 70 metres long and 12 metres wide and one lane in each direction, comprising a two span precast Super T girder with a central pier located in the Great Western Highway median.
Service Road 3 bridge	The bridge is located where the proposed Service Road 3 crosses over the proposed new highway. The bridge would be about 75 metres long and 13 metres wide and one lane in each direction, comprising a two span precast Super T girder with a central pier located in the Great Western Highway median.
Coxs River Road	
Coxs River Road bridge	The bridge is located where the proposed Great Western Highway alignment crosses under Coxs River Road. The bridge would be about 80

Bridge	Description
	metres long and 11 metres wide and one lane in each direction, comprising a two span precast Super T girder with a central pier located in the Great Western Highway median.
River Lett Hill to Forty Bends	
River Lett twin bridges	The twin bridges are located where the proposed new highway passes over River Lett. The bridges would be about 80 metres long and 12 metres wide and provide two lanes each direction, comprising three span precast Super T girders with piers located outside of the watercourse.
River Lett existing bridge refurbishment	The existing bridge over River Lett would be retained for use as a local service road connected to Off Ramp 1. The existing fascia panels would be removed and barriers upgraded.
Jenolan Caves Road twin bridges	The twin bridges are located where the proposed new highway passes over Boxes Creek, Blackmans Creek Road and Jenolan Caves Road. The bridges would be about 370 metres long and 12 metres wide and two lanes each direction, comprising eleven span precast Super T girders.

Intersections

The proposal would require the construction, upgrade and/or adjustment of local road, service road and connecting road intersections, as summarised in Table 3-4.

Table 3-4 Proposed intersection upgrades

Intersection	Description
Little Hartley to River Lett Hill	
Great Western Highway and eastbound rest area	Single eastbound exit lane into rest area. Exist via Connecting Road 4 T intersection.
Great Western Highway and Connecting Road 4	Left in movement with dedicated left hand turn lane from Great Western Highway eastbound. Left out movement to dedicated lane, then merge onto Great Western Highway eastbound.
Connecting Road 5 and Service Road 3	T intersection with all movements permitted.
Connecting Road 5 and westbound rest area	T intersection with all movements permitted.
Coxs River Road	
Great Western Highway and Connecting Road 2	Left in movement with dedicated left hand turn lane from Great Western Highway westbound. Left out movement to merge onto Great Western Highway westbound.
Coxs River Road and Connecting Road 2	T intersection with all movements permitted.
Great Western Highway and Connecting Road 3	Left in movement with dedicated left hand turn lane from Great Western Highway eastbound. Left out movement to merge onto Great Western Highway eastbound.

Intersection	Description
Connecting Road 3 and Service Road 2	T intersection with all movements permitted.
Great Western Highway and Baaners Lane	Seagull intersection with all movements permitted.
Service Road 2 and Browns Gap Road	T intersection with all movements permitted.
River Lett Hill to Forty Bends	
Great Western Highway and Kelly Street	Left in movement with dedicated left hand turn lane from Great Western Highway eastbound. Left out movement to merge onto Great Western Highway eastbound.
Great Western Highway Off Ramp 1	Single lane off ramp from Great Western Highway westbound.
Great Western Highway Off Ramp 1 and Old Great Western Highway	Left in movement with dedicated left hand turn lane from Great Western Highway Off Ramp 1 westbound. Right in movement from Great Western Highway Off Ramp 1 eastbound.
Great Western Highway Off Ramp 1 and Blackmans Creek Road	T intersection with all movements permitted.
Great Western Highway and Service Road 6	Single eastbound exit lane into Service Road 6.
Great Western Highway On Ramp 1	Single lane on ramp from Service Road 6 to Great Western Highway eastbound.
Great Western Highway Off Ramp 1 and Service Road 6 / Jenolan Caves Road	T intersection with all movements permitted.
Great Western Highway On Ramp 2	Single lane on ramp from Jenolan Caves Road to Great Western Highway westbound.
Great Western Highway and Service Road 8	Left in movement with dedicated left hand turn lane from Great Western Highway westbound. Left out movement to merge onto Great Western Highway westbound. Right in movement from dedicated lane on Great Western Highway eastbound.
Great Western Highway and Service Road 10	Left in movement with dedicated left hand turn lane from Great Western Highway eastbound. Left out movement to merge onto Great Western Highway eastbound. Right in movement from dedicated lane on Great Western Highway westbound.
Forty Bends to Lithgow	
Great Western Highway and Forty Bends Road (eastern junction)	Left in, left out movement from Great Western Highway westbound.
Great Western Highway and Forty Bends Road (western junction)	Seagull intersection with all movements permitted.

Intersection	Description
Great Western Highway and McKanes Falls Road	Seagull intersection with all movements permitted.
Great Western Highway and Service Road 11	Left in, left out movement from Great Western Highway westbound.
Great Western Highway and Old Bathurst Road	Seagull intersection with all movements permitted.
Great Western Highway and Service Road 12	Left in, left out movement from Great Western Highway eastbound.
Great Western Highway and Service Road 13	Left in, left out movement from Great Western Highway eastbound.
Great Western Highway and Mudgee Street	Seagull intersection with all movements permitted.

Service roads and property access

The proposal would involve creation of 10 service roads, as summarised in Table 3-5, to minimise direct access to the Great Western Highway from adjacent properties.

Property access would be maintained throughout construction and operation of the proposal, although some access may be relocated or reinstated to tie into new road levels, as shown in Figure 3-1.

Table 3-5 Proposed service roads

Service Road	Description
Little Hartley to River Lett Hill	
Service Road 1	New road. Accessed via Coxs River Road. Aligned adjacent to the Great Western Highway on the northern side.
Service Road 3	New road. Accessed via Connecting Road 4 for eastbound traffic and Connecting Road 5 for westbound traffic. Allows for Mid Hartley Road and Carroll Drive intersections to remain in their current state.
Coxs River Road	
Service Road 2	New road with some overlap of the existing Great Western Highway alignment. Accessed via Connecting Road 3. Aligned adjacent to the Great Western Highway on the northern side. Allows for Brows Gap Road intersection upgrade.
River Lett Hill to Forty Bends	
Service Road 6	Existing Great Western Highway alignment. Accessed via Great Western Highway Off Ramp 1, Jenolan Caves Road and Great Western Highway Off Ramp 2. Allows for maintained property access.
Service Road 8	New tie in to Great Western Highway westbound, then utilises existing Great Western Highway alignment to allow for maintained property access. Cul-de-sac proposed at eastern end of service road.

Service Road	Description
Service Road 9	New road. Adjoins the existing Great Western Highway alignment north of the proposed highway to allow for property access.
Service Road 10	New tie in to Great Western Highway, then utilises existing Great Western Highway alignment to allow for maintained property access.
Forty Bends to Lithgow	
Service Road 11	New tie in to Great Western Highway westbound to allow for maintained property access.
Service Road 12	New road. Adjoins the existing Great Western Highway alignment eastbound north of the proposed highway to allow for property access.
Service Road 13	New road. Adjoins the existing Great Western Highway alignment eastbound north of the proposed highway to allow for property access.

Batters and retaining walls

Batter slopes and earthworks have been designed in accordance with the proposal design criteria. Batter slopes are predominantly 2:1 except in areas of low cut and fill where 4:1 batters can be accommodated. The development of the road design has considered cut and fill earthworks balance and the need to provide an alignment that is well suited to the undulating topography. Benches for earthworks (i.e. a series of horizontal steps) would be provided where:

- A cut or fill batter steeper than 2:1 is higher than seven metres
- A cut or fill batter of 2:1 or flatter is higher than 10 metres.

There are nine retaining walls required for the proposal, as summarised in Table 3-6.

Table 3-6 Proposed retaining walls

Retaining wall	Description
Coxs River Road	
RS11	Located on the Great Western Highway eastbound. Soldier piled wall with precast concrete facing panel about 5 metres high and 150 metres long.
River Lett Hill to Forty Bends	
RS21	Located on the Great Western Highway westbound. Soldier piled wall with precast concrete facing panel about 3 metres high and 75 metres long.
RS22	Located on the southern side of Off Ramp 1. L-shape concrete cantilever wall about 4.5 metres high and 80 metres long.
RS23	Located on the Great Western Highway westbound, east of the Jenolan Caves Road twin bridges. Reinforced soil wall about 8.5 metres high and 270 metres long.
Forty Bends to Lithgow	

Retaining wall	Description
RS31	Located on the Great Western Highway eastbound at the intersection with McKanes Falls Road. Soil nail wall with gabion basket facing about 285 metres long.
RS32	Located on the Great Western Highway eastbound, west of the McKanes Falls Road intersection to the Service Road 12 intersection. Soil nail wall with gabion basket facing about 600 metres long.
RS33	Located on the Great Western Highway eastbound, west of the Service Road 12 intersection to the Service Road 13 intersection. Soil nail wall with gabion basket facing about 315 metres long.
RS34	Located on the eastern side of Service Road 12. Soil nail wall with gabion basket facing about 200 metres long.
RS35	Located on the Great Western Highway westbound, north of the Old Bathurst Road intersection. Reinforced concrete cantilever fill wall with designer block facing about 225 metres long.

Drainage

Provision of cross and longitudinal drainage would be required for the proposal. This would include upgrades to existing pipes and culverts where feasible, as well as new drainage infrastructure for new sections of road, provision of scour protection and pit and pipe drainage where gutters are proposed. Structural culverts are described in Table 3-7. Drainage outlets would discharge to open channels, water quality basins or existing waterways depending on the quality of the runoff.

Table 3-7 Proposed structural culverts

Culvert	Description
Little Hartley to River Lett Hill	
CULBR19	Extension of the existing two cell 3.6 metre by 2.4 metre box culvert at Rosedale Creek.
River Lett Hill to Forty Bends	
CUL26.39	Single 3.3 metre by 3.3 metre reinforced concrete box culvert that is a combined fauna crossing and culvert located about 180 metres east of Off Ramp 1.
CULBR20	Extension of the existing four cell 2.7 metre by 2.7 metre box culvert at Boxes Creek.
CUL28.48	Single 3.3 metre by 3.3 metre reinforced concrete box culvert that is a combined fauna crossing and culvert located at Off Ramp 2.
CUL30.21	Single 3.3 metre by 3.3 metre reinforced concrete box culvert that is a combined fauna crossing and culvert located about 65 metres west of the Service Road 8 intersection.

Water quality treatment infrastructure

Construction phase sediment basins and permanent dry biofiltration basins are proposed to ensure runoff meets the relevant water quality criteria. ISome temporary sediment basins would be converted to permanent dry biofiltration basin at the completion of construction.

Sediment and biofiltration basins are shown in Figure 3-1 and summarised in Table 3-8.

Table 3-8 Temporary sediment basins and permanent biofiltration basins

Basin	Description
Coxs River Road	
B22400L	520 cubic metre construction sediment basin that would be converted to a 600 square metre (base) permanent dry biofiltration basin after construction is completed
B22780L	700 cubic metre construction sediment basin that would be converted to a 500 square metre (base) permanent wet biofiltration basin after construction is completed
B22925L	720 cubic metre construction sediment basin.
B23080L	250 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B23740L	620 cubic metre construction sediment basin.
B23900L	300 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B24125L	480 cubic metre construction sediment basin.
B24210L	250 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B24400L	300 cubic metre construction sediment basin.
River Lett Hill to Forty Bends	
B26550R	100 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B26920R	100 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B27040L	100 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B27680L	1300 cubic metre construction sediment basin that would be converted to a 350 square metre (base) permanent dry biofiltration basin after construction is completed.
B28400L	2975 cubic metre construction sediment basin that would be converted to a 670 square metre (base) permanent dry biofiltration basin after construction is completed.
B30220L	685 cubic metre construction sediment basin.
B301150L	400 square metre (base) permanent dry biofiltration basin.

Basin	Description
B30400L	540 cubic metre construction sediment basin.
B30880L	485 cubic metre construction sediment basin that would be converted to a 200 square metre (base) permanent dry biofiltration basin after construction is completed.
Forty Bends to Lithgow	
B3470L	200 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B3442L	175 square metre (base) permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B3398L	510 cubic metre construction sediment basin that would be converted to a 200 square metre (base) permanent dry biofiltration basin after construction is completed.
B3362L	460 square metre construction sediment basin that would be converted to a 300 square metre (base) permanent dry biofiltration basin after construction is completed.
B3330L	220 square metre permanent dry biofiltration basin. Basin would be utilised as a sediment basin during construction.
B3182L	Existing 1980 cubic metre permanent dry biofiltration basin. The existing 35 metre long swale would require widening of its base width to 4 metres.
B3142L	Existing 900 cubic metre permanent dry biofiltration basin. The existing 70 metre long swale would require widening of its base width to 4 metres.
B3112L	Existing 350 square metre (base) permanent dry biofiltration basin may be upgraded. This would be determined as design progresses.

Fauna crossing structures

There are three proposed fauna crossing culverts within the River Lett Hill to Forty Bends Section, as described in Table 3-7 and shown in Figure 3-1. Existing fauna crossings within the Forty Bends to Lithgow Section would be maintained.

Design of underpasses would be in accordance with *Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects (draft)* (Roads and Maritime, 2011) and best available knowledge from other Transport projects.

Roadside furniture

Roadside furniture, including safety barriers, fencing, signposting, line marking and lighting, that would be installed or modified for the proposal are described below.

Safety barriers

The following types of safety barriers are proposed:

- Wire rope safety barrier for nearside shoulder treatments and mainline median consistent with existing conditions where earthworks are not constrained
- Steel rail safety barrier for nearside shoulder treatments in constrained locations and bridge barrier transitions
- Type F concrete barrier in constrained locations in the mainline median such as narrow medians and bridge abutments
- High containment safety barrier compliant with MASH TL4 load rating in areas of the Forty Bends to Lithgow Section that are narrow with a known risk of black ice formation
- Temporary safety barriers are to be used as part of the staging strategy to control access and delineate the construction work area in accordance with the staging arrangements.

Fencing

Rural boundary fencing is proposed around the carriageway. Where the existing boundary fencing of adjacent properties is impacted, it would be reinstated in consultation with property owners.

Fauna fencing would be installed in wildlife connectivity areas to reduce the risk of vehicle strike and fauna mortality as well as guide fauna towards fauna crossing structures.

Signposting

The signposting scheme for the proposal would provide clear and unambiguous direction and information to motorists, achieving a safe and compliant design. Signs would be installed to enforce road rules and regulations, indicating items such as the direction of travel, posted speed limits, and parking restrictions. Directional signs would also be provided to advise of key destinations, places of interest and through routes.

Line marking

Line marking would be provided in accordance with Transport's design and construction specifications. The proposed line marking would comprise of longitudinal markings (lane lines, edge lines, continuity lines), transverse markings (stop/hold lines, give way lines), posted speed numerals and pavement arrows to provide clear driver information. Symbols, lettering and numerals would be clearly drawn at a size that is easily readable from a distance while travelling at the nominated speed limit.

Lighting

Lighting is not required on the main carriageway but would be provided at intersections and connecting roads for safety reasons as required. In the Forty Bends to Lithgow Section, lighting provided in the 2017 road upgrade will be upgraded from 150 Watt HPS luminaires to 100 Watt LED luminaires.

Hartley Valley Rest Areas

There are two rest areas included as part of the proposal, referred to as the Hartley Valley Rest Areas. The rest areas are located within the Little Hartley to River Lett Section, one eastbound and one westbound as seen in Figure 3-1. These rest areas will have provisions for both light and heavy vehicles, as well as facilities including restrooms and picnic tables with seating.

Intelligent Transport Systems infrastructure

The existing communications infrastructure would be utilised for the Intelligent Transport Systems (ITS) power and communications, however conduits have been provided for the full extent of the Great Western Highway to facilitate the future provision of ITS infrastructure.

Shared paths

Design development has considered the future development of shared paths in the vicinity of the proposal. The alignment and structure of the future shared paths would be developed and finalised during future design development and in consultation with Lithgow City Council and other relevant stakeholders. An indicative route is provided in Appendix R.

3.3 Construction activities

This section describes how the proposal would be constructed. The methodology presented in this section would be refined during further design development.

The proposal construction footprint is shown in Figure 3-3. The areas highlighted in orange would be used as ancillary facilities, as detailed in Section 3.4.

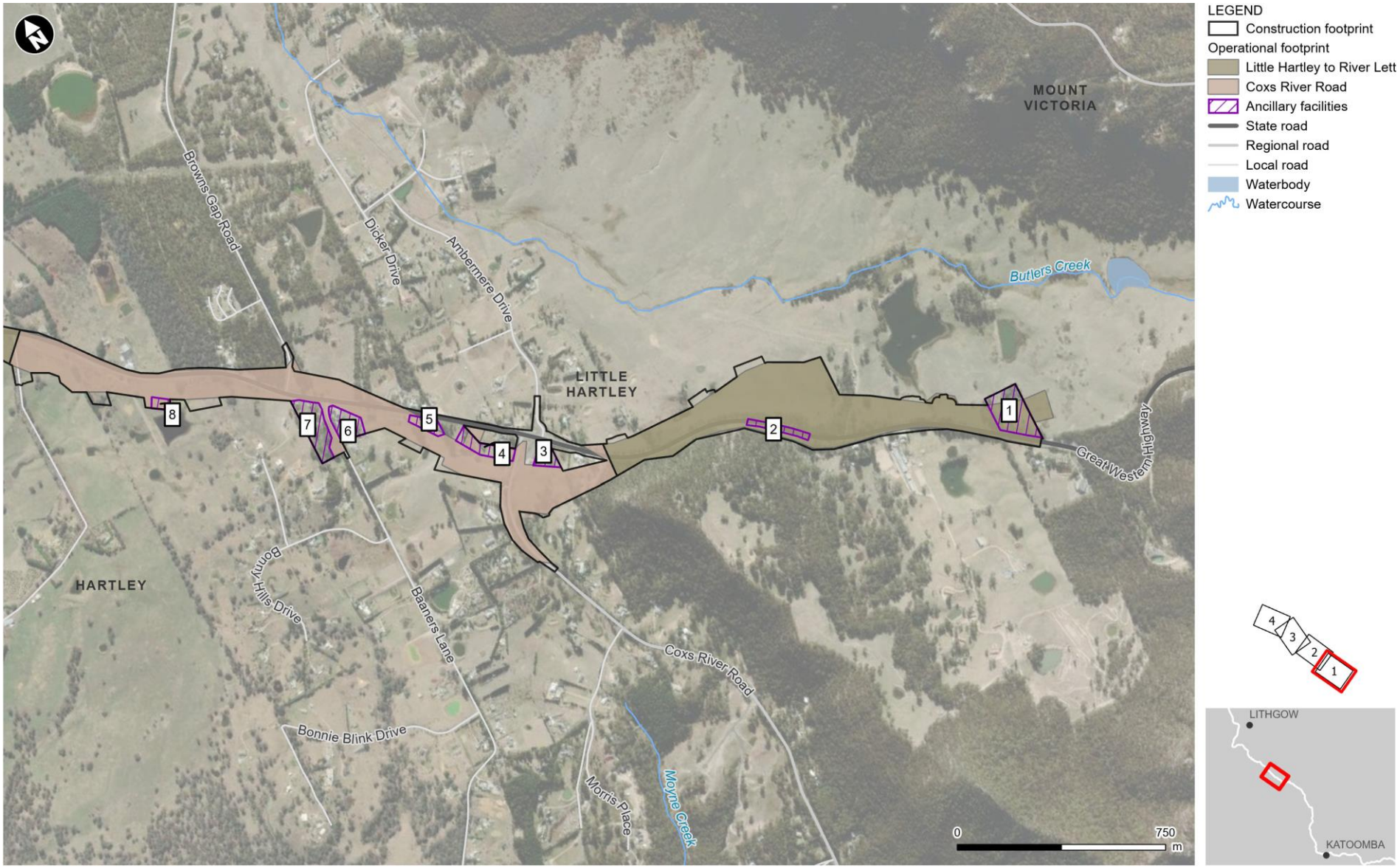


Figure 3-3 a Proposal construction footprint

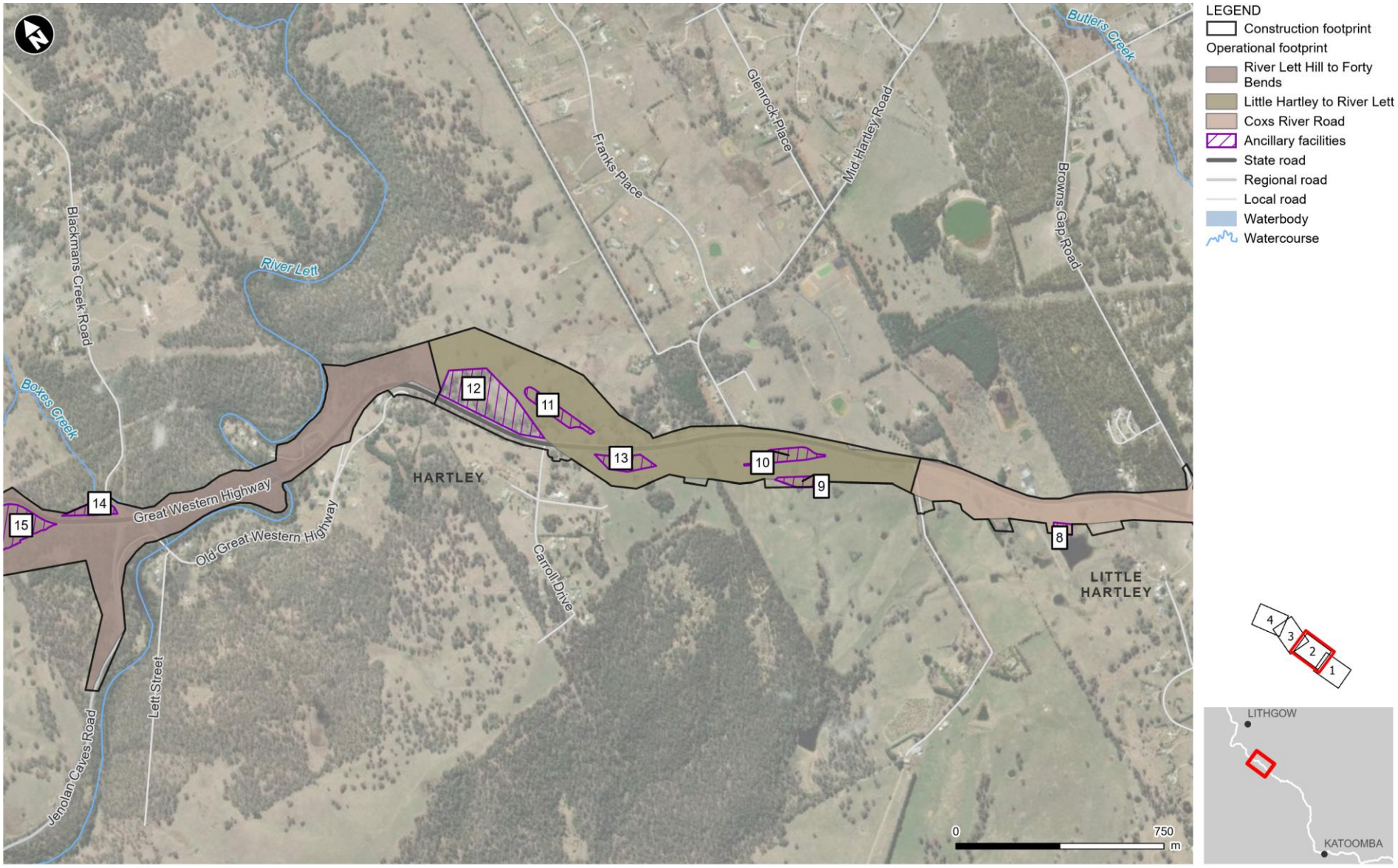


Figure 3-3 b Proposal construction footprint

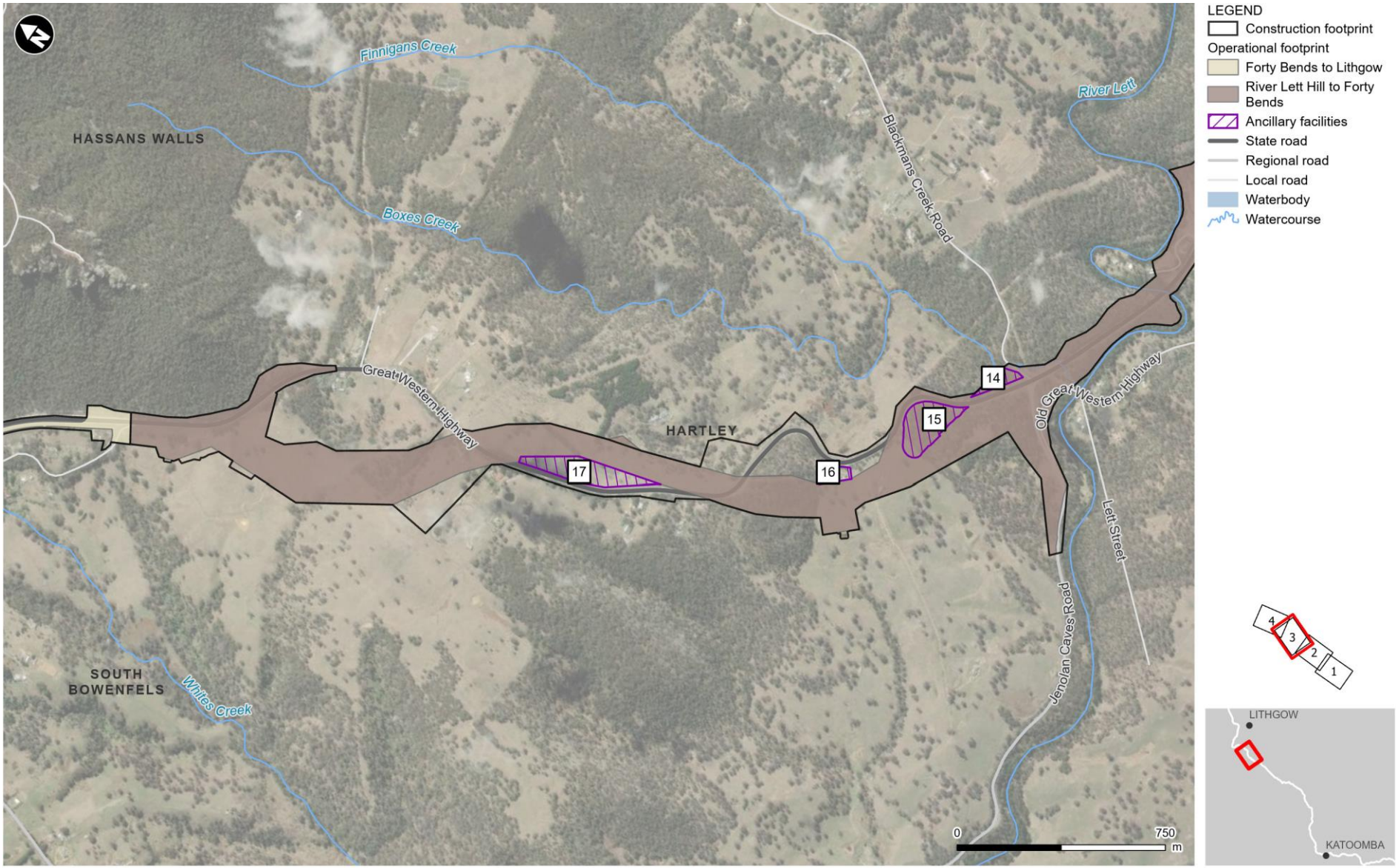


Figure 3-3 c Proposal construction footprint

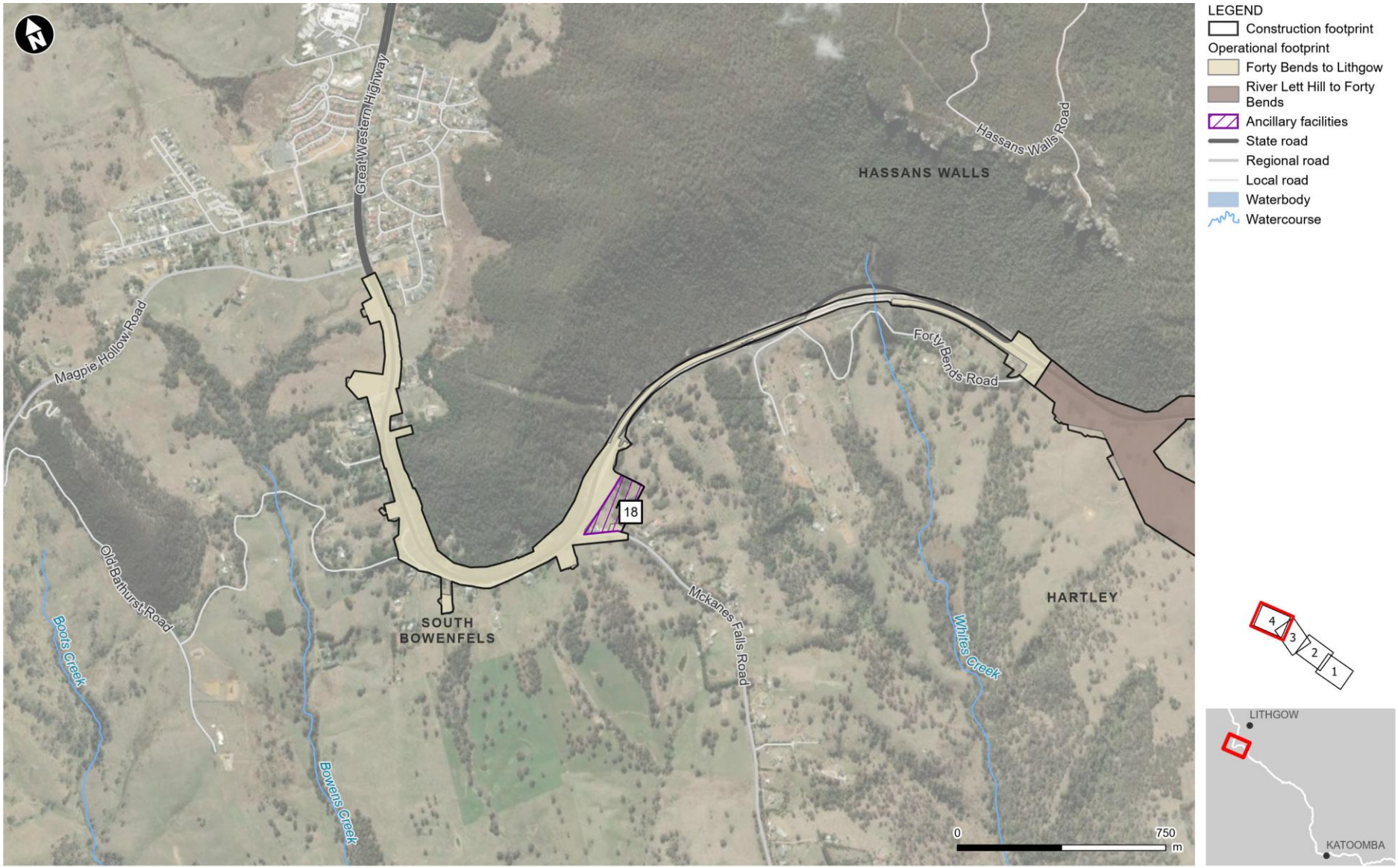


Figure 3-3 d Proposal construction footprint

3.3.1 Work methodology

Indicative construction work methodologies are provided below. Detailed construction work methodologies would be identified by the construction contractor following award of the tender. Construction activities would be carried out in accordance with a Construction Environmental Management Plan (CEMP) to ensure work complies with Transport's commitments and legislative requirements.

Construction staging

Detailed construction staging strategy reports have been prepared for each section of work (JAJV, 2021). Construction at each section of the proposal would generally involve the sequence of activities described in Table 3-9. A summary of the construction staging for each section are provided in Table 3-10 to

Table 3-13. The staging presented has been prepared to demonstrate that the works can feasibly and practically undertaken but may well be modified by the construction contractor following award of tender.

Table 3-9 Indicative construction activities

Construction phase	Typical activities
Pre-construction and early works	• Demarcation of construction footprint with construction fencing and temporary safety barriers where required • Installation of erosion and sediment controls • Set up of temporary traffic management arrangements.
Site establishment	• Pre-clearing biodiversity surveys • Vegetation clearing and grubbing • Mobilisation and establishment of ancillary facilities as described in Section 3.4 and shown in Figure 3-3**.**
Construction	• Works as described in Table 3-10, Table 3-11, • • Table 3-12 and • Table 3-13.
Finishing work	• Rehabilitation of disturbed areas and landscaping in accordance with the urban design and landscape plan • Installation of safety barriers, street lighting, fencing and other roadside furniture • Decommission and rehabilitation of ancillary facilities

Table 3-10 Little Hartley to River Lett Hill Section construction staging

Stage	Site	
	East	West
1	Construction of Service Road 1 and sections of the new Great Western Highway that are offline from the existing Great Western Highway. • Clearing and grubbing • Environmental management measures implementation • Bulk Earthworks, including importing large fill volumes • Drainage and pavements for the Great Western Highway and Service Road 1 • Bridge over the Great Western Highway on Service Road 1 • Culvert extension of existing two cell 2.4 metre by 3.6 metre wide box culvert (CULBR19) Stage 1 East works would ideally commence during the Coxs River Road section works.	Construction of Service Road 3 and sections of the new Great Western Highway that are offline from the existing Great Western Highway. • Clearing and grubbing • Environmental management measures implementation • Bulk Earthworks, including excess excavated material • Drainage and pavements • Bridge over the Great Western Highway on Service Road 1 Stage 1 West works would commence concurrently with Stage 1 East works.
2	Construction of the section of the new Great Western Highway that overlaps the existing Great Western Highway. • Switch traffic to Service Road 1 • Clearing and grubbing • Environmental management measures implementation • Bulk earthworks • Drainage and pavements for the Great Western Highway.	Construction of the section of the new Great Western Highway that overlap the existing Great Western Highway. • Switch traffic to Service Road 1 • Clearing and grubbing • Environmental management measures implementation • Bulk earthworks • Drainage and pavements for the Great Western Highway.
3	• Final traffic switch only new Great Western Highway • Tie-in to River Lett Hill to Forty Bends Section and Coxs River Road Section • Landscaping • Final pavement markings.	

Table 3-11 Coxs River Road Section construction staging

Stage	Site			
	Overall	Coxs River Road	Browns Gap Road	Banners Lane
1	• Clearing and grubbing • Environmental management measures implementation • Provide access to Hartley Café from Browns Gap Road • Bulk earthworks • Drainage and pavement • Construction of Service Road 2 to facilitate offline construction of the proposal. At the completion of Stage 1, traffic would be switched onto Service Road 2 with connections to Browns Gaps Road and Baaners Lane.	No works occurring.	• Construct Service Road 2 to final levels with the exception of Browns Gap Road alignment • Temporary road closure at Browns Gap Road would be required to construct the new Browns Gap Road connection. Traffic would be detoured via Mid Hartley Road • Switch traffic onto new Browns Gap Road and Service Road 2.	• Temporary connection between Baaners Lane and Service Road 2.
2	• Clearing and grubbing • Environmental management measures implementation • Bulk earthworks • Drainage and pavement • Construct bridge over the Great Western Highway on Coxs River Road • Retaining wall works adjacent to the Lolly Bug • Maintain property accesses.	• Maintain connectivity with the existing highway and properties • Construct offline sections of new Coxs River Road and bridge • Construct temporary side-track adjacent to Coxs River Road • Switch traffic onto temporary side-track and reduce posted speed to 40 kilometres per hour to construct Coxs River Road connection	No works occurring. All works completed.	• Construct new Great Western Highway to final levels with the exception of Baaners Lane alignment • Construct temporary side-track in adjacent lot • Switch traffic onto temporary side-track and reduce posted speed to 40 kilometres per hour to construct Baaners Lane connection

Stage	Site			
	Overall	Coxs River Road	Browns Gap Road	Banners Lane
	At the completion of Stage 2, the traffic would continue on Service Road 2.	• Switch traffic onto new Coxs River Road.		• Switch traffic onto new Baaners Lane.
3	Provide local road and property access across the Coxs River Road Section to the existing Great Western Highway or Service Road 2. The completed Great Western Highway mainline would remain closed to traffic until the Little Hartley to River Lett Hill Section is completed.			

Table 3-12 River Lett Hill to Forty Bends Section construction staging

Stage	Site			
1	1 Hartley Historic Village	2 River Lett to Jenolan Caves Road	3 River Lett Hill	4 Top of River Lett Hill
	• Retaining wall works adjacent to the Royal Hotel (RS21) • Pavement works adjacent to RS21 • New access to Hartley Historic Village • Adjustment to westbound lane and shoulders to provide additional width for adjacent construction.	• Off Ramp 1 construction • Retaining wall works adjacent to Off Ramp 1 (RS22) • Extension of existing culvert at Boxes Creek (CULBR20) • Temporary connection between Off Ramp 1 and the existing Great Western Highway north of Blackmans Creek Road • Piles and pile capes for piers 7 and 8 of the twin bridges over Jenolan Caves Road (BR32)	Construction of a temporary connection road and supporting retaining wall on the northern side of the proposed Great Western Highway to be used during Stage 2 to divert traffic off the existing highway, permitting the decommissioning of the existing highway and allowing unimpeded construction access along the new highway corridor.	Construction of Service Road 8 Temporary access road between the existing Great Western Highway and Service Road 8
2	1		2	

Stage	Site	
	East of Jenolan Caves Road	**West of Jenolan Caves Road**
	• Embankment construction • Excavation of various cuttings on approaches to bridges • Temporary median pavement for cross over to be used during Stage 3 • Temporary pavement/access road for left turn into Hartley Historic Village and access to Off Ramp 1 • Retaining wall works on the eastern approach of the twin bridges over Jenolan Caves Road (RS23) • Construction of the twin bridges over River Lett (BR31) • Construction of the twin bridges over Jenolan Caves Road (BR32) • Construction of combined drainage and fauna culvert (CUL26.39).	• Embankment construction • Excavation of large cuttings on River Lett Hill • On Ramp 1 and On Ramp 2 construction • Off Ramp 2 construction • On Ramp • Retaining wall works adjacent to Service Road 6 (RS34) • Construction of combined drainage and fauna culverts (CUL28.48, CUL30.21) • Temporary pavement connection between Service Road 6 and the Great Western Highway ramps.
3A	**1** **Eastern limit of works to River Lett**	**2** **Service Road 10 to Forty Bends**
	• Off Ramp 1 construction • Construction of the westbound carriageway	• Construction of Service Road 10 • Construction of the eastbound carriageway. Once completed, these works would allow access for the construction of Service Road 9 in Stage 3B.
3B	**1** **Hartley Historic Village**	**2** **River Lett Hill**
	• Construction of the westbound carriageway • Removal of the temporary pavement	• Removal of the temporary Great Western Highway connection • Construction of Service Road 9
3C	**1** **Twin bridges over Jenolan Caves Road**	

Stage	Site
	• Removal of temporary Off Ramp 1 connection • Construction of Jenolan Caves Road • Construction of Off Ramp 1 between the box culverts and Jenolan Caves Road • Construction of Service Road 6 and final pavement connections to the on and off ramps • Construction of Blackman's Creek Road • Removal of abandoned pavements, leveling and finishing works at the Jenolan Caves Road intersection.

Table 3-13 Forty Bends to Lithgow Section construction staging

Stage	Site			
	1 Forty Bends: Added lane in verge	2 Forty Bends: Added lane in median	3 South Bowenfels: Eastern Section	4 South Bowenfels: Western Section
1	All proposed works within Site 1 would be completed in Stage 1. • Construction of temporary median crossover would be constructed to allow for general traffic to flow onto the westbound carriageway (ie into Site 2) and allow single lane traffic flow in both directions • Concrete pavement reconstruction and widening along the westbound verge	No works occurring. Site 2 would be used for single lane traffic flow in both directions to allow for construction at Site 1.	• Construction of about 225 metres of new permanent pavement and gutter and about 155 metres of temporary pavement to allow for traffic diversion and enable Stage 2 and 3 works to be completed safely • Offline construction of the new eastbound carriageway, including earthworks to enable carriageway widening and securing cut retaining walls with a gabion facing (ie wire mesh cage with rocks or stones).	• Construction of two sections of temporary pavements pavement to allow for traffic diversion and enable Stage 2 and 3 works to be completed safely • Earthworks, drainage and full pavement construction for the new westbound carriageway • Construction of the Mudgee Street intersection pavement and widening works • Sediment basins and erosion control provisions.

Stage	Site			
	1 Forty Bends: Added lane in verge	2 Forty Bends: Added lane in median	3 South Bowenfels: Eastern Section	4 South Bowenfels: Western Section
	• Construction of the new intersection island at Forty Bends Road • Construction of new pit and pipe drainage. Following the completion of Stage 1 at Site 1, the dual lane carriageway would be opened to traffic.			
2	No works occurring. All works completed.	• Concrete pavement reconstruction and widening along Great Western Highway eastbound median • Utilities relocation works • Construction of new island at the intersection of Forty Bends Road through the median • Construction of new pit and pipe drainage and culvert extensions.	• Traffic reduced to a single lane in each direction along the existing Great Western Highway • Completion of excavation and cut retaining walls that commenced in Stage 1 • Drainage works associated with the eastbound carriageway • Asphalt pavement works on the eastbound carriageway.	• Completion of the eastbound carriageway earthworks and property accesses • Drainage works on the eastbound carriageway • Asphalt pavement works on the eastbound carriageway.
3	No works occurring. All works completed.	No works occurring.	• Completion of westbound carriageway earthworks and property accesses • Construction of McKanes Falls Road and Old Bathurst Road intersection works	• Completion of westbound carriageway earthworks • Completion of westbound carriageway asphalt pavement works

Stage	Site			
	1 Forty Bends: Added lane in verge	2 Forty Bends: Added lane in median	3 South Bowenfels: Eastern Section	4 South Bowenfels: Western Section
			• Drainage works on the westbound carriageway • Asphalt pavement works on the westbound carriageway.	• Final pavement course and line marking.
4	No works occurring. All works completed.	Stage 4 works are proposed to be undertaken with a single lane open to traffic on each carriageway. Works would be undertaken with reduced traffic speed depending on conditions during this period. Stage 4 is the final stage of works and involve the following: • Final signage • Median island and barrier works • Remaining intersection pavement within the median • Removal of any temporary median cross overs. At the completion of Stage 4, all carriageway and intersections are completed and can be fully opened to traffic at their final posted speed.		

3.3.2 Construction workforce

The indicative construction workforce that would be required at each stage of works is described in Table 3-14.

Table 3-14 Indicative construction workforce

Section	Indicative maximum workforce required (number of full time equivalents)
Little Hartley to River Lett Hill	60 to 100
Coxs River Road	60 to 100
River Lett Hill to Forty Bends	120 to 200
Fort Bends to Lithgow	60 to 100

3.3.3 Construction hours and duration

Subject to planning approval, construction of the proposal is planned to commence in 2022 and is expected to be open by the end of 2026.

A high-level construction program has been developed during concept design development that would be refined during further design development.

The current construction staging starts with the Coxs River Road section, with a construction program of about 14 months. the Little Hartley to River Lett Hill (West) section would be constructed concurrently with the River Lett Hill to Forty Bends section, and would take about three years to complete. The Forty Bends to Lithgow section would take about 18 months to complete.

Construction hours would be in accordance with the standard construction hours as defined in the *Interim Construction Noise Guideline* (DECCW, 2009):

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturday
- No work on Sundays and public holidays.

Certain construction activities that may result in traffic restrictions including bringing in oversized equipment and materials such as bridge girders and pavemnt resurfacing are likely to be carried out outside of Standard Construction Hours during night-time periods to minimise disruption to traffic and provide a safer working environment for construction workers. Any work outside of standard construction hours would be undertaken in accordance with the *Interim Construction Noise Guideline* (DECC 2009), the *Construction Noise and Vibration Guidelines* (Roads and Maritime, 2016), any road occupancy licence requirements and the environmental management measures listed in Section 7.

Potential construction work that would be carried out outside of standard construction hours is described in Table 3-15. Consultation with the community would be carried out before any work proposed to be carried out outside of standard construction hours in accordance with the proposal's community consultation strategy.

Table 3-15 Potential work outside of standard construction hours

Activity	Justification
Temporary median crossover construction	A temporary median crossover would be constructed during the Forty Bends to Lithgow section construction works to allow for general traffic to flow onto the westbound carriageway. This work would be completed out of standard construction hours to minimise road users disruption.
Utility adjustments	Some utility relocations would require work near the carriageways and crossing the carriageways. This work would need to be completed outside of standard construction hours to minimise road users disruption and maintain the safety of construction personnel.
Delivery and placement of large precast concrete components	The delivery and placement of large precast concrete components (eg bridge girders) would take place outside of standard construction hours to minimise disruptions to highway and local traffic flows and maintain the safety of construction personnel. Due to the potential safety risks to road users and construction personnel associated with operating over the existing alignment, these works would need to be undertaken at night when there are lower traffic flows. Avoiding peak periods would also minimise the disruption to traffic.
Construction of major drainage structures	Major drainage structures located beneath or near the carriageways may need to be undertaken during out of hours work to minimise the impact on road users and ensure the safety of workers involved.
Completion of tie-ins, and completion of temporary diversions and traffic switches	Large parts of the proposal would be built offline. The tie-ins would require some level adjustments and new pavement construction which would need to be built outside of standard construction hours to minimise performance and safety impacts for Great Western Highway and local road traffic.

3.3.4 Plant and equipment

The following equipment are likely to be used during construction of the proposal:

- Air compressors
- Asphalt pavers
- Asphalt profiling machines
- Backhoes
- Bitumen sprayers
- Bobcats
- Boggie trucks
- Bulldozers
- Chainsaws
- Cherry pickers
- Chipping machines
- Compactors
- Compressors
- Concrete agitator trucks
- Concrete mixers
- Concrete pavers
- Concrete pumps
- Concrete saws
- Concrete-cutting saws
- Cranes
- Crushing and screening plant

- Dewatering pumps
- Drill/boring rigs
- Dump trucks
- Elevated working platforms
- Excavators
- Flatbed trucks
- Front-end loaders
- Generators
- Graders and rollers
- Hand tools
- Hydraulic hammer
- Jack hammers
- Kerb extrusion machine
- Light commercial and passenger vehicles
- Lighting units
- Line marker
- Milling machines
- Pre-splitting equipment
- Road headers
- Road rollers
- Road sweepers
- Rock breakers
- Rock crushers
- Scrapers
- Semi-trailers and large haulage trucks
- Trenching machine
- Side Tripping Trucks
- Under-bore equipment
- Vibratory rollers
- Water carts
- Welding equipment

The plant and equipment listed would be subject to refinement of design and during the construction planning phase. Not all of the above plant and equipment would be in use at any one time, and some would only be used on an intermittent or temporary basis.

Further details of construction plant and equipment will be determined during the detailed design.

3.3.5 Earthworks

Due to the topography of the local area, a series of cut and fill earthworks would be required for each stage, as described below and summarised in Table 3-16. The majority of cuttings will be excavated by ripping, however in areas where high strength rock is encountered, blasting will be required. There are two large cuts in the River Lett to Forty Bends Section that will require blasting, as described below.

The proposal has been designed to minimise excess spoil and the need to import large quantities of fill. Overall, earthworks would require (to the nearest 1,000 cubic metres) about 1,547,000 cubic metres of excavation and about 2,273,000 cubic metres of fill. The current design would therefore require the importing of about 726,000 cubic metres.

The proposal would need to source additional earth fill material from off site to meet this deficit. The quantity and quality of required material is available from other projects and/or established quarries in the local area (refer to Section 3.3.6).

A Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the *Protection of the Environment Operations (Waste) Regulation 2014* for excavated natural material would be required to meet the conditions for excavated natural material that is, or is intended to be, for use in earthworks for the proposal.

Blasting

Construction of the deep cut through River Lett Hill will require a significant amount of blasting to remove the large volume of hard rock. A blasting specialist has been engaged and would further inform the blasting methodology, including times, road closures and diversions, as detailed design progresses. Blasting would only occur during standard construction hours (as described in Section 3.3.3) and, for safety reasons, would require all Great Western Highway traffic to be stopped for five to 15 minutes at a time for each blast. A blasting management plan would be prepared to mitigate and manage impacts of blasting as discussed in Section 6.3 Noise and vibration and Section 6.6 Soils and surface water. There is also the potential for flyrock (rock that is ejected from the blast site) to impact areas up to 500 metres from the point of each blast. A Flyrock management plan would be developed in consultation with technical specialists, as discussed in Section 6.3 Noise and vibration.

Table 3-16 Cut and fill requirements

Stage	Cut (cubic metres)	Fill (cubic metres)	Difference (cubic metres)
Little Hartley to River Lett Hill	534,000	688,000	154,000
Coxs River Road	177,000	225,000	48,000
River Lett Hill to Forty Bends	793,000	1,272,000	479,000
Forty Bends to Lithgow	43,000	88,000	45,000
Total	1,547,000	2,273,000	726,000

3.3.6 Source and quantity of materials

Construction would require various resources and materials. Typical materials that would be used for the construction of the proposal and estimated quantities are presented in Table 3-17.

The source of materials required to construct the proposal would be finalised during detailed design through the development of a construction materials and resources plan. Material source would comply with relevant Transport material quality specifications.

Table 3-17 Typical construction materials and approximate quantities

Material	Approximate quantity
Imported fill material	726,000 m^3
Imported select material	180,000 m^3
Asphalt	344,850 m^2
Concrete	339,000 m^3
Steel	4,400 T

Earthworks materials

Imported earthworks material would be required. The source of materials required to construct the proposal would be finalised by the construction Contractor through the development of a construction materials and resources plan. Where possible, materials would be sourced from the surrounding area. There are numerous quarries in Little Hartley and Lithgow, which is located within 30 kilometres of the proposal, as well as the proposed Great Western Highway Upgrade – Central Package which requires substantial excavation, that could provide suitable material.

Asphalt pavement materials

Asphalt pavement materials would be sourced from existing batch plants operating within the Lithgow City local government area and beyond. If batching plants are needed closer to the proposal, they would be established within ancillary facilities located on land owned by Transport.

Reinforced steel

Reinforcing steel for structures would be sourced from suppliers throughout Australia. The construction contractor would select a source that conforms to the quality and performance requirements of the proposal.

Concrete

A number of concrete batching plants are located near the proposal. Concrete for the bridge, pavement sub-bases and other proposal elements would be sourced from local batch plant facilities selected by the construction contractor with agitator trucks delivering to the work fronts via the haulage routes presented in Section 6.2 Traffic and Transport. If batching plants are needed closer to the proposal, they would be established within ancillary facilities located on land owned by Transport.

3.3.7 Traffic management and access

Construction of the proposal would result in a temporary increase in heavy vehicle movements along the Great Western Highway and nearby local roads. Construction traffic associated with the proposal at all construction stages would generate a range of vehicle type movements including cars, light and heavy trucks and concrete trucks. Construction vehicle traffic would be greatest during the main earthworks and road pavement construction stages, and would comprise vehicles transporting equipment, materials and spoil and construction workers accessing the work sites.

Construction of the proposal would be subject to comprehensive traffic management measures to ensure the ongoing functionality of the Great Western Highway and local roads, and the safety of members of the public, motorists and construction workers.

Temporary Traffic management arrangements

Temporary construction traffic management arrangements would be required in each section of the proposal. The construction staging strategy reports prepared for each section of work (JAJV, 2021) provide an overview of the temporary construction traffic management arrangements. In particular, there are two road closures required during certain stage of construction:

- Coxs River Road - road closure of Browns Gap Road would be required to construct the new pavement at the intersection of Service Road 2 and Browns Gap Road. Detoured traffic would utilise Mid Hartley Road to reconnect to the Great Western Highway northwest of the Browns Gap Road and Great Western Highway intersection
- River Lett Hill to Forty Bends - blasting would require temporary closures of the existing highway to maintain safety. All Great Western Highway traffic would be stopped for five to 15 minutes at a time for each blast.

Detailed arrangements would be developed during construction planning and described in a traffic management plan.

Construction vehicle movements and haulage routes

High level estimated daily construction light and heavy vehicle movements are presented in Table 3-18.

Mass haulage of materials would be undertaken within the construction site by off-road vehicles. Where it is not feasible to use off-road vehicles, mass haulage will be carried out with on-road vehicles using the existing Great Western Highway. Some haulage would take place on local roads between the ancillary facilities. Internal access roads would provide vehicle access between work sites and ancillary facilities.

Controlled construction would use controlled construction traffic entry and exit points and these would be minimised. The use of the existing highway would be restricted at peak hours, especially during holiday periods. This may require the introduction of temporary traffic management measures, which would be determined in the construction traffic management plan for the proposal (as discussed in Section 6.2 Traffic and Transport).

Table 3-18 High-level estimated daily construction vehicles movements

Section	Estimated daily construction vehicle movements in the Great Western Highway		
	Light vehicles	Heavy vehicles	Total
Little Hartley to River Lett Hill	200	320 to 420	520 to 620
Coxs River Road	200	167 to 487	367 to 687
River Lett Hill to Forty Bends	400	218 to 450	618 to 850
Forty Bends to Lithgow	200	88 to 450	288 to 650

Public and active transport arrangements

Existing public and active transport provisions would be maintained throughout construction of the Little Hartley to River Lett Hill stage of the proposal.

Property access arrangements

Access to residences, businesses and roads would be maintained during construction of the proposal. Any unavoidable temporary access closures would only be carried out following appropriate planning and consultation with the property owners.

3.4 Ancillary facilities

A number of ancillary facilities would be required to support the proposal construction. These ancillary facilities would include, but not be limited to:

- Portable buildings with amenities (such as lunchrooms and toilets)
- Secure and bunded storage areas for hazardous materials, including fuels and chemicals
- Dedicated stockpile sites
- Plant and equipment laydown areas
- Concrete and asphalt batching plants

- Office space
- Parking.

The selection criteria used to identify ancillary facility locations included, in order of priority:

- Sites located within or directly adjacent to the proposal construction footprint
- Sites to be located on land owned/acquired by Transport
- Sites that can be leased from Lithgow City Council
- Sites that can be leased from private property owners.

Eighteen locations have been identified for ancillary facilities, as summarised in Table 3-19 and shown in Figure 3-4. The potential environmental impacts associated with the ancillary facilities are assessed in Section 6. The location of any batching plants (if required) would be identified during construction planning and further assessment of potential impacts undertaken at this stage.

Table 3-19 Ancillary facilities

Ancillary facility	Lot and DP	Area (square metres)	Proposed use
Little Hartley to River Lett Hill (east)			
1	Lot 360 DP 751644	20,000	• Construction Compound • Stockpile • Eastern turnaround area
2	Existing Road Reserve	500	• Stockpile • Laydown and Storage
Coxs River Road			
3	Existing Road Reserve	5,000	• Construction Compound • Stockpile • Laydown and Storage
4	Lot 23 DP 837440	9,500	• Construction Compound • Stockpile • Laydown and Storage
5	Lot 1 DP 416067	9,500	• Construction Compound • Stockpile • Laydown and Storage
6	Lot 6 DP 1192566	10,000	• Construction Compound • Stockpile • Laydown and Storage
7	Lot 7 DP 1192566	16,600	• Construction Compound • Stockpile

Ancillary facility	Lot and DP	Area (square metres)	Proposed use
			• Laydown and Storage
8	Lot 14 DP 1192566	2,500	• Stockpile • Laydown and Storage
Little Hartley to River Lett Hill (west)			
9	Lot 15 DP 880798	5,100	• Stockpile • Laydown and Storage
10	Lot 15 DP 880798	8,650	• Stockpile • Laydown and Storage
11	Lot 11 DP 1192695	42,000	• Stockpile • Laydown and Storage • Batching plant
12	Lot 11 DP 1192695	10,800	• Stockpile • Laydown and Storage • Batching plant • Western turnaround area • Future use as the westbound rest area
13	Lot 15 DP 880798	8,100	• Main Site Compound • Stockpile • Laydown and Storage • Batching plant • Future use as the eastbound rest area
River Lett Hill to Forty Bends			
14	Lot 7035 DP 1057030 Lot 7030 DP 1057700	6,200	• Stockpile • Laydown and Storage
15	Existing Road Reserve	22,600	• Stockpile • Laydown and Storage
16	Lot 11 DP 734662	6,000	• Stockpile • Laydown and Storage
17	Lot 11 DP 1134053 Lot 3 DP 1187719	12,400 15,400	• Stockpile • Laydown and Storage
Forty Bends to Lithgow			

Ancillary facility	Lot and DP	Area (square metres)	Proposed use
18	Lot 1 DP 378232	22,000	• Stockpile • Laydown and Storage

3.5 Public utility adjustment

Some major public utilities are located within the proposal construction footprint. For any utilities where potential for relocation has been identified, further consultation with utility asset owners would be undertaken to determine opportunities for protection, rather than relocation, of utility assets.

A summary of the major utilities that would be impacted by the proposal are presented in Table 3-20 and shown in Figure 3-4. The main utilities considerations include the realignment or adjustment of overhead powerlines, overhead and underground communications assets and water mains. Separate Utilities Management Plans have been prepared for each section of work that would be refined during further design development.

Table 3-20 Major public utilities impacted by the proposal

Asset owner	Asset type	Stage	Relocation required?
Endeavour Energy	11kV and low voltage distribution overhead powerlines	Little Hartley to River Lett Hill Coxs River Road Forty Bends to Lithgow	Some sections would require relocation of the overhead powerline and poles. Protection is proposed for other sections. Additional survey may be required to confirm treatment in some areas.
	132kV transmission overhead powerlines	River Lett Hill to Forty Bends	Some sections would require relocation of the overhead powerline and poles. Disconnection and demolition is proposed for other sections. Connection points may require modification or relocation.
Telstra	Conduit and direct buried communication lines	Little Hartley to River Lett Hill Coxs River Road River Lett Hill to Forty Bends	Relocation and/or demolition would be required in some sections. Protection is proposed for other sections.
Lithgow City Council	Water mains	Forty Bends to Lithgow	Relocation would be required.

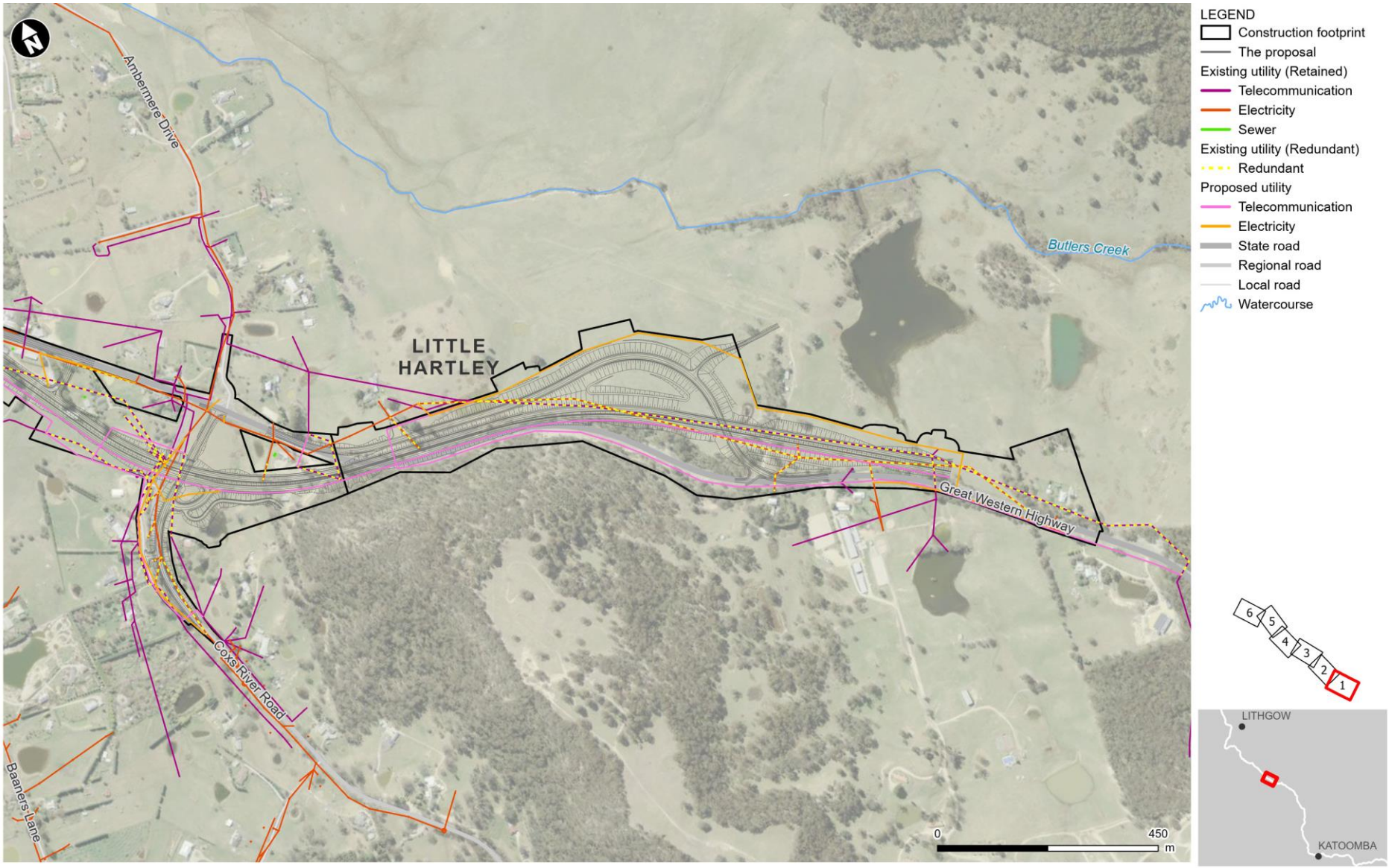


Figure 3-4 a Existing and proposed utilities

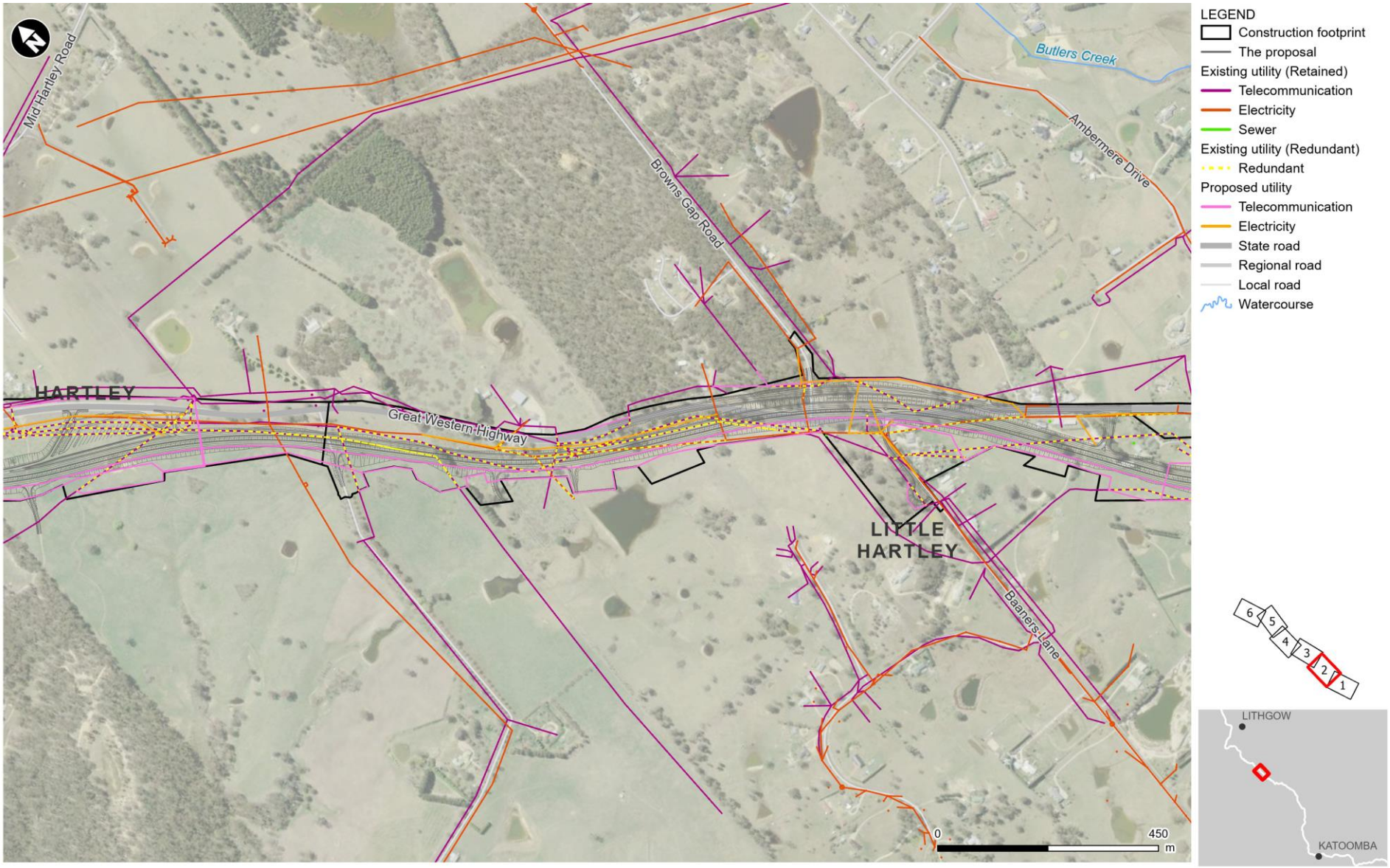


Figure 3-4 b Existing and proposed utilities

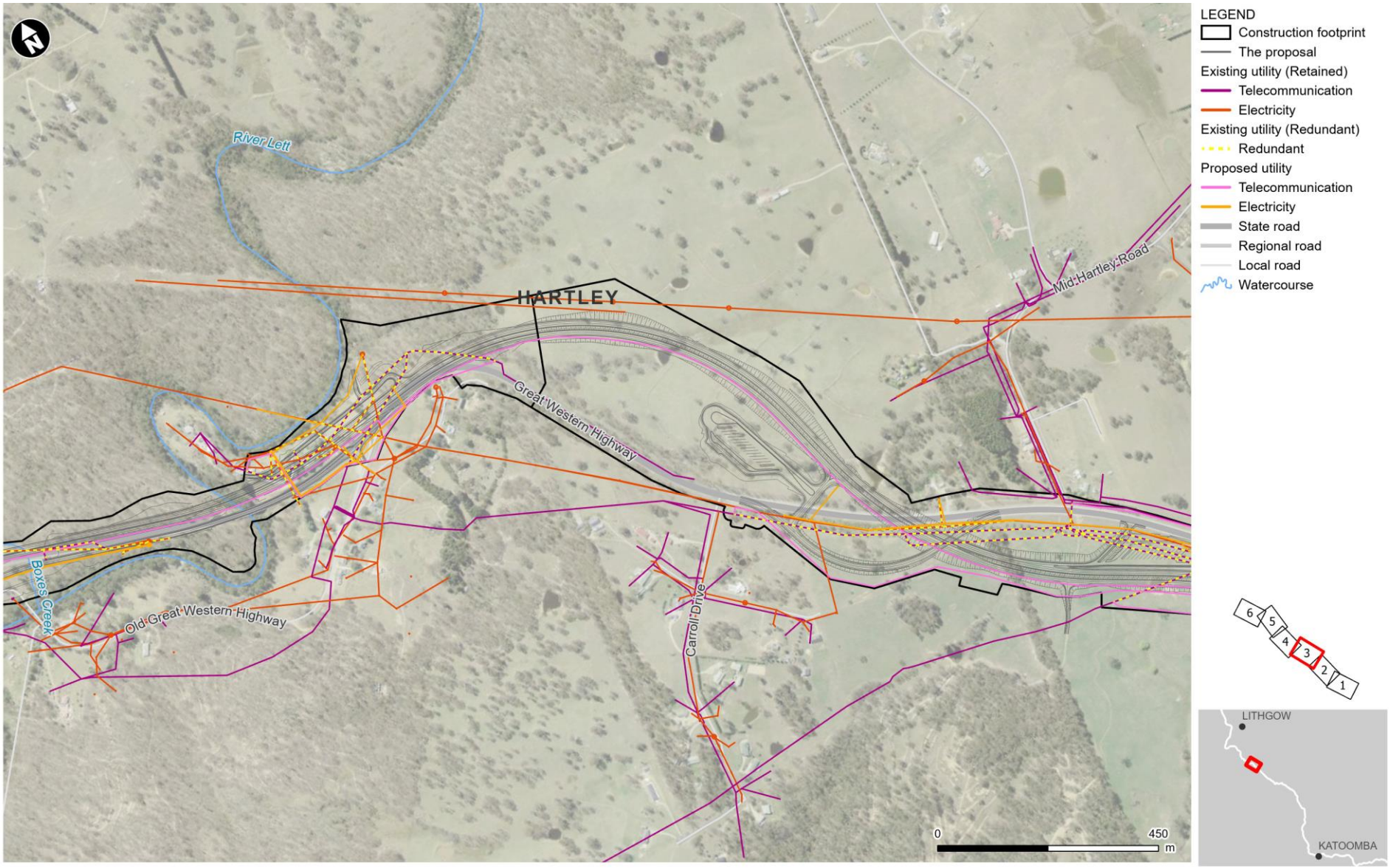


Figure 3-4 c Existing and proposed utilities

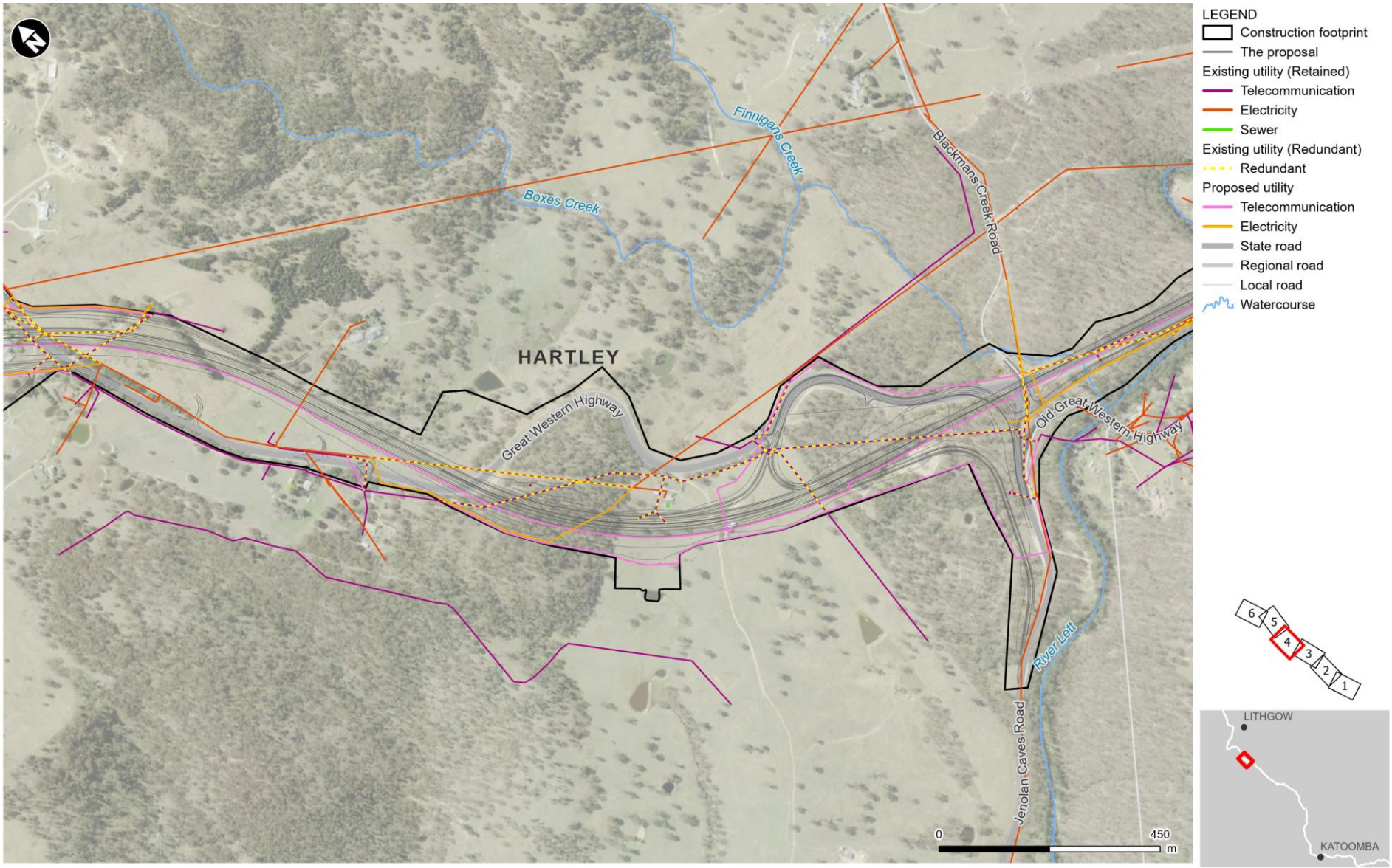


Figure 3-4 d Existing and proposed utilities

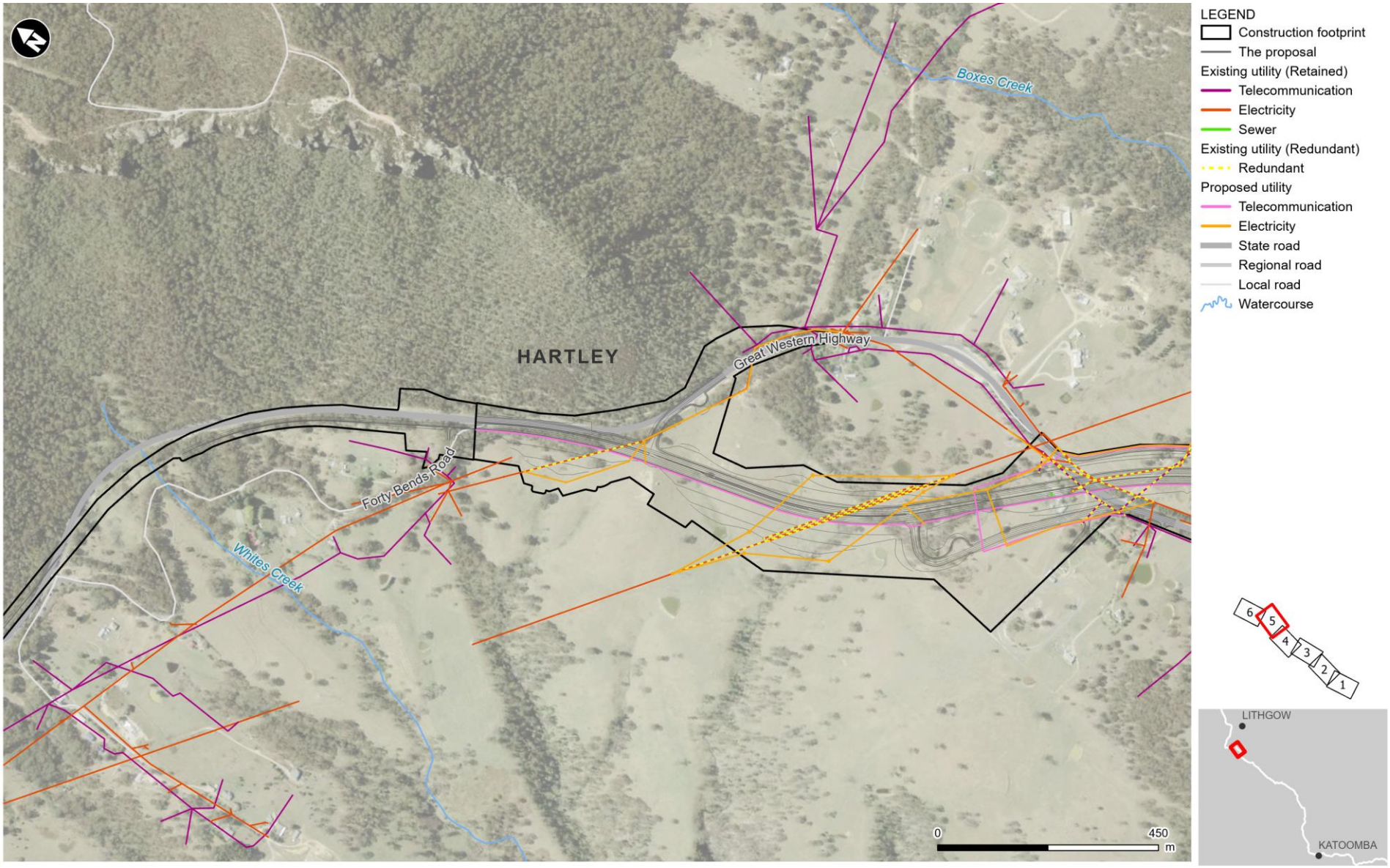


Figure 3-4 e Existing and proposed utilities

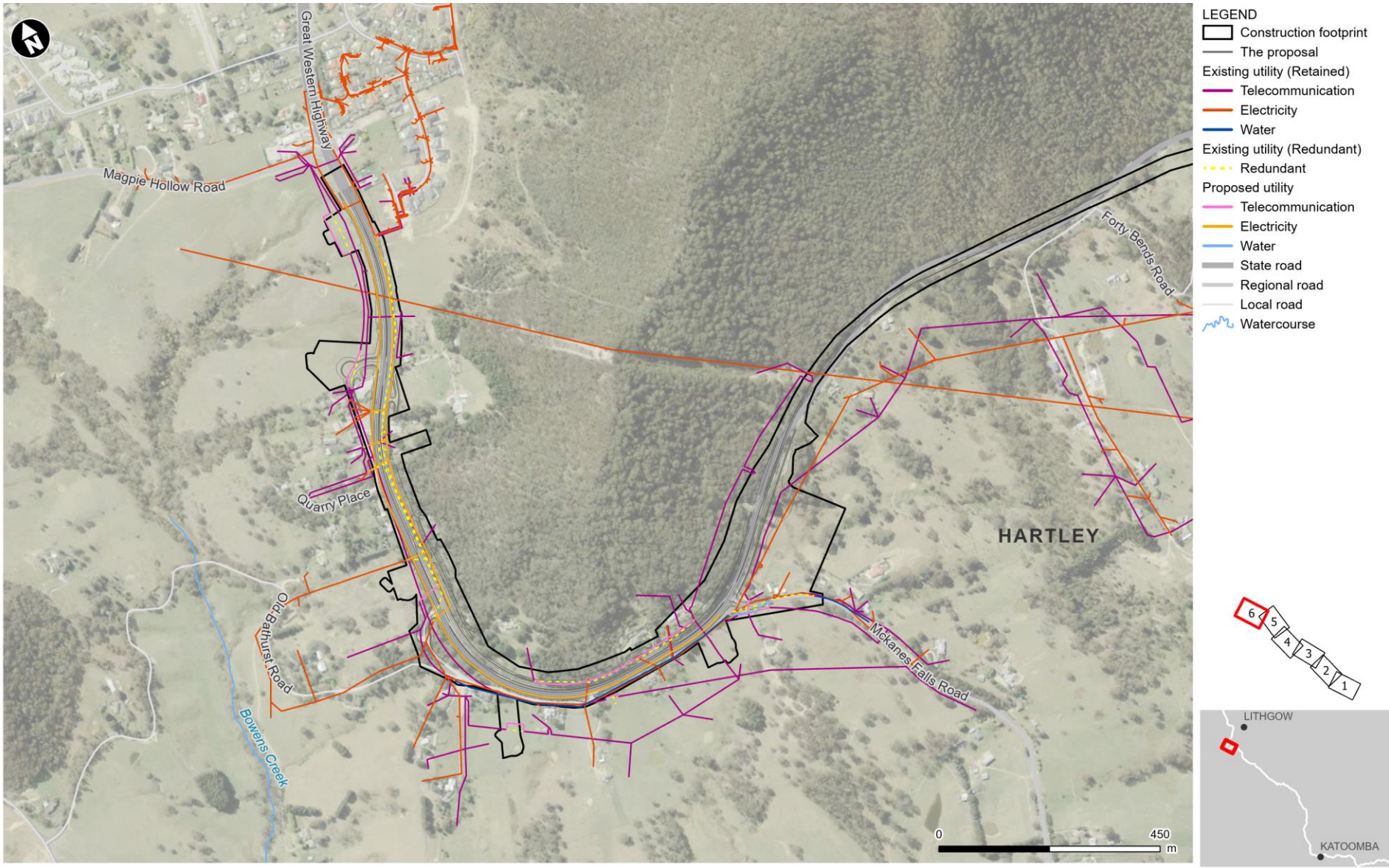


Figure 3-4 f Existing and proposed utilities

3.6 Property acquisition

The proposal has been designed and developed to minimise property acquisitions and has prioritised the use of Transport land. Notwithstanding this, some temporary use and permanent acquisition of properties would be required.

All property acquisitions required for the proposal would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the Transport Land Acquisition Information Guide (Roads and Maritime Services, 2014).

The proposal would require the full acquisition of 11 lots and the partial acquisition of 50 lots. About 84.6 hectares of privately owned land and 2.6 hectares of National Parks and Wildlife Services land and 4.4 hectares of Crown land would be acquired. Additionally, about 6.3 hectares of land would be temporarily leased for the duration of construction. Refer to Section 6.11 Property and land use for further details on properties to be acquired or leased.

4. Statutory and planning framework

This section provides the statutory and planning framework for the proposal and considers the provisions of relevant state environmental planning policies, local environmental plans and other legislation.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State.

Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the proposal is for a road and road infrastructure facilities and is to be carried out on behalf of Transport, it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

Part of the proposal is on land within Hartley Historic Village which comprises land reserved under the *National Park and Wildlife Act 1979* (NPW Act). Development within national park estate cannot proceed by virtue of Clause 94 of ISEPP until the land is revoked from the national park estate via an Act of Parliament. This revocation process is currently ongoing.

The proposal does not require development consent or approval under State Environmental Planning Policy (Coastal Management) 2018, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (State Significant Precincts) 2005.

Part 2 of ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by ISEPP (where applicable), is discussed in Section 5 of this REF.

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The proposal is located within the boundary of the Sydney Drinking Water Catchment. Consequently, the SEPP (Sydney Drinking Water Catchment) is applicable to the proposal.

Clause 9 of the SEPP states that any development or activity within this catchment should incorporate the Sydney Catchment Authority's (SCA) current recommended practices and performance standards that relate to the protection of water quality.

Clause 12 of the SEPP (Drinking Sydney Water Catchment) states that: 'A public authority must, before it carries out any activity to which Part 5 of the Act applies, consider whether the activity would have a neutral or beneficial effect on water quality.'

While the SEPP does not affect the permissibility of the proposal, consideration would be required regarding the proposal's impact on water quality. A qualitative Neutral or Beneficial Effect (NorBE) water quality assessment has been carried out and is included in Appendix I.

State Environmental Planning Policy (Koala Habitat Protection) 2021

The Koala Habitat SEPP applies to a range of local government areas including Blue Mountains and Lithgow.

Part 2 of the Koala Habitat SEPP regulates impact on Koala habitats. While the SEPP does not affect the permissibility of the proposal as a Division 5.1 or 5.2 assessment, consideration would be required regarding the proposal's impact on Koala habitat.

There are previous records for the Koala adjacent to the study area and a record within the investigation area near Little Hartley.

4.1.2 Local Environmental Plans

Lithgow City Local Environmental Plan 2014

Land use and development within the Blue Mountains local government area is primarily regulated by the Lithgow City Local Environmental Plan 2014 (Lithgow 2014 LEP).

The investigation area traverses a number of zones outlined in under the Lithgow 2014 LEP. These zones are summarised in Table 4-1and shown on Figure 4-1.

Table 4-1 Consistency of the proposal with Lithgow LEP 2014

Zone	Objectives of the zone	Consistency of the proposal with objectives
R2	• To provide for the housing needs of the community within a low density residential environment. • To enable other land uses that provide facilities or services to meet the day to day needs of residents. • To maintain or improve the water quality of receiving water catchments.	The proposal would support the needs of residents by improving the transport network.
R5	• To provide for a range of land uses, services and facilities that are associated with a rural village. • To maintain and enhance the unique character of each of the rural villages. • To encourage and promote opportunities for population and local employment growth commensurate with available services and infrastructure capacity. • To minimise the impact of non-residential uses and ensure those uses are compatible with surrounding residential development. • To maintain or improve the water quality of receiving water catchments.	The proposal would support the needs of residents by improving the transport network and minimising impacts on rural land.
RU1	• To encourage sustainable primary industry production by maintaining and enhancing the natural resource base. • To encourage diversity in primary industry enterprises and systems appropriate for the area.	The proposal has been designed to minimise impacts on land used for primary production and farming.

Zone	Objectives of the zone	Consistency of the proposal with objectives
	• To minimise the fragmentation and alienation of resource lands. • To minimise conflict between land uses within this zone and land uses within adjoining zones. • To minimise the environmental and visual impact of development on the rural landscape. • To provide for recreational and tourist development and activities of an appropriate type and scale that do not detract from the economic resource, environmental or conservation value of the land. • To maintain or improve the water quality of receiving water catchments.	
E1	• To enable the management and appropriate use of land that is reserved under the *National Parks and Wildlife Act 1974* or that is acquired under Part 11 of that Act. • To enable uses authorised under the *National Parks and Wildlife Act 1974*. • To identify land that is to be reserved under the *National Parks and Wildlife Act 1974* and to protect the environmental significance of that land.	The proposal has been designed to minimise impacts to land protected under the *National Parks and Wildlife Act 1974.*The proposal will revoke the impacted section of National Park and offset impacts with compensatory land of equivalent or greater value.
E3	• To protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values. • To provide for a limited range of development that does not have an adverse effect on those values. • To facilitate the management of environmentally sensitive lands and riparian areas. • To protect and conserve the vegetation and escarpment landscape surrounding Lithgow. • To maintain or improve the water quality of receiving water catchments.	The proposal has been designed to minimise its impact on environmental values of the area.
SP2	• To provide for infrastructure and related uses. • To prevent development that is not compatible with or that may detract from the provision of infrastructure. • To maintain or improve the water quality of receiving water catchments.	The proposal would be consistent with the objectives of this zone as it is road infrastructure.

Except for the E1 National Parks and Nature Reserves zone (where roads are prohibited) and the E3 Environmental Management zone (where roads are permitted with consent), development for the purposes roads is permitted without development consent in all the affected zones. The ISEPP operates to remove those consent requirements. Within the E1 zone, the only permitted development is that which is authorised under the *National Parks and Wildlife Act 1974*. Authorised development is permitted without consent. Impacts on land zones is further discussed in Section 6.10 Socio-economic.

The Lithgow City LEP 2014 also provides a listing of local heritage items. Potential impacts to heritage items located near the proposal are discussed and assessed in Section 6.5 Non-Aboriginal Heritage.

Consultation carried out for the proposal as required by the ISEPP is detailed in Section 5.4.

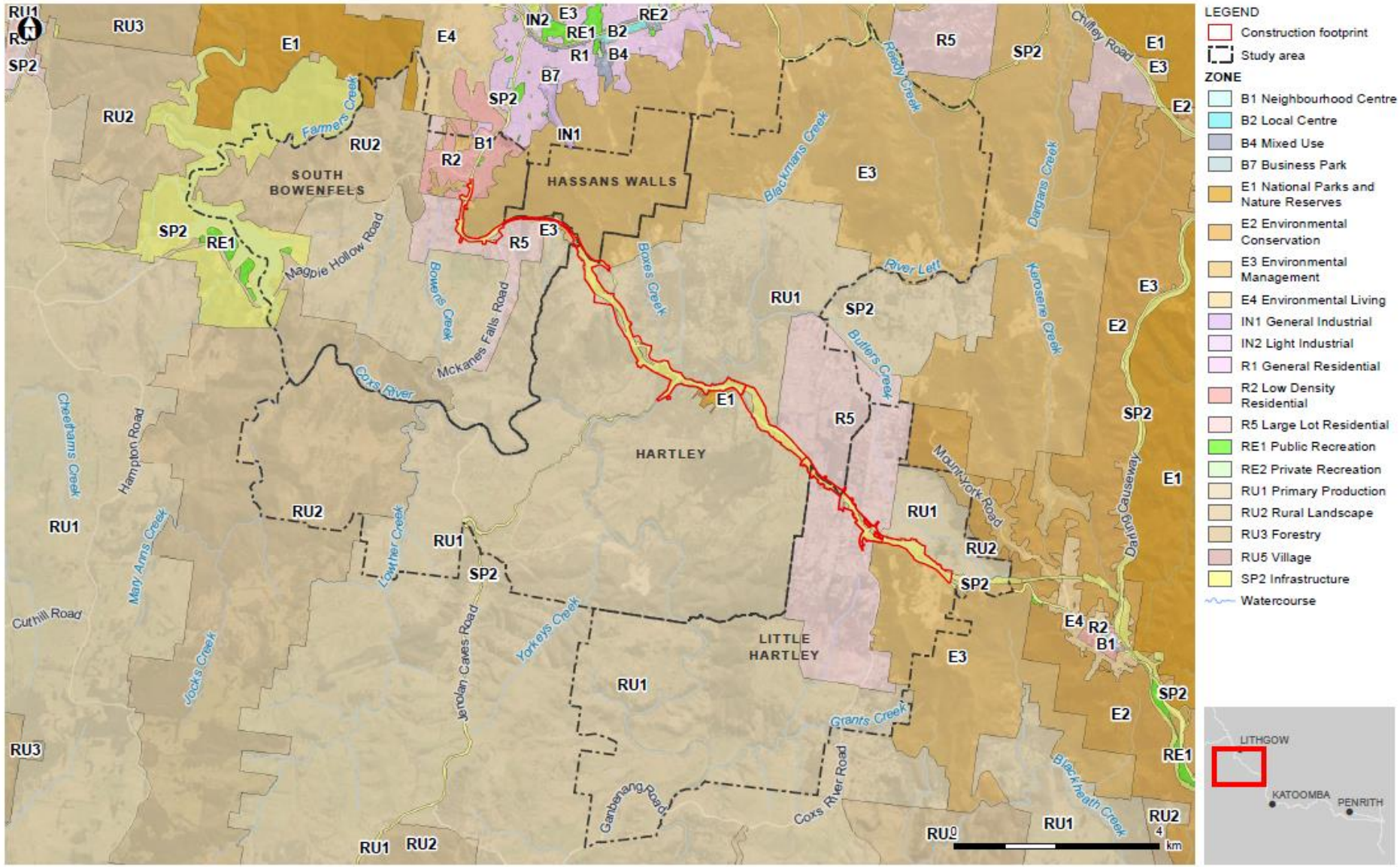


Figure 4-1 Land zones within and surrounding the proposal

4.2 Other relevant NSW legislation

4.2.1 Roads Act 1993

Part 2 of the Roads Act sets out the provisions for the opening of public roads, including notification procedures. Part 4 of the Roads Act sets out the provisions for the closing of public roads, including notification procedures.

The proposal requires construction work on Great Western Highway, which is a classified road within the Lithgow City LGA, and temporary interruption to traffic along the proposal. A Road Occupancy Licence is required for any activity likely to impact on traffic flow, even if that activity takes place off-road. Transport is the proponent and the relevant roads authority for the proposal.

4.2.2 Crown Lands Management Act 2016

Under Division 5.8 of the Crown Land Act, the Minister may on the application of a holder of land, grant a permit (an enclosure permit) to the holder of the land to enclose, whether wholly or partly, any Crown road or Crown watercourse that crosses or bounds the land.

There are nine Crown Land lots that are located within the construction footprint. These lots would be partially or fully acquired for the construction of the proposal.

In accordance with the Crown Land Act, work proposed to be carried out on Crown Land requires a permit from the Department of Planning, Industry and Environment (Crown land). A licence would be sought following consultation with the Department of Planning, Industry and Environment (Crown land).

4.2.3 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) provides the legal framework for the management of air, noise, water and waste pollution. Under Section 48 of the POEO Act, scheduled activities (as defined in Schedule 1 of the Act) require an environment protection licence (EPL).

Part 3.2 of the POEO Act requires an environment protection licence (EPL) for scheduled development work and the carrying out of scheduled activities (as set out in Schedule 1 of the POEO Act). This section of the Act was updated on 5 July 2019 making clauses 16 and 19 no longer apply to road construction activities. Clause 35 of Schedule 1 of the POEO Act applies to road construction, meaning the construction, widening or rerouting of roads. Development activities require an EPL under the POEO Act if those activities meet the following assessment criteria:

Clause 35(3)(a) the extraction or processing (over the life of the construction) of more than:

- 50,000 tonnes of materials in the case of premises in the regulated area or in the local government areas of Bega Valley, Eurobodalla, Goulburn Mulwaree, Queanbeyan-Palerang Regional or Snowy Monaro Regional.

Clause 35(3)(b) the existence of 4 or more traffic lanes (other than bicycle lanes or lanes used for entry or exit) for a continuous length of at least:

- (iii) 5 kilometres — where the road is not in a metropolitan area and is classified, or proposed to be classified, as a main road, freeway or tollway under the Roads Act 1993.

The proposal is likely to require a substantial volume of earthworks and at least five kilometres of road with four or more lanes, which would trigger the need for an EPL under Schedule 1.

4.2.4 Heritage Act 1977

Approval under section 60 of the *Heritage Act 1977* is required for any action that would adversely affect an item that is subject to an Interim Heritage Order or a listing on the State Heritage Register. A section 60 permit may not be required if the works are undertaken in accordance with the *Standard Exemptions for Works Requiring Heritage Council Approval* (Heritage Council of NSW 2020). Three State Heritage Register listed items are located within the study area. The Hartley Historic Village and Fernhill would be moderately impacted by the proposal. Bowenfels National School Site would have a negligible impact from the proposal. A section 60 permit for Fernhill and the Hartley Historic Village will be required for the Proposal.

An excavation permit is required to disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed. A permit is also required to disturb or excavate any land on which the person has discovered or exposed a relic. Section 139(4) of the *Heritage Act 1977* makes provision for the issuing of an exception in certain prescribed circumstances. An excavation permit will be required for the Proposal where there is archaeological potential.

4.2.5 National Parks and Wildlife Act 1979

The *National Parks and Wildlife Act 1974* (NPW Act) provides the basis for legal protection and management of National Parks estate and Aboriginal sites and objects in NSW. The NPW Act reserves land as historic sites to protect and conserve areas associated with a person, event or historical theme, or containing a building, place, feature or landscape of cultural significance.

The proposal is on land reserved under the NPW Act being the Hartley Historic Village. Where a new non-permissible activity or development is proposed by another party and requires the use of NPWS land, the park boundary can be re-defined to exclude the proposed development or the development cannot proceed because it would encroach upon the park. In order for the land to be transferred to Transport under Part 11 of the Act, it would need to be revoked from the gazetted park by an Act of Parliament.

Transport submitted a proposal to revoke a section of national park estate in September 2021. The submission addresses the requirements of National Park and Wildlife Service (NPWS) *Revocation, recategorisation and road adjustment policy,* including an outline of the potential impacts of the revocation. A compensation package will also be negotiated with NPWS.

The harming or desecrating of Aboriginal objects or places is an offence under section 86 of the NPW Act. Under section 90, an Aboriginal heritage impact permit may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons.

The Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (Department of Environment, Climate Change and Water, 2010). The due diligence process and the Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) (Roads and Maritime Services, 2011) would need to be followed during detailed environmental assessment.

There are 25 registered Aboriginal heritage sites within the investigation area. If harm to these objects or any other found through the PACHCI process cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) would be required (unless the proposal is State Significant Infrastructure and assessed under Part 5.2 of the EP&A Act).

4.2.6 Water Management Act 2000 and Water Act 1912

The study area is covered by the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 and the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources. It is subject to the provisions of the Water Management Act 2000. Potentially relevant Water Management Act approval requirements are reviewed in Table 4-2.

Table 4-2 Water Management Act 2000 approvals

Provision	Application
Water access licences (s.56 & s.60A)	Exemption for roads authorities in relation to water required for road construction and road maintenance under clause 21 and Schedule 4 of the Water Management (General) Regulation 2018.
Water use approval (s.89 & s.91A)	Exemption for roads authorities in relation to water required for road construction and road maintenance under clause 34 and Schedule 5 of the Water Management (General) Regulation 2018.
Water supply work approval	Water supply works generally not proposed. Limited exemptions in clause 39 and Schedule 1 of the Water Management (General) Regulation 2018
Controlled activity approval Required for carrying out controlled activities including works on waterfront land (s.91 and s.91E).	Exemption in clause 41 of the Water Management (General) Regulation 2018.

The Water Act 1912 remains relevant for aquifer interference activities such as construction dewatering because the requirement for aquifer interference approvals under the Water Management Act 2000 has not yet commenced. Localised dewatering of construction excavations is expected to benefit from a Crown exemption under Section 112 of the Water Act 1912.

Predicted groundwater level reductions are less than the NSW Aquifer Interference Policy (AIP) minimal impact considerations. The beneficial use category of groundwater sources is not anticipated to be lowered beyond 40 metres of the proposal, which is an AIP water quality criterion. It is not anticipated that an Aquifer Interference License will be required for the proposal.

4.2.7 Fisheries Management Act 1994

Section 220 of the Fisheries Management Act 1994 requires the Minister to issue a permit for causing a barrier to fish passage.

The proposal includes bridge structures to traverse River Lett, Boxes Creek and Whites Creek, which are mapped as ‘Key Fish Habitat’ under the Fisheries Management Act 1994 Key Fish Habitat mapping.

The proposal would be designed in such a way that fish movement is not impeded, and carried out so that fish passage would be maintained throughout construction. This would be verified during detailed design, including the potential impact on creek realignments if found to be required. Should it be determined that

avoiding impact on fish passage is not feasible during detailed design, a permit to block fish passage would be obtained under Section 220(1) of the Act prior to construction.

Section 199 of the Fisheries Management Act 1994 was developed to assist in the protection of key fish habitats. The proposal would be carried out so that fish habitat would be protected and maintained throughout construction. This would be verified during detailed design.

The study area contains a number of first, second and third order streams. Schedules 4, 4A and 5 of the Fisheries Management Act 1994 list species, populations and ecological communities that have been identified as being endangered, critically endangered and vulnerable to extinction, respectively. If a threatened species, population, ecological community or their habitat could be impacted by an activity, an assessment that addresses the requirements of Section 5A of the EP&A Act must be completed to determine the significance of the impact.

4.2.8 Biodiversity Conservation Act 2016

The purpose of the Biodiversity Conservation Act 2016 (BC Act) is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development.

The NSW Biodiversity Offsets Scheme is established under Part 6 of the BC Act and the Biodiversity Assessment Method (BAM) is established under Section 6.7 of the BC Act. The purpose of the Biodiversity Assessment Method is to prescribe requirements for the assessment of certain impacts on listed threatened species, populations and ecological communities, areas of outstanding biodiversity value, and key threatening processes.

Section 7.3 of the BC Act provides a test for determining whether proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Where a significant impact is likely, a Species Impact Statement or a Biodiversity Development Assessment Report (BDAR) must be prepared.

The assessment applied to threatened species and ecological communities relevant to the proposal is presented in Section 6.1 and Appendix D. The proposal is likely to have a significant impact on the critically endangered ecological community White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as critically endangered under the BC Act, therefore a BDAR has been prepared (Appendix D).

4.2.9 Aboriginal Land Rights Act 1983

Through the *Aboriginal Land Rights Act 1983*, vacant Crown land not lawfully used or occupied or required for an essential purpose or for residential land, is returned to Aboriginal people (and vested in Aboriginal Land Councils). In accordance with Section 42B of the Aboriginal Land Rights Act, land vested in an Aboriginal Land Council can only be acquired by Transport through an Act of Parliament.

A review of controlling interests specified in the Digital Cadastral Database identified several parcels of Crown land within the investigation area (map set 4.0 in Appendix A).

Correspondence from the Office of the Registrar dated 6 March 2019 confirmed that many of the Crown land parcels in the section of the investigation area between Katoomba and Mount Victoria were subject to claims. An updated search covering the whole of the investigation area should be carried out as part of the proposal development process.

Previous correspondence from the Office of the Registrar and a schedule of Crown land derived from the Digital Cadastral Database is included in Appendix S.

4.2.10 Coal Mine Subsidence Compensation Act 2017

Under Section 21 of the *Coal Mine Subsidence Compensation Act 2017*, a person must not carry out work, or cause work to be done, in connection with the erection or alteration of an improvement within a mine subsidence district, except in accordance with the approval Subsidence Advisory NSW. For the purposes of the Act 'improvement' includes infrastructure, whether above or below the surface of the land. Part of the construction footprint is directly adjacent to the boundary of the Lithgow South Mine Subsidence District.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are considered in Appendix D and Section 6 of the REF.

A referral is not required for proposed road activities that may affect nationally listed threatened species, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts to these biodiversity matters are also considered as part of Section 6 of the REF and Appendix D.

Findings – matters of national environmental significance

The assessment of the proposal's impact on matters of national environmental significance and the environment of Commonwealth land found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. Accordingly, the proposal has not been referred to the Australian Government Department of Agriculture, Water and the Environment under the EPBC Act.

Findings – nationally listed biodiversity matters (where the strategic assessment applies)

The assessment of the proposal's impact on nationally listed threatened species, endangered ecological communities and migratory species found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Section 6 of the REF describes the safeguards and management measures to be applied.

4.3.2 Native Title Act 1993

The *Native Title Act 1993* recognises and protects native title. The Act covers actions affecting native title and the processes for determining whether native title exists and compensation for actions affective native title. It establishes the Native Title Registrar, the National Native Title Tribunal, the Register of Native Title Claims and the Register of Indigenous Land Use Agreements, and the National Native Title Register. Under the Act a future act includes proposed public infrastructure on land or waters that affects native title rights or interest.

A search of the Native Title Tribunal Native Title Vision website was undertaken, with two Native Title holders/claimants identified (refer to Table 4-3).

Table 4-3 Native title search results

Type	Name	Tribunal file no.	Status
Native title claim	Warrabinga-Wiradjuri #7	NC2018/002	Registered 22/11/18
Indigenous Land Use Agreement	Gundungurra Area Agreement	NI2014/001	Registered 27/02/15

Transport will provide a notice of the proposal to NTSCORP under Section 24KA of the Act and will invited comment on the proposal.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and road infrastructure facilities and is being carried out by or on behalf of a public authority.

Transport has commenced a process to revoke a portion of the Hartley Historic Village. Subject to the revocation being passed by Parliament, the proposal can proceed by virtue of Clause 94 of ISEPP. Under clause 94 of ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

Transport is the determining authority for the proposal. This REF fulfils Transport's obligation under Section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

5. Consultation

This section discusses the engagement undertaken to date for the proposal and the consultation proposed for the future. The engagement strategy and approaches used to consult on the proposal are described along with the results of engagement with the Aboriginal community, the wider community, and relevant government agencies and stakeholders to date.

5.1 Engagement strategy

Engagement has been managed as part of the community and stakeholder engagement strategy for the wider program to upgrade the Great Western Highway between Katoomba and Lithgow. Transport has developed a community consultation and stakeholder engagement plan (communications plan) to guide consultation activities. The Great Western Highway Upgrade Program (GWHUP) communications plan identifies key objectives and outcomes of consultation activities with the community, stakeholders and government agencies.

The consultation objectives are to:

- Ensure the Blue Mountains community, Central West communities and the broader NSW community, including key stakeholders and interest groups, are aware of and involved in consultation opportunities about the proposed duplication
- Provide targeted information to the community and other stakeholders, and to clearly communicate whether we are providing information or seeking feedback so that expectations are clear
- Ensure the proposed concept designs are developed appropriately, incorporating and acknowledging feedback and concerns of the local community and stakeholders
- Collaborate with government agencies and local councils to ensure a whole-of-government approach to managing issues and providing consistent messages
- Ensure that the communications and engagement approach and key messages align with Transport Road Network and Corridor Planning, and Future Transport strategy
- Monitor and evaluate stakeholder feedback and communication activities to review planning as required
- Engage in a manner that is open and transparent, collaborative, innovative, responsive, adaptive and sustainable
- Build stakeholder and community confidence in Transport and its decisions
- Ensure that members of the local community have sufficient opportunity to provide feedback, in light of fluid COVID-19 advice and restrictions on community consultation.

The following sections outline the consultation that has been carried out specifically for the proposal.

For further information on community consultation carried out as part of the wider program to upgrade the Great Western Highway between Katoomba and Lithgow, refer to Transport's website: **nswroads.work/gwhd**

5.2 Community involvement

5.2.1 Proposal development

The NSW Government first announced an upgrade from Mount Victoria to Lithgow in May 2008. The first stages of community consultation commenced in June 2008 with identification of an initial study area. Community engagement was identified by Transport as an essential component of the proposal development. Since then, and throughout the options assessments and proposal development, substantial consultation has been undertaken with the community and relevant stakeholders.

A summary of the consultation activities at each stage of the proposal's development is provided in Table 5-1.

Table 5-1 Engagement activities undertaken during each stage of the proposal development

Development Stage	Engagement activities
Study area investigations	• Thirteen stakeholder meetings and briefings were held with NSW Government agencies, local Aboriginal land councils, organisations and local councils • An introduction to the proposal was provided through four community meetings and four staffed displays in June 2008 • A community meeting to identify transport needs of the Central West was held in June 2008 • Four constraints workshops were held with the community in August 2008 • A presentation was provided at the general meeting of the Dargan/Bell Residents Association in August 2008 • A stakeholder meeting/workshop was held with local council, government agencies and organisations on the Newnes Plateau corridor option in September 2008 • A community meeting/workshop was held on the Newnes Plateau corridor option in September 2008 • Public exhibition of the Mount Victoria to Lithgow Background and Proposed Project Development Report (RTA, 2008) in June 2008
Corridor options in which routes may be feasible	• Public exhibition of the Study Area Investigation and Corridor Identification Report (RTA, 2008) and the Strategic Evaluation of the Newnes Plateau Corridor Report (RTA, 2008) in November 2008 for community submission • Distribution of a community update in November 2008 outlining the key findings of the two studies to more than 12,000 residents in Blackheath, Katoomba, Mount Victoria, Lithgow, Hampton, Jenolan, Little Hartley, Hartley Vale, Oberon, Newnes, Clarence, Dargan, Marrangaroo and Bell • Letters to more than 650 landowners in the study areas • Direct mail to about 150 stakeholders, including local councils, government agencies and local community groups enclosing copies of the Study area investigations and corridors identifications report (RTA, 2008) and the Strategic review of a Newnes Plateau corridor report (RTA, 2008) • Email notification to stakeholders in the proposal database advising of updated information available on the proposal website

Development Stage	Engagement activities
	• Advertisements during November 2008 in the Blue Mountains Gazette, Lithgow Mercury, Oberon Review, The Land, Sydney Morning Herald, Daily Telegraph, The Koori Mail and The National Indigenous Times to advise the community about upcoming meetings, workshops and displays • Online recording of the Newnes Plateau corridor presentation • Media release in November 2008 • Provision of a dedicated proposal information toll free number, email address and website to distribute information and receive feedback • An additional 26 CD copies of the two November 2008 reports to individuals (following requests).
Confirmed corridors	• A total of 462 submissions were received in response to the exhibition of the Study area investigations and corridor identification report (RTA, 2008) and the Strategic review of a Newnes Plateau corridor report (RTA, 2008) • Announcement of confirmed corridors (community update) • Community meetings • Community route option development workshops • Aboriginal focus group meetings and drive throughs • Public exhibition of the four modified corridors in the Submissions Report – corridors in which routes may be feasible (RTA, 2008) released in April 2009 • Public announcement of the preferred corridor in August 2009.
Route options	• Property owners within the route options areas and those no longer affected by the route options were individually contacted via mail • Over 10,000 community updates were distributed via unaddressed mail and over 1,500 were sent to those registered on the mailing list • Information on route options was put on public display at six publicly accessible venues • Information was updated on the proposal website • Public exhibition of the Route Options Report (RTA, 2009) and associated working papers in October 2009 for community submissions.
Preferred route selection	• Announcement of preferred route (community update) • Staffed displays • Aboriginal focus group meeting • A total of 3,691 submissions were received in response to the Route Options Report display. This included 3,678 from individuals and 13 from government agencies, local councils or organisations • Four community members from along the proposal alignment were selected to participate in the value management workshop who reported back to the community on the process and outcomes at a community meeting in November 2009 • Public exhibition of the Preferred Route Report (RTA, 2010) in May 2010 for community submission.

5.2.2 Great Western Highway Upgrade Program consultation

In November 2019, the strategic corridor for the Great Western Highway Upgrade Program between Katoomba and Lithgow (of which the proposal forms part) was announced and put to the community for feedback.

The proposed upgrade was displayed to the community between Thursday 7 November and Monday 16 December 2019 at locations including Katoomba, Oberon, and Bathurst and Orange libraries.

The display locations and website link were included in advertisements in the Central Western Daily, Bathurst Western Advocate, Lithgow Mercury, Blue Mountains Gazette and Oberon Review. They were also advertised on the NSW Roads Facebook page.

Twelve community information sessions were held in Katoomba, Medlow Bath, Blackheath, Mount Victoria, Hartley and Lithgow, and were attended by 1045 people. The community was invited to view the proposed corridor at staffed information sessions which provided an opportunity to learn more, ask questions and have their say.

During the consultation period, Transport received 1759 pieces of feedback from members of the community, businesses and stakeholders. Of this feedback, 446 were forms (hard and soft copy), 756 were via email and 557 were pinned comments on the online map.

The main issues from consultation and a summary of Transport's responses follow.

Table 5-2 Summary of issues raised by the community

Aspect	Issue raised	Response / where addressed in REF
Options	The community would like to see rail options explored for freight.	The Highway upgrade is being developed alongside long term rail options as both road and rail solutions are required to meet future demands, ease congestion and increase safety. The rail line is being upgraded to allow for modern trains to provide service all the way to Lithgow.
	The community queried why Bells Line of Road did not appear to be considered as an alternate route for development, given its connectivity to the Castlereagh Highway, and the potential to avoid impacts to Great Western Highway townships.	• The Great Western Highway is a key transport corridor through the Blue Mountains, which is already at capacity during certain periods. Traffic volumes are expected to continue to grow. If the Bells Line of Road was upgraded significant traffic volumes would still remain on the Great Western Highway. • An upgrade of Bells Line Road, which crosses extremely challenging terrain, could significantly impact the World Heritage Area and would not achieve the same local benefits for the highway townships. Upgrading Bells Line of Road remains a longer term priority for the NSW Government.
	Some community members believe the speed limit should remain a consistent 100 km/h to support current and future demand for an efficient connection from Sydney to the Central West.	The Great Western Highway will need to cater for through traffic mixing with slower moving local traffic as it remains the key route between communities in the Blue Mountains. As the corridor design is progressed, including further community consultation, Transport will consider opportunities to improve travel times and deliver a more consistent speed limit along the route.

Aspect	Issue raised	Response / where addressed in REF
Environment	Concerns were raised for the environment and protecting cultural and historical heritage of the townships along the Highway and the World Heritage Area.	Transport aims to maintain local heritage in the Blue Mountain and avoid impacting heritage listed items and places wherever possible. There will be no direct impact on the Greater Blue Mountains World Heritage Area and Transport is committed to minimising impacts to the natural environment, local heritage and property.
	Anticipated noise and pollution created from the completed upgrade was a concern for community members living along the Highway.	• A detailed noise assessment (refer to Section 6.3 Noise and Vibration) has been carried out as per the Environmental Protection Authority's *Road Noise Policy* in conjunction with Transport's *Noise Criteria Guidelines* and *Noise Mitigation Guidelines* • Transport understands air quality is important to the community and is committed to improving air quality by effectively managing the NSW roads and traffic system. Air quality impacts have been considered further in Section 6.13 Air Quality.
	Concerns were raised about the potential impact on the natural surroundings and visual amenity of the area.	Transport is sensitive to the area's natural environment and the recreational value of the area. Community consultation will be ongoing throughout the Program and will help the proposal team to continue to identify and respond to these sensitive and highly valued areas. Impacts to landscape character and visual amenity are considered further in Section 6.9 Landscape Character and Visual Impact.
Road use	Concerns were raised about the safety of road users, including cyclists, as a result of a perceived increase in the number of heavy vehicles and changes to the speed limit.	Transport appreciates the concern community members raised about potential increased heavy vehicle traffic. During the road design process, Transport has incorporated safety principles to ensure the upgraded highway meets road safety standards and that the risks to all road users including pedestrians and cyclists are minimised. The Program will complement the existing investment on pedestrian and cyclist safety as part of the Great Western Highway Safety Upgrades program.
	Concerns were expressed about increased traffic congestion in towns where congestion is already an issue.	The Program is being designed to reduce congestion along the entire route, including through all the villages between Katoomba and Lithgow, and will separate long distance from local traffic where possible.
	Concern was raised about the size of freight vehicles moving through communities which want to preserve tranquillity and reduce pollution.	The highway is being designed to carry the safest and most productive heavy vehicles, which means fewer heavy vehicles on the road and a safer road environment for local communities and motorists. This includes B-doubles up to 26 metres and more modern, productive vehicles up to 30 metres long.
	Potentially impacted property owners are concerned for their	Transport understands that some property owners have concerns about potential impacts including future property values. If a property is required for the program, compensation

Aspect	Issue raised	Response / where addressed in REF
Property and business	homes and businesses and want to understand what can be expected from the property acquisition process.	is assessed under the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991.* Transport uses professionally qualified industry-based valuers to assess compensation. The process allows for both owners and Transport to have valuations completed so that an agreement can be reached.
	Concern was raised from business owners that the upgrade will impact on their livelihood if their businesses are lost due to acquisition or impacted by a decline in tourism.	The Great Western Highway Upgrade Program is designed to make mountain communities more accessible and boost tourism and the Program will take every opportunity to increase the liveability of towns along the corridor. Our bypassed towns initiative has been proven to provide social benefits to towns in NSW (refer to Section 6.10 Socio-economic and Technical working paper – socio-economic (Appendix M)).
Community consultation	Some community members shared interest and support for the Program.	Transport acknowledges the benefits this Program will bring to those travelling in, around and through the Blue Mountains. Community feedback is vital in shaping the Program and the final route designed.

5.2.3 Targeted consultation

Targeted consultation has been undertaken throughout 2021 with communities along the proposal alignment including the Hartley District Progress Association and the National Parks and Wildlife Service. The purpose of this consultation was to:

- Introduce the proposal to the community including any changes that have been made to the proposal since the last community consultation in 2019 (refer to Section 5.2.2)
- Explain the future consultation for 2021 with the REF public display planned for November 2021 (refer to Section 5.6)
- Provide an opportunity for the community to ask questions about the proposal.

5.3 Aboriginal community involvement

Consultation is underway in accordance with the PACHCI and in accordance with Department of Environment, Climate Change and Water (DECCW) consultation guidelines (DECCW 2010a). The stages of Transport's PACHCI procedure and the consultation activities undertaken during each stage is summarised in Table 5-3.

Table 5-3 Summary of Transport Procedure for Aboriginal Cultural Heritage Consultation and Investigation

Stage	Description	Consultation activities
Stage 1	Initial Transport assessment	Stage 1 of the PACHCI activities undertaken for this assessment involved a desktop risk assessment and internal Transport action to determine whether the proposal would potentially impact on Aboriginal cultural heritage and therefore require further assessment. This stage did not involve any consultation activities.

Stage	Description	Consultation activities
Stage 2	Site survey and further assessment	• Identification of key Aboriginal stakeholders. This involved: – A search of the National Native Title Register was carried out in November 2019 to identify registered native title claimants or native title holders for the assessment area. Two native title claimants were identified – Identifying the Local Aboriginal Land Councils (LALCs) relevant to the proposal area. These included Deerubbin LALC and Bathurst LALC as well as Darug Tribal Aboriginal Corporation and Gundungurra Tribal Council. • Engagement of Aboriginal stakeholders to undertake an archaeological survey. Nominated representatives for Deerubbin and Bathurst LALCs, Native Title and Traditional Owner Groups were engaged to participate in the archaeological survey where the proposed route corridor traversed their boundaries • Carrying out the archaeological survey in consultation with nominated representatives of the LALCs and Traditional Owner groups. Key Aboriginal stakeholders provided comment on: – The potential for Aboriginal cultural material to be present within the proposed route corridor – The cultural significance of any Aboriginal cultural heritage sites identified during the survey – The proposed management recommendations, including recommendations for further assessment. • Preparation of the cultural heritage survey report with involvement from Aboriginal stakeholders. Deerubbin and Bathurst LALCs were asked to provide a cultural heritage survey report to Transport advising on Aboriginal cultural heritage issues that may arise as a result of the proposal. These issues are summarised in Table 5-4.
Stage 3	Formal consultation and preparation of a cultural heritage assessment report	• Identification of Aboriginal people with cultural knowledge. In August 2020 letters were sent to organisations seeking the details of Aboriginal people who may have an interest in the proposal and who hold cultural knowledge about objects and places relevant to the proposal. Based on these responses a list of 46 Aboriginal groups or people with potential cultural knowledge was compiled. • Notification of Aboriginal people with cultural knowledge. – In August 2020, a letter of notification was sent to all the Aboriginal groups or people identified at that time inviting them to register their interest in the proposal. – Advertisements inviting Aboriginal groups or people to register their interest in the proposal were placed in the public notices section of multiple newspapers. • Preparation of a register of Aboriginal parties (RAPs). A RAPs for the proposal was prepared based on responses received from the letter and newspaper advertisement. Thirty-four RAPs registered their interest in the

Stage	Description	Consultation activities
		proposal and Heritage NSW and local Aboriginal land councils were notified. • Hold an Aboriginal Focus Group (AFG) meeting. Invitations to an AFG meeting were sent to all RAPs along with an agenda and relevant proposal documentation. The AFG meeting was held in April 2021 during which the proposal details and draft archaeological methodology were presented to participants and feedback was sought. Meeting minutes from the AFG meeting were provided to participants. • Finalisation of archaeological methodology. Comments from RAPs and Heritage NSW were incorporated into the archaeological methodology and finalised. • Engagement of Aboriginal site officers for test excavations. Aboriginal site officers for the test excavations were selected from the attendees at the AFG meeting. • Development of an Aboriginal Cultural Heritage Assessment Report (ACHAR).
Stage 4	Implement environmental impact assessment recommendations	A copy of the Aboriginal Cultural Heritage Assessment Report (ACHAR) provided in Appendix G was provided to Heritage NSW and all RAPs for the proposal for review and comment. Following a review period of 28 days a second AFG meeting was held to provide a forum for the discussion of the proposal impacts and proposed management recommendations documented in the ACHAR in Appendix G and summarised in Section 6.4 of this REF. During future stages of the proposal, RAPs would be consulted about significant design or consultation changes in a manner consistent with the relevant guidelines.

5.4 ISEPP consultation

Clause 13 to 16 of the State Environmental Planning Policy (Infrastructure) (ISEPP) specify the requirements for consultation with councils and other public authorities for infrastructure development carried out by or on behalf of a public authority. Appendix B contains an ISEPP consultation checklist that documents how ISEPP consultation requirements have been considered as part of this REF. Consultation is required in relation to specified development or development that impacts on:

- Council related infrastructure or services (clause 13)
- Local heritage (clause 14)
- Flood liable land (clause 15)
- Public authorities other than councils (clause 16).

Transport has consulted with the following agencies about the proposal in accordance with the ISEPP:

- Lithgow City Council in accordance with the requirements of clause 13, 14 and 15
- National Parks and Wildlife Service in accordance with the requirements of clause 16
- State Emergency Services (SES) in accordance with the requirements of clause 15AA.

Issues that have been raised as a result of this consultation are outlined below in Table 5-4. A copy of the letters sent, and the response received are provided in Appendix S.

Table 5-4 Issues raised through ISEPP consultation

Agency	Issue raised	Response / where addressed in REF
National Parks and Wildlife Service (NPWS)	**General environmental matters to be considered** Refer to Developments adjacent to National Parks and Wildlife Service lands for guidance on the range of environmental matters to be considered during the preparation of the REF for works adjoining park.	The proposal has considered *Developments adjacent to National Parks and Wildlife Service lands* as part of the preparation of the REF. Section 6 assesses the environmental impacts of the proposal with consideration of the environmental issues identified in the document.
	Ensure the conservation values of the park are recognised in the preparation of the REF. Useful references include the Hartley Historic Site Plan of Management (NPWS 1994) and the Hartley Historic Site Conservation Management Plan (NPWS 2002).	The Statement of Heritage Impacts has considered the conservation values of Hartley Historic Village identified in the *Hartley Historic Site Plan of Management* (NPWS 1994) and the *Hartley Historic Site Conservation Management Plan* (NPWS 2002) and proposed adequate management measures to ensure the proposal is in accordance with the conservation values. Refer to Appendix H and Section 6.5 Non-Aboriginal Heritage.
	The construction and operational footprint of the Great Western Highway Upgrade is to be identified in relation to the existing legal boundary of the highway corridor and NPWS managed lands (including areas of park proposed for revocation).	The construction and operational footprint relative to the NPWS managed lands boundary is provided in Figure 1-2.
	An adequate description of the proposed activity and a complete scope of works is provided. The description must clearly specify what works (if any) will directly affect park. This includes the true extent of any landform modification (cut and fill) requirements of the proposal.	A description of the proposal and construction methodology is provided in Section 3. A description of the impacts on NPWS land is provided in Section 6.11 Property and Land Use.
	Appropriately scaled figures (maps) are provided to support the activity description and the construction and operational footprint of the proposal.	An overview of the proposal is provided in Figure 3-1. A summary of the key features of the proposal is provided in Figure 3-2. The proposal construction footprint is provided in Figure 3-3.

Agency	Issue raised	Response / where addressed in REF
	Remediation of the park interface should include suitable methods to stabilise exposed cuts and batters, to be applied where cut/fill is proposed proximate to the park. The addition of native vegetation is recommended where viable.	An Urban Design Plan will be prepared to support the final detailed proposal design and implemented as part of the CEMP. The Urban Design Plan will present an integrated urban design for the proposal, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include the location and identification of existing vegetation and proposed landscaped areas, including species to be used. Native vegetation will be re-established in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).
	No unauthorised works, access or encroachments are permitted Where the development encroaches into the park and revocation of NPWS land is proposed for the works to become permissible, the REF should provide: • a full account of the biological, cultural and other values (such as recreational, public use and park management assets) protected by the reservation, including those identified in the Hartley Historic Site Plan of Management (NPWS 1994) and the Hartley Historic Site Conservation Management Plan (NPWS 2002) • an evaluation of the contribution of the affected land to the cultural and other values protected by the reservation and the impact of the loss of these lands from the NSW reserve system • details of any compensation proposal, consistent with the NPWS Revocation, Recategorisation and Road Adjustment Policy, including an assessment of the biological, cultural and other values of potential compensatory land (noting that it may not be possible to publicly	The Statement of Heritage Impacts has considered the conservation values of Hartley Historic Village identified in the *Hartley Historic Site Plan of Management* (NPWS 1994) and the *Hartley Historic Site Conservation Management Plan* (NPWS 2002) and proposed adequate management measures to ensure the proposal is in accordance with the conservation values. Refer to Appendix H and Section 6.5 Non-Aboriginal Heritage. A Biodiversity Development Assessment Report has been prepared for the proposal and is provided in Appendix D and summarised in Section 6.1 Biodiversity. This considers the impacts of the proposal on biodiversity. Compensatory lands will be acquired by Transport with the agreement of NPWS to ensure that the land has equal value both financially and ecologically to the area that will be acquired by Transport from NPWS.

Agency	Issue raised	Response / where addressed in REF
	disclose the location of specific land), financial contributions for land management, restoration or rehabilitation, and/or any other forms of proposed compensation.	
	Alternative options that have been explored to avoid the park and a clear justification of any on-park components of the proposal infrastructure where revocation is proposed.	Section 2 provides a summary of the options development process.
	Ensure clear direction is provided as part of the REF and all operation documents that the park is classified as a restricted area, and that environmental safeguards are in place to protect the interface between the park and the proposal's works.	Mitigation measure PR04 in Section 6.11 ensures that all personnel will be made aware that they are not permitted to enter NPWS land and that demarcation between the construction site and park is established.
	Apply procedures to ensure demarcation of the park boundary occurs before works commence and that such demarcation remains a visually obvious barrier during all operations. This demarcation could take the form of temporary fencing or flicker tape with signs posted to reduce the risk of accidental encroachments or damage to park.	Exclusion zones will be set up to ensure a clear demarcation between the proposal and NPWS land in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).
	Ensure staff and contractors are adequately briefed on park boundary management protocols and procedures and restrictions applying to the protection of the park before commencement of works.	Prior to the commencement of construction, personnel will be briefed through inductions and toolbox talks on NPWS park boundary management protocols and procedures and restrictions applying to the protection of the park.
	Ensure all operational documentation contains clear procedures for incident management should issues arise on the interface or directly affecting park. Procedures should include emergency reporting via the Environment Line on 131555 and in writing to the Manager, NPWS Kanangra Area.	Operational documentation would contain clear procedures for incident management and would include a provision that emergency reporting would be via the Environment Line on 131 555 and in writing to the Manager of NPWS Kanangra Area.

Agency	Issue raised	Response / where addressed in REF
	No ancillary construction related facilities or access are to be provided on park.	No ancillary construction facilities or site access tracks would be provided within NPWS land.
	Tree protection and felling techniques Apply tree protection on the park interface in accordance with Australian Standard 4970-2009 Protection of Trees on Development Sites, to prevent adverse long-term damage. Particular care is to be taken with significant, old-growth and hollow bearing trees on the park interface.	Tree protection would be applied to trees within the park interface in accordance with Australian Standard 4970-2009 Protection of Trees on Development Sites.
	Employ controlled directional, soft and sectional felling techniques on the interface of the park under the direction of a qualified arborist to avoid direct impacts to park, reducing the risk of any tree (or partial tree) being felled into park.	Vegetation and habitat removal will be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).* All tree removal would be undertaken by a suitably qualified arborist to avoid impacts to adjacent trees and structures.
	Sediment and erosion control Ensure application of adequate sediment and erosion control is utilised to limit the movement of sediment across the park interface in accordance with recognised standards such as the 'Blue Book'.	Erosion and sediment control measures would be implemented and maintained in accordance with *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom, 2004) and *Volume 2D* (DECC, 2008).
	Stormwater management systems are designed and function to limit adverse impacts to surface water flow and water quality associated with the upgrades during construction and operation.	Construction phase sediment basins and permanent dry biofiltration basins are proposed to ensure runoff meets the relevant water quality criteria. Operational drainage and water quality treatment infrastructure are outlined in Section 3.2.3.
	Amenity impacts on the historic heritage values of the Historic Site Cultural (historic heritage) values are to be identified, and likely impacts are assessed accordingly. Such values are	The Statement of Heritage Impacts has considered the conservation values of Hartley Historic Village identified in the Hartley Historic Site Plan of Management (NPWS 1994) and the Hartley Historic Site Conservation Management Plan (NPWS

Agency	Issue raised	Response / where addressed in REF
	detailed in NPWS plans including the Hartley Historic Site Plan of Management (NPWS 1994) and the Hartley Historic Site Conservation Management Plan (NPWS 2002).	2002) and proposed adequate management measures to ensure the proposal is in accordance with the conservation values. Refer to Appendix H and Section 6.5 Non-Aboriginal Heritage.
	Where impacts to historic heritage values of the park are assessed, appropriate mitigation measures are to be considered and implemented. Any necessary mitigation measures are to be located off park.	The Statement of Heritage Impacts (Appendix H) and summary in Section 6.5 Non-Aboriginal Heritage assesses the potential impacts of the proposal on historic heritage and proposes a number of measures to mitigate these impacts.
	Park and public safety Ensure risks to park visitors are considered and identified risks are addressed appropriately. Traffic management solutions should be sought and implemented to mitigate any identified risks.	A Traffic Management Plan (TMP) will be prepared and implemented for traffic as part of the Construction Environmental Management Plan (CEMP) for the construction phase of the proposal. This will include site specific traffic control measures to manage and regulate traffic movement and ensure the safety of visitors to NPWS land.
	Hygiene protocols Ensure hygiene protocols are established and implemented for machinery, vehicles, equipment and materials to limit the introduction of foreign soil, plant matter or pathogens.	A Flora and Fauna Management Plan will be prepared in accordance with Transport's Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects (RMS, 2011) and implemented as part of the CEMP. It will include protocols to manage weeds and pathogens. Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).
	Use the Hygiene Guidelines for Wildlife (DPIE 2020) to assist in designing appropriate protocols for the proposal works.	A Flora and Fauna Management Plan will be prepared in accordance with Transport's Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects (RMS, 2011) and implemented as

Agency	Issue raised	Response / where addressed in REF
		part of the CEMP. It will include protocols to manage weeds and pathogens. Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).
	Visitors and NPWS access to park Ensure park visitor entry roads and management trails remain open, unless subject to prior arrangement with the Manager, NPWS Kanangra Area.	Access to NPWS lands would be maintained at all times during construction.
	The Traffic Management Plan should demonstrate that there will be no long term or protracted loss or delay to park access during construction.	During construction the proposal would not result in any long term delays for visitors accessing NPWS lands.
	Ensure NPWS maintains access to all lands it manages post construction.	Access to NPWS lands would be maintained during the operation of the proposal.
	Ensure adequate community notification occurs of any programmed closure of any access to visitor precincts to limit impacts on the public.	Access to NPWS lands would be maintained at all times during construction.
	Access to reliable clean drinking water supply and related infrastructure Ensure that water quality of the River Lett is not impacted by any of the activities outlined in the proposal. This should be addressed by the REF.	An assessment of the potential impacts of the proposal on water quality has been undertaken and is provided in Appendix I and summarised in Section 6.6 Soils and Surface Water. Safeguards and mitigation measures have been proposed to prevent any impacts to water quality including the establishment of erosion and sedimentation controls in accordance with *Managing Urban Stormwater – Soils and*

Agency	Issue raised	Response / where addressed in REF
		Construction, Volume 1 (Landcom, 2004) and *Volume 2D* (DECC, 2008).
	Ensure access will remain available to NPWS infrastructure. If this is unachievable, alternate solutions should be found prior to works restricting access to the site. Discussions should be undertaken with the Manager, NPWS Kanangra Area prior to any agreement on a solution. This could include upgrading of the station, and pipe network or development of new infrastructure in a suitable location.	Access to NPWS lands would be maintained at all times during construction.
	Ongoing communication with National Parks and Wildlife Services and the public Provide a copy of the final REF once determined by Transport, for NPWS records.	A copy of the REF will be provided to NPWS once the REF has been determined.
	Ensure notification from Transport occurs at least one week before works commence adjacent to park. The notification should include relevant contact details of the: • Transport communications team and direct website links to the proposal page to assist in the management of any public enquiries received regarding the proposal • Transport project coordinator as the primary contact for NPWS during proposal delivery • Onsite primary contractor delivering the project works adjacent to the park, to assist in any incident management	Transport will ensure that NPWS are notified prior to the commencement of any works that are adjacent to NPWS land. This will include the details of the relevant point of contact for any public enquiries.
	• Take appropriate steps to inform the community and any relevant key local groups about the proposed works, well in advance of the works commencing.	Transport is committed to ongoing consultation with the community and key stakeholders regarding the proposal. Further information regarding ongoing consultation is provided in Section 5.6.1.

5.5 Government agency and stakeholder involvement

Various government agencies and stakeholders have been consulted about the proposal, including:

- Lithgow City Council
- National Parks and Wildlife Services
- Hartley Crown Land Management Board
- NSW Rural Fire Service
- NSW Trainlink
- Lithgow Buslines
- Utility providers (Endeavor Energy, Telstra/NBN)
- Hartley district Progress Association
- Central Tablelands Mountain Bike Club.

Issues that have been raised as a result of consultation with these agencies and stakeholders are outlined below in Table 5-5. Across all proposal stages, Transport have also consulted with Lithgow City Council and relevant public authorities in accordance with and in addition to the obligations of the ISEPP framework. In addition to the inter-departmental consultation required under ISEPP, Transport has consulted with relevant agencies, including OEH, during the development of the proposal and obtained feedback on their potential future involvement.

Consultation with Lithgow City Council has been conducted throughout the development of the proposal and will continue during detailed design. Initial feedback from Lithgow City Council has been considered and incorporated into the concept design where agreed. The design refinements resulting from this consultation are detailed in Section 2.

Transport will continue to consult with government authorities and agencies and consider any issues raised where reasonable and feasible. Formal notifications to relevant authorities will be provided where applicable.

Table 5-5 Issues raised through stakeholder consultation

Agency	Issue raised	Response / where addressed in REF
Lithgow City Council	Design, landscape character and visual impacts, environment, road maintenance, economic development	• Chapter 6 • Appendix L: Urban design, landscape character and visual impact assessment • Appendix M: Socio-economic Assessment
National Parks and Wildlife Services	Revocation of land	Section 4.2.5 and section 4.4

Agency	Issue raised	Response / where addressed in REF
Hartley Crown Land Management Board	Acquisition of Crown Land	Section 6.11
NSW Rural Fire Service	South Bowenfels Fire Brigade shed access, highway access during fires	Section 6.2, section 6.11 and Appendix E: Traffic and Transport Assessment
NSW Trainlink	Bus services along the route during trackwork and train emergencies	Appendix E: Traffic and Transport Assessment.
Lithgow Buslines	Bus routes and bus stop locations from Little Hartley to Lithgow	Section 6.2 and Appendix E: Traffic and Transport Assessment.
Endeavour Energy	Powerline relocation and adjustment	Section 3.5.
Telstra/NBN	Telecommunications relocation and adjustment	Section 3.5.
Hartley District Progress Association	Concept design, safety, access, speed limit, heavy vehicle rest areas, environment, consultation	Chapter 3 Section 6.2 and Appendix E: Traffic and Transport Paper Chapter 5.
Central Tablelands Mountain Bike Club	Recreational cycling	Section 3.2.

5.6 Ongoing or future consultation

5.6.1 Ongoing consultation

Transport would continue to work closely with the community and relevant stakeholders through all stages of the proposal. The following consultation would be ongoing throughout proposal development and construction will include, but not limited to:

- Provision of information via print, online and face-to-face means
- Provision of regular information updates via the project web page and virtual portal
- Provision of regular information updates via media releases and proposal advertisements in local media
- Face-to-face and online consultation/drop-in sessions
- Targeted engagement with local stakeholder groups, Lithgow City Council, utility providers and other government agencies
- Pop-up displays
- Production of a community consultation and general issues response summary report

- Provision of information and project updates at key stages during design finalisation
- Engagement with affected landowners and community stakeholder groups about the project and key design decisions that may impact them
- Follow-up meetings to discuss and agree access arrangements with directly affected landowners prior to and during construction
- Engagement and coordination with transport and other infrastructure providers, particularly around project interfaces and in relation to cumulative impacts
- Engagement with the local community about construction timing, impacts and mitigation

Should the proposal proceed, the construction contractor would develop a Community and StakeholderInvolvement Plan to keep residents and road users up to date about construction progress. This would include:

- Consultation with community stakeholders to help manage impacts during construction
- Notifying residents when work is proposed to start
- Notifying residents of night work
- Notifying residents of access issues

5.6.2 Display of REF

The REF will be on display between 22 November 2021 and 21 December 2021. The document will be accessible via various different ways as outlined on the Display of the REF page at the start of this document.

The REF will be open to public submissions and will be managed in accordance with the Transport Privacy Statement.

6. Environmental assessment

6.1 Biodiversity

This section provides an assessment of the potential impacts of the proposal on biodiversity and identifies safeguards and management measures to avoid or minimise these impacts. A detailed assessment of biodiversity impacts is presented in a Biodiversity Development Assessment Report (BDAR) (Appendix D).

6.1.1 Methodology

The methodology for the biodiversity assessment included a desktop assessment, habitat suitability assessment, field surveys and the assessment of biodiversity impacts.

Desktop assessment

A desktop assessment was undertaken in the first half of 2021 which included a review of the following relevant databases and previously undertaken assessments:

- The NSW BioNet Wildlife Atlas and Threatened Biodiversity data collection (DPIE, 2020a)
- The NSW BioNet Vegetation Classification data collection (DPIE, 2020b)
- The Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (BoM, 2020)
- DPI threatened species list (DPI, 2021)
- NSW Interim Biogeographic Regions of Australia (IBRA) regions and sub-regions – Version 7 (DAWE, 2021a)
- Southeast NSW Native Vegetation Classification and Mapping (VIS_ID 2230) based on Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands (Tozer, et al., 2010)
- Species Profile and Threats (SPRAT) Database (DAWE, 2021b)
- The Protected Matters Search Tool (DAWE, 2020)
- Species profiles from the Threatened Biodiversity Data Collection (DPIE (EES))
- Biodiversity Assessment Method (BAM) Calculator
- The NSW DPI weeds database (DPIE, 2020c)
- Directory of Important Wetlands (DAWE, 2019)
- Soils and geology database (eSPADE) (DPIE, 2020d)
- The Fisheries NSW Spatial Data Portal (DPI, 2020)
- Key Fish Habitat maps (DPI, n.d.)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey NPWS revocation area – Little Hartley (Niche, 2021a)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey NPWS revocation area – Medlow Bath to Blackheath (Niche, 2021b)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey Report 1 – Proposed tunnel portal locations (Niche, 2021c)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey Report 2 – TfNSW surplus lands (Niche, 2021d)

- Great Western Highway Upgrade - Katoomba to Lithgow, Preliminary Biodiversity Survey Report 3 – Additional areas (Niche, 2021e)
- BioBanking agreement ID number: 424 Under the Threatened Species Conservation Act 1995 for Roads and Maritime Services for 40 Bends Road Biobank (OEH, 2017b)
- Great Western Highway Upgrade, Katoomba to Lithgow Preliminary Environmental Investigation (Transport for NSW, 2020)
- Great Western Highway Upgrade, Mount Victoria to Lithgow Alliance Forty Bends Upgrade – Review Of Environmental Factors Technical Paper 1 Biodiversity (RMS, SKM & PB, 2012)
- Mount Victoria to Lithgow Great Western Highway Upgrade Route Options Report (SKM, 2009).

Habitat suitability assessment

In order to identify species for targeted field surveys, a list of candidate species identified by the BAM Calculator known or considered likely to occur was refined based on the known geographic distribution and the suitability of habitat features present, including associated plant community types and soil and geological preferences. A habitat assessment was then undertaken to determine the likelihood for each of the listed candidate species to occur and, as such, require targeted field survey and assessment of potential impacts of the proposal.

Field surveys

Vegetation, flora and fauna field surveys were undertaken in March, April and May 2021 to target specific threatened species to validate the results of the desktop and habitat assessments. Survey effort is in accordance with current biodiversity assessment guidelines (OEH, 2017). A summary of the survey effort for the biodiversity assessment is shown in Table 6-1.

Table 6-1 Summary of biodiversity assessment field survey effort

Date	Method
15 to 16 March 2021	Fauna surveys including habitat assessment, diurnal bird surveys, nocturnal surveys (spotlighting and call playback) and deployment of detection devices. Remote cameras deployed targeting ground dwelling (Spotted-tailed Quoll) and arboreal mammals (Squirrel Glider, Greater Glider and Koala). Ultrasonic detectors deployed to survey for threatened microbat species.
7 to 8 April 2021	Fauna surveys including habitat assessment, diurnal bird surveys, inspection of culverts, nocturnal surveys (spotlighting and call playback), collection and re-deployment of detection devices. Remote cameras and ultrasonic detectors re-positioned to survey different locations within subject land.
14 to 15 April 2021	Flora surveys including six vegetation plots sampling Plant Community Types (PCTs): 731 and 1103.
12 to 13 May 2021	Fauna surveys including habitat assessment, diurnal bird surveys, collection and re-deployment of detection devices. Remote cameras and ultrasonic detectors re-positioned to survey different locations within subject land.
	Flora surveys including seven vegetation plots sampling PCTs: 731, 732, 963, 1103 and 1155.

Date	Method
20 to 21 May 2021	Condition assessment of aquatic habitats and named waterways in accordance with Policy and Guidelines for fish habitat conservation and management (DPI, 2013)
27 to 28 May 2021	Fauna surveys including habitat assessment, diurnal bird surveys, targeted Koala scat searches using the Rapid Spot Assessment Technique (SAT) (Phillips & Wallis, 2016; based off Phillips & Callaghan, 2011) (SAT) and collection of detection devices.
	Flora surveys including eight vegetation plots sampling PCTs: 731, 1103 and 1155.
11 to 13 August 2021	Stag watch for suitable breeding hollows of threatened large forest owl species including Sooty Owl, Powerful Owl, Barking Owl and Masked Owl. Diurnal searches for breeding individuals and breeding habitat of threatened raptor species (Little Eagle and White-bellied Sea-Eagle). Additional Koala scat searches using Rapid SAT. Confirmation of PCTs and vegetation condition classes. Confirmation of the extent of present Threatened Ecological Communities (TECs).
5 to 6 October 2021	Targeted surveys in locations where Purple Copper Butterfly presence was considered most likely
Survey to be conducted	Spring 2021: Targeted surveys for non-seasonal threatened flora species and spring flowering species including Acacia flocktoniae, Asterolasia buxifolia, Baloskion longipes, Boronia deanei, Eucalyptus pulverulenta, Kunzea cambagei, Swainsona sericea and Thesium australe. Diurnal searches for breeding individuals and breeding habitat of threatened Gang-gang Cockatoo. Targeted spotlighting searches for the Booroolong frog (*Litoria booroolongensis)*
	Summer 2021/2022: Targeted surveys for summer flowering threatened flora species *Veronica blakelyi*.

Impact assessment

Potential impacts to biodiversity as a result of the proposal were identified and assessed. This included an assessment of direct and indirect construction and operational impacts. Mitigation measures for avoiding, managing or reducing impacts on biodiversity values during detailed design, construction and operation were identified. Offsetting requirements for any residual impacts that cannot be avoided, minimised or mitigated were outlined and discussed.

6.1.2 Existing environment

Landscape features

The biodiversity landscape features of the construction footprint are summarised in Table 6-2 and shown in Figure 6-1.

Table 6-2 Biodiversity landscape features

Landscape feature	Subject land
IBRA bioregions and subregions	The subject land lies within two IBRA Bioregions: the Sydney Basin bioregion and the South Eastern Highlands Bioregion shown in Figure 6-1. The north-western and south-eastern 208.45 hectares of the subject land are located within the Sydney Basin bioregion and the central 58.69 hectares, plus 1.44 hectares at the north-western extent of the subject land, are located within the South Eastern Highlands bioregion. All areas of the subject land within the Sydney Basin bioregion are in the Burragorang IBRA subregion, and all areas within the South Eastern Highlands bioregion are in the Bathurst IBRA subregion. In accordance with Section 5.2.1 of the BAM, separate habitat suitability assessments have been undertaken for threatened species in each IBRA subregion. Consequently, two BAM calculator files have been established and species and PCTs have been split and assessed according to PCT/IBRA subregion association of Burragorang and Bathurst.
NSW landscape regions (Mitchell landscapes)	The subject land lies within two Mitchell Landscapes as mapped by Eco Logical Australia (2008), the boundaries of which roughly follow the IBRA bioregion boundary. The north western and south eastern areas are mapped within the Sydney Basin Western Escarpment Mitchell Landscape, while the central area is mapped within the Bathurst Granites Mitchell Landscape. The Sydney Basin Western Escarpment has a landscape of steep dissected slopes on the western margin of Triassic rocks, descending into Permian conglomerate, shale and sandstone (Eco Logical Australia, 2008). The Bathurst Granites landscape consists of undulating to steep hills on Carboniferous granites and granodiorite, with tors and rock outcrops around the margins (Eco Logical Australia, 2008).
Areas of geologic significance and soil hazard features	The construction footprint does not contain any karst, caves, crevices, cliffs or other areas of geological significance. It is located to the west of the Blue Mountains and south of the Newnes Plateau, both of which contain substantial geological formations of exposed sandstone cliffs sitting above deep incised valleys. Soils within the construction footprint are comprised of Lithgow, Hassans Walls, Cullen Bullen, Marrangaroo and Round Mount soil landscape types, with some minor areas of Disturbed Terrain (DPIE, 2021a). Exposed granite rocks and boulders are present throughout many portions of the construction footprint, particularly associated with the Bathurst Granites Mitchell Landscape in the centre of the proposal. High risk areas for erosion include a large portion of both the River Lett Hill to Forty Bends and Forty Bends to Lithgow sections as well as the far eastern and western section of the Little Hartley to River Lett Hill Section and far eastern section of the Coxs River Road Section.

Landscape feature	Subject land
Native vegetation extent surrounding the proposal	Native vegetation covers about 40 per cent of land within 500 metres of the proposal, as mapped in the Central Tablelands Biometric Vegetation Mapping (DPIE, 2017a), as shown in Figure 4-2 of the BDAR (Appendix D).
Cleared areas	Of the 319 hectares of land within the construction footprint, about 215 hectares is cleared. Cleared land comprises mostly of cleared grassland on rural and rural-residential land.
Rivers and streams	The proposal transects several named and unnamed waterways, including River Lett (a sixth order stream), Boxes Creek (a fourth order stream) and its associated unnamed tributaries, tributaries of Butlers Creek and Whites Creek and several other first and second order streams.
Wetlands	The construction footprint does not contain any wetlands. The closest wetland to the subject land is the Macquarie Marshes, over 300 kilometres from the proposal.
Connectivity features	There are no mapped wildlife corridors within the construction footprint, however the Blue Mountains Western Escarpment wildlife corridor occurs between Mount Victoria and Little Hartley to the east of the proposal. More broadly, the proposal is located to the south and west of expansive vegetation of the Greater Blue Mountains area. The Blue Mountains National Park lies to the east and Newnes Plateau to the north. Narrow remnants of native vegetation pass through the construction footprint in a north-south orientation linking vegetation in these expanses to more fragmented vegetation on rural land and riparian corridors. These corridors are important for habitat connectivity to native vegetation remnants to the immediate south and conservation areas further on such as Kanangra-Boyd National Park.
Areas of geological significance and soil hazard features	The subject land does not contain any karst, caves, crevices, cliffs or other areas of geological significance. It is located to the west of the Blue Mountains and south of the Newnes Plateau, both of which contain substantial geological formations of exposed sandstone cliffs sitting above deep incised valleys. Soils within the subject land are comprised of Lithgow, Hassans Walls, Cullen Bullen, Marrangaroo and Round Mount soil landscape types, with some minor areas of Disturbed Terrain (DPIE, 2021b). Exposed granite rocks and boulders are present throughout many portions of the subject land, particularly associated with the Bathurst Granites Mitchell Landscape in the centre of the subject land. High risk areas for erosion include a large portion of both the River Lett Hill to Forty Bends and Forty Bends to Lithgow sections as well as the far eastern and western section of the Little Hartley to River Lett Hill section and far eastern section of the Coxs River Road section.
Areas of outstanding biodiversity value	No Areas of Outstanding Biodiversity Value (AOBVs) occur within or surrounding the construction footprint.

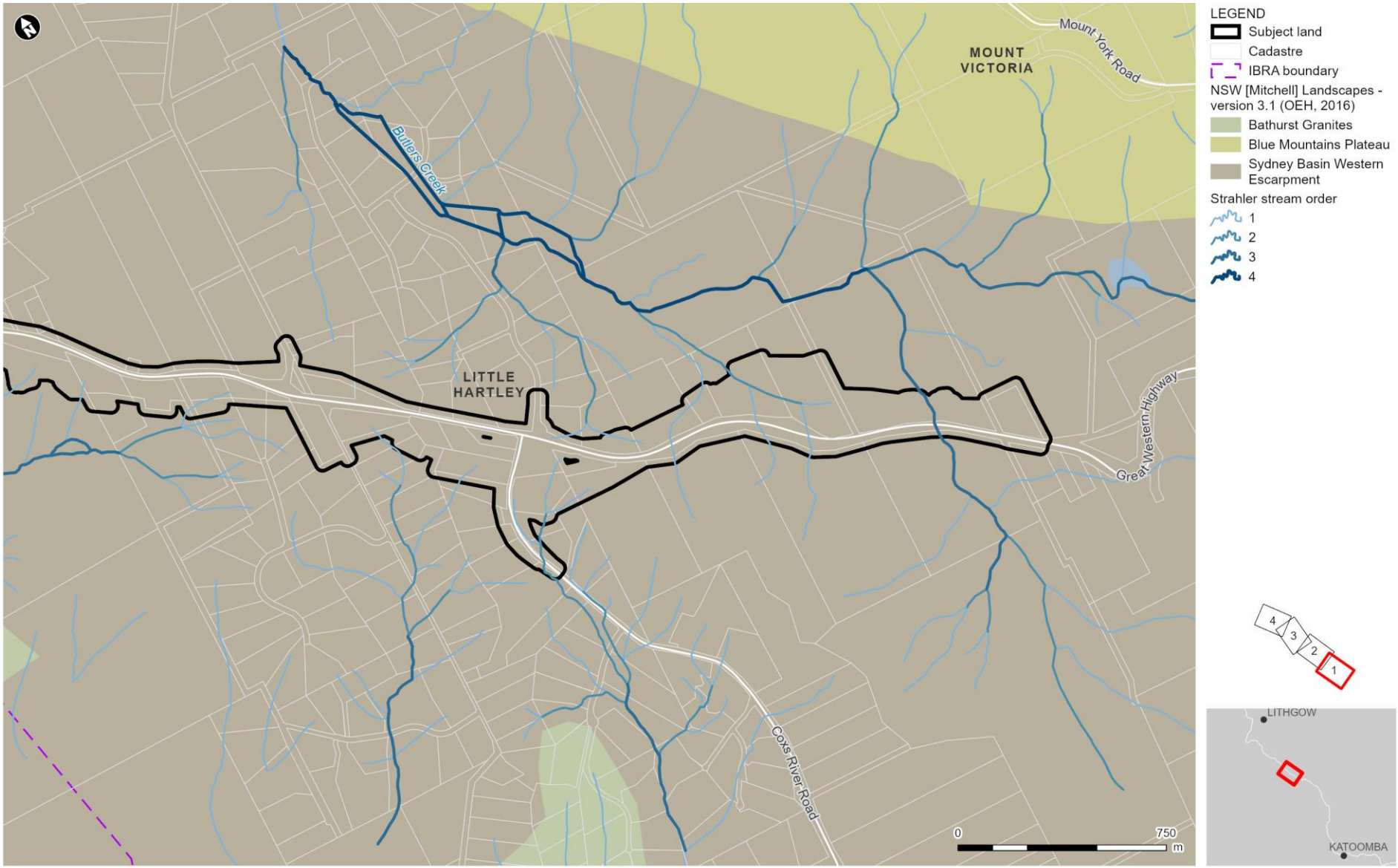


Figure 6-1 a Biodiversity landscape features

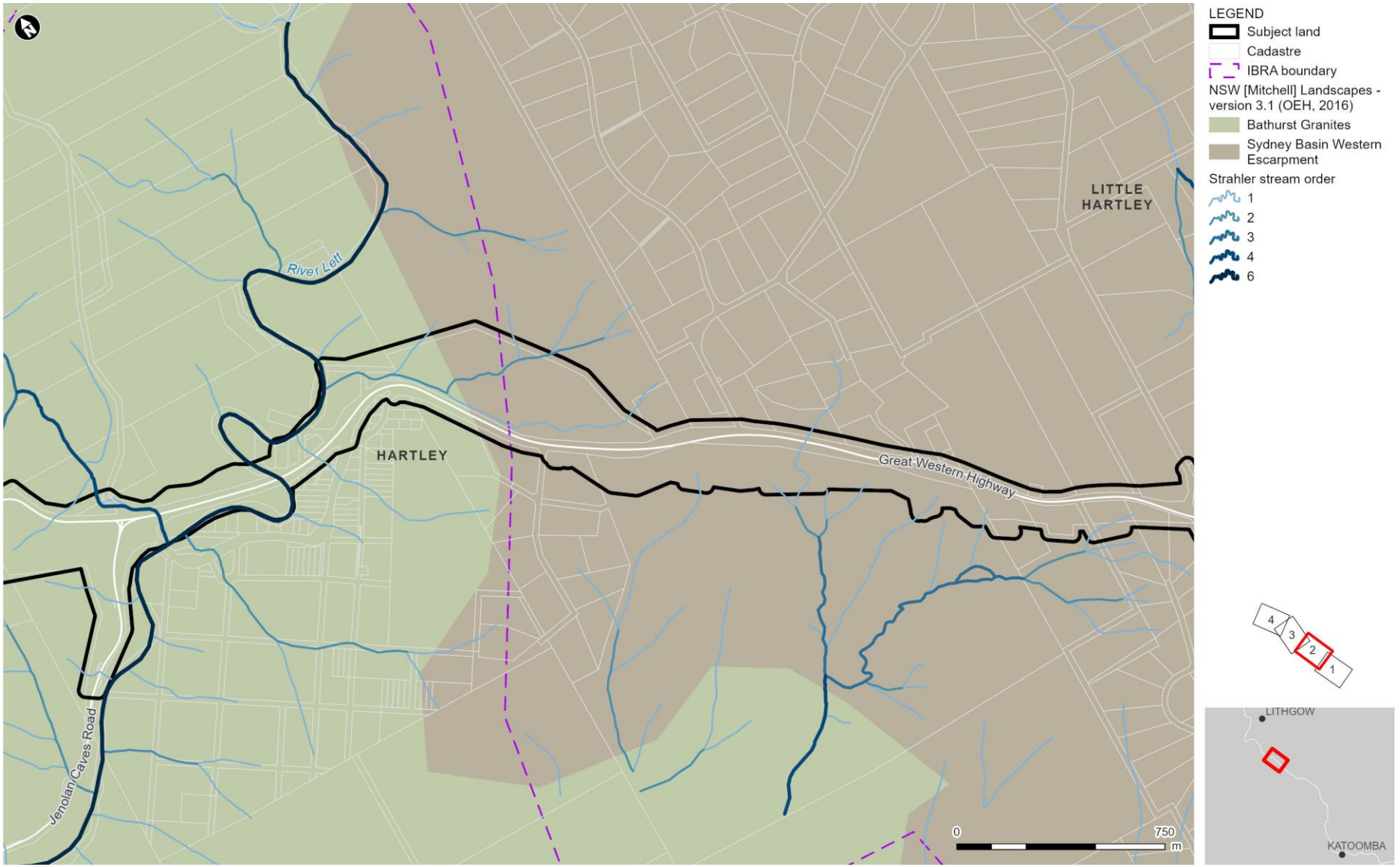


Figure 6-1 b Biodiversity landscape features

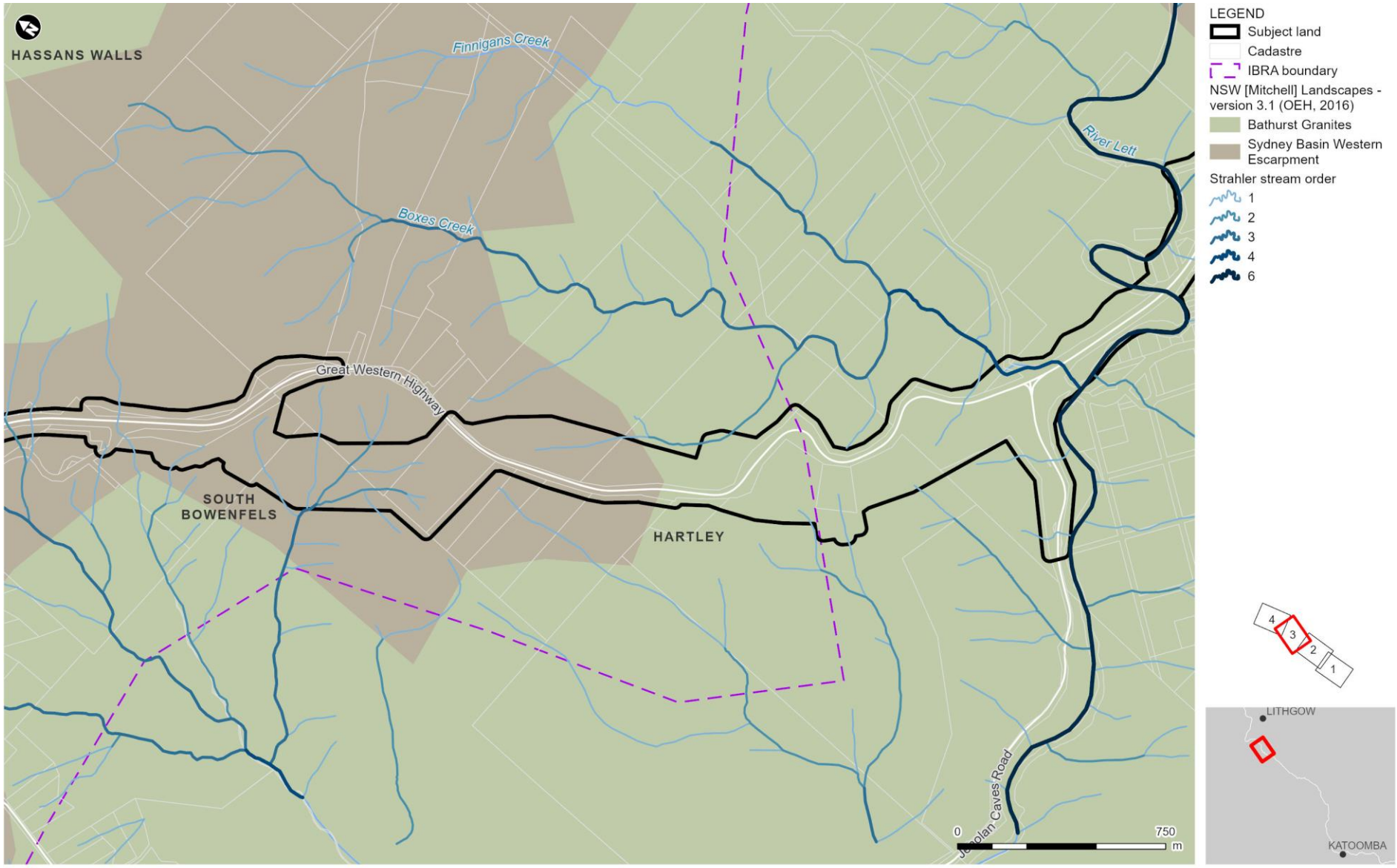


Figure 6-1 c Biodiversity landscape features

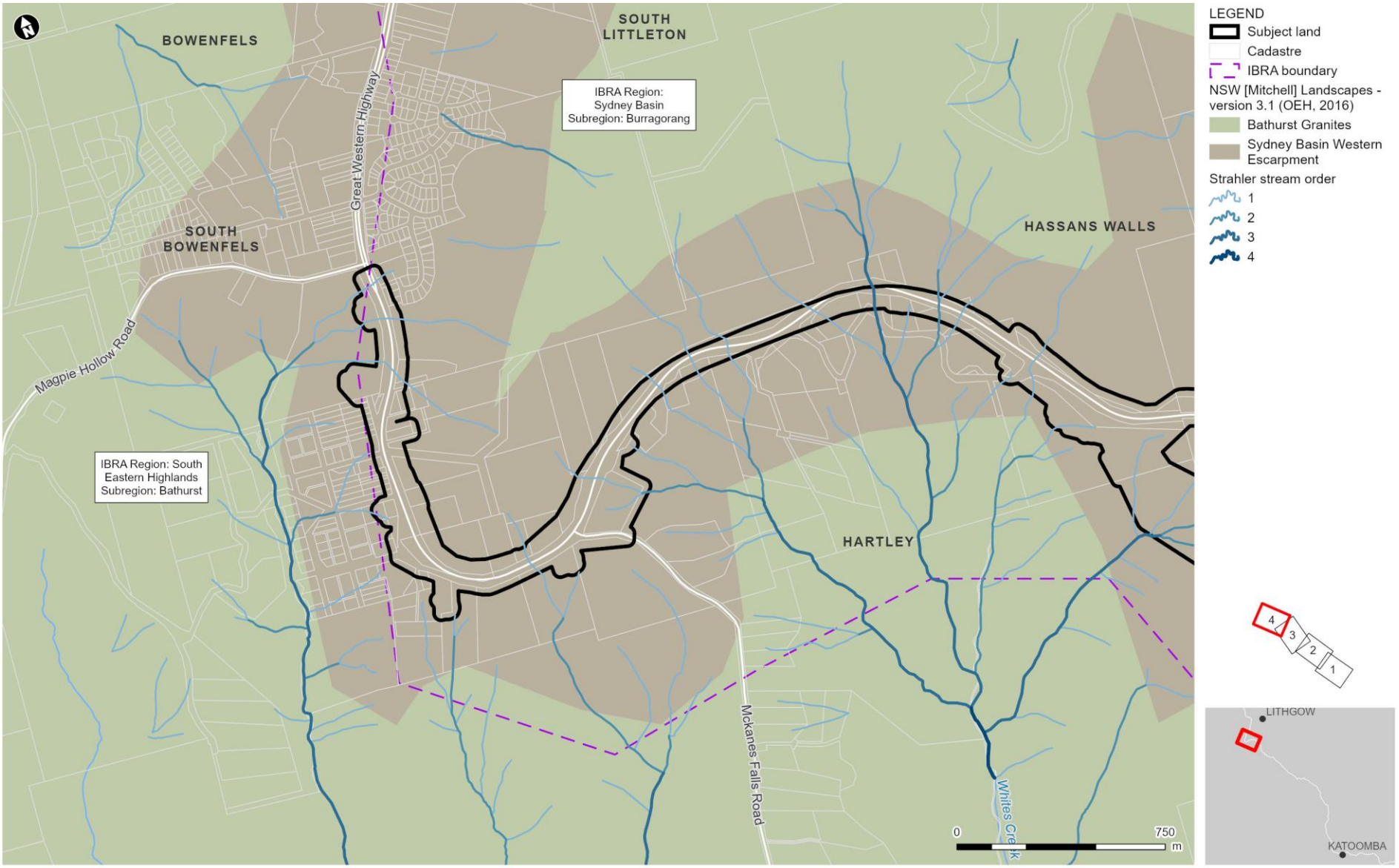


Figure 6-1 d Biodiversity landscape features

Flora

Vegetation types

The native vegetation within the construction footprint is consistent with six plant community types (PCT):

- River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (PCT 85)
- Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (PCT 732)
- Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (PCT 963)
- Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (PCT 1103)
- Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (PCT 731)
- Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (PCT 1155)

Native vegetation covers about 27 per cent of the construction footprint. The remaining 73 per cent is cleared, comprising mostly of cleared grassland on rural and rural-residential land.

The area of coverage of the vegetation types is provided in Table 6-3 and their location is shown in Figure 6-2.

Threatened ecological communities

There are 17.59 hectares of PCT 1103 within the construction footprint that meets the description of the threatened ecological community (TEC) Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as endangered under the *Biodiversity Conservation Act 2016*.

There are 7.60 hectares of PCT 1103 within the construction footprint that meets the description of the TEC White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as critically endangered under the *Biodiversity Conservation Act 2016*. Of this area, there are 4.64 hectares that also meet the size and condition threshold criteria for the TEC listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

The location of TECs is shown in Figure 6-3.

Table 6-3 Vegetation types

Vegetation type	PCT number	Structure/ condition class	Status		Extent within construction footprint (hectares)	Hollow bearing trees present
			BC Act	EPBC Act		
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion	85	Moderate	-	-	3.95	2
		Disturbed	-	-	0.35	2
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion	731	Good	-	-	12.44	4
		Variant - good	-	-	3.08	4
		Moderate	-	-	14.61	5
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion	732	Moderate	-	-	6.42	11
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion	963	Good	-	-	2.34	10
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the	1103	Good	Endangered[12]	Critically Endangered[3]	11.62	41

[1] Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion
[2] White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions

Vegetation type	PCT number	Structure/ condition class	Status		Extent within construction footprint (hectares)	Hollow bearing trees present
			BC Act	EPBC Act		
eastern tablelands; South Eastern Highlands Bioregion		Moderate	Endangered[12]	Critically Endangered[3]	6.94	27
		Low-Moderate	Endangered[1]		4.79	10
		Disturbed	Endangered[1]		1.85	0
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion	1155	Moderate	-	-	10.24	13
Total area native vegetation					78.63	129

[3] Patches meet the criteria for Critically Endangered listed under the EPBC Act

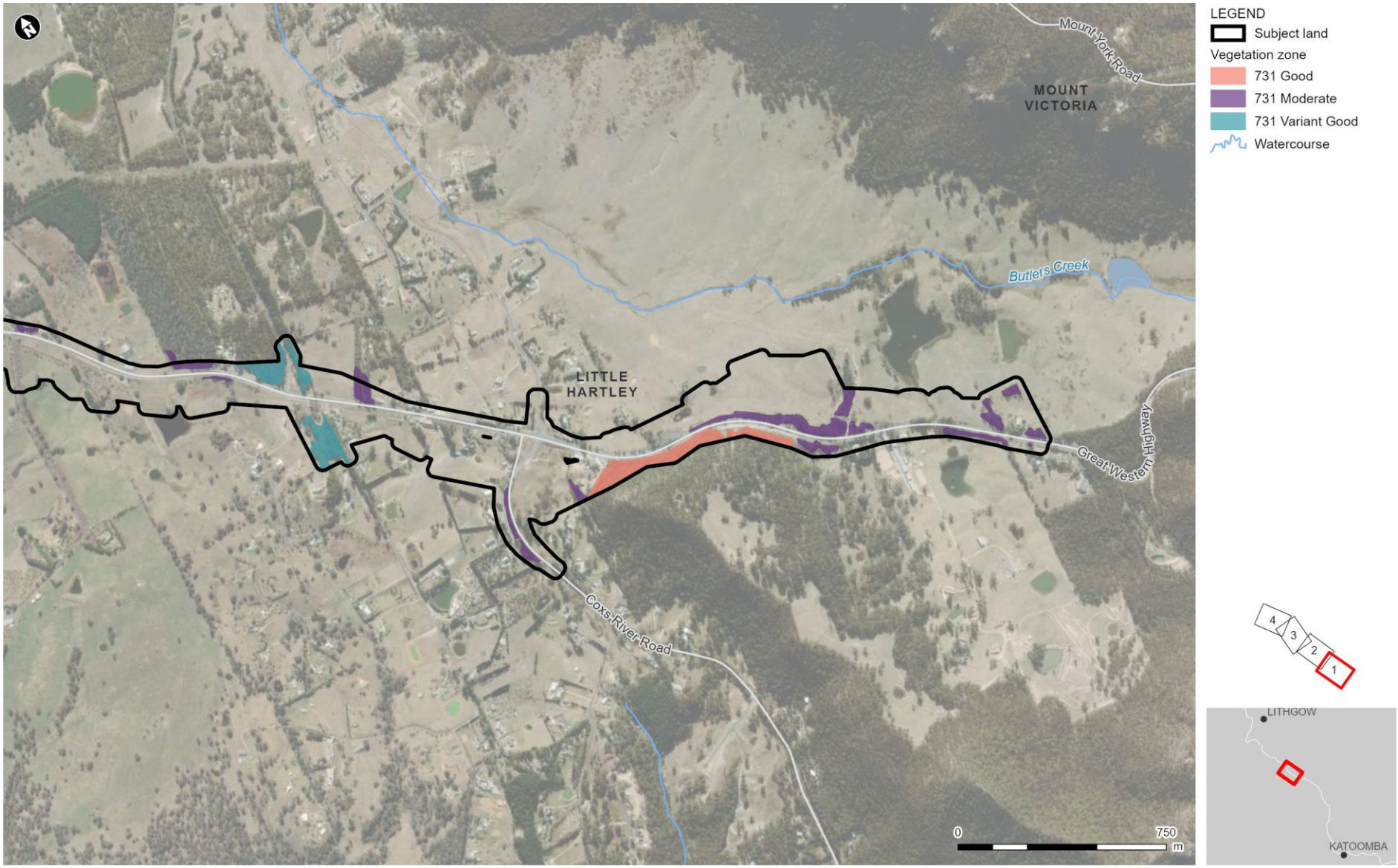


Figure 6-2 a Vegetation types

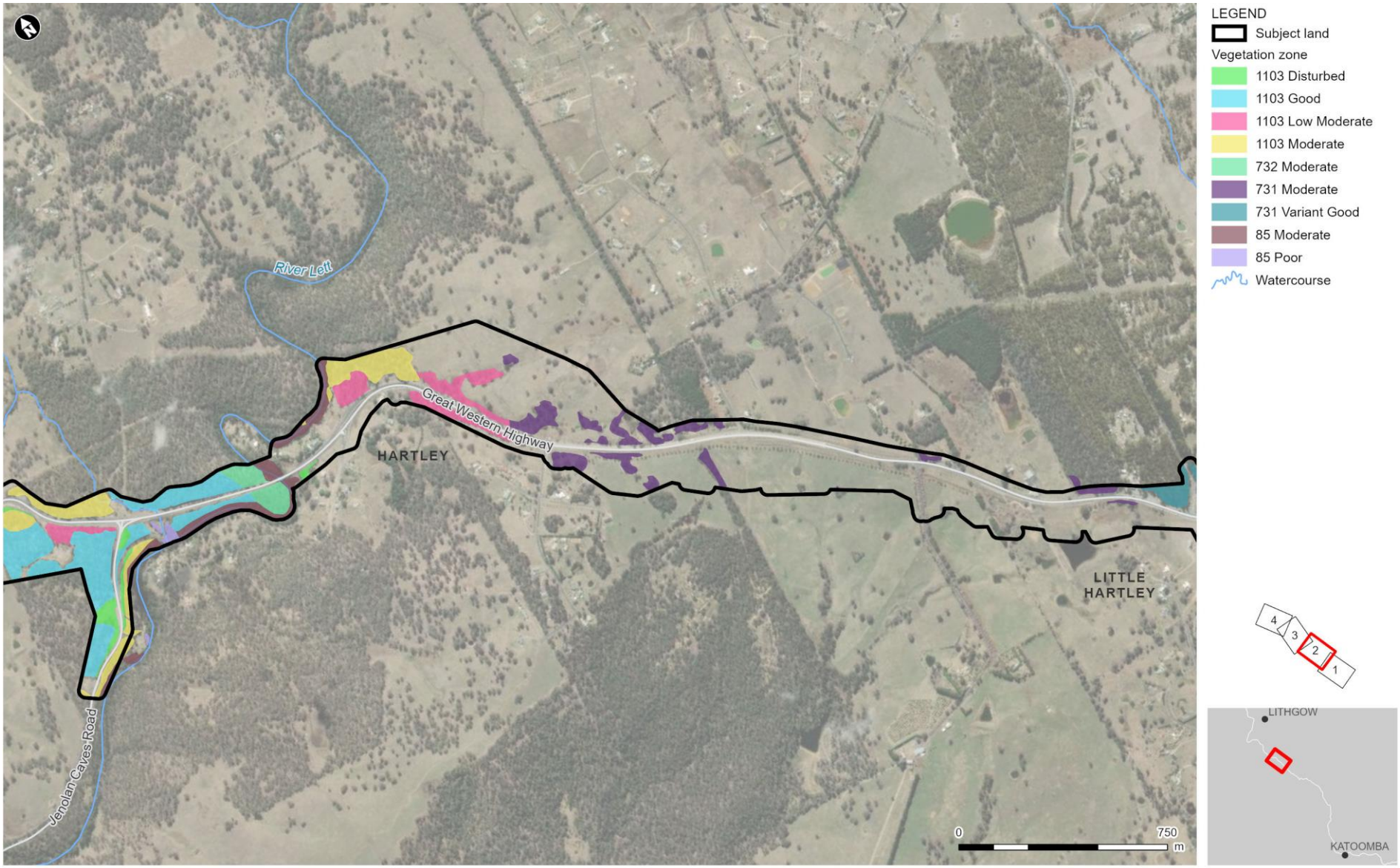


Figure 6-2 b Vegetation types

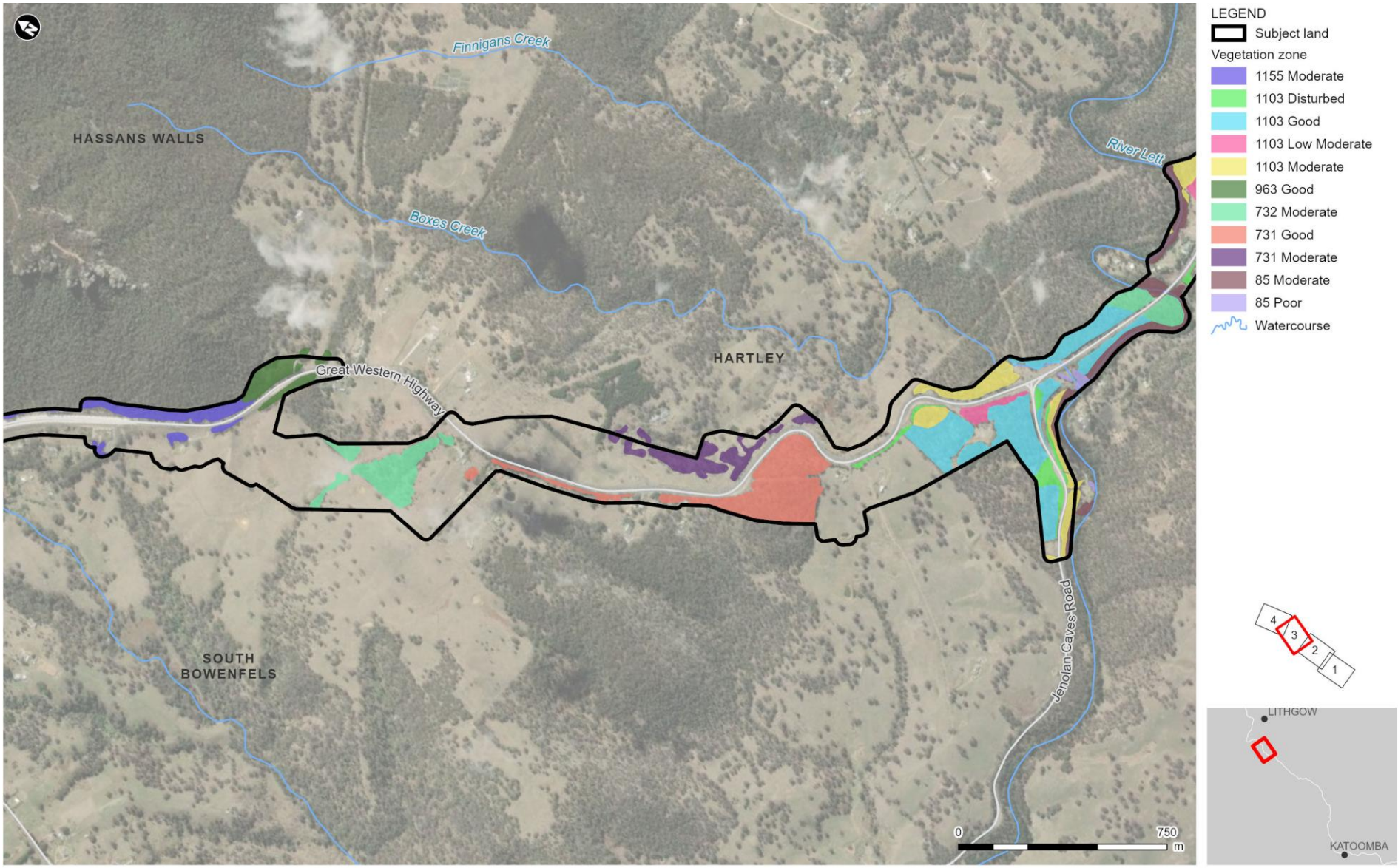


Figure 6-2 c Vegetation types

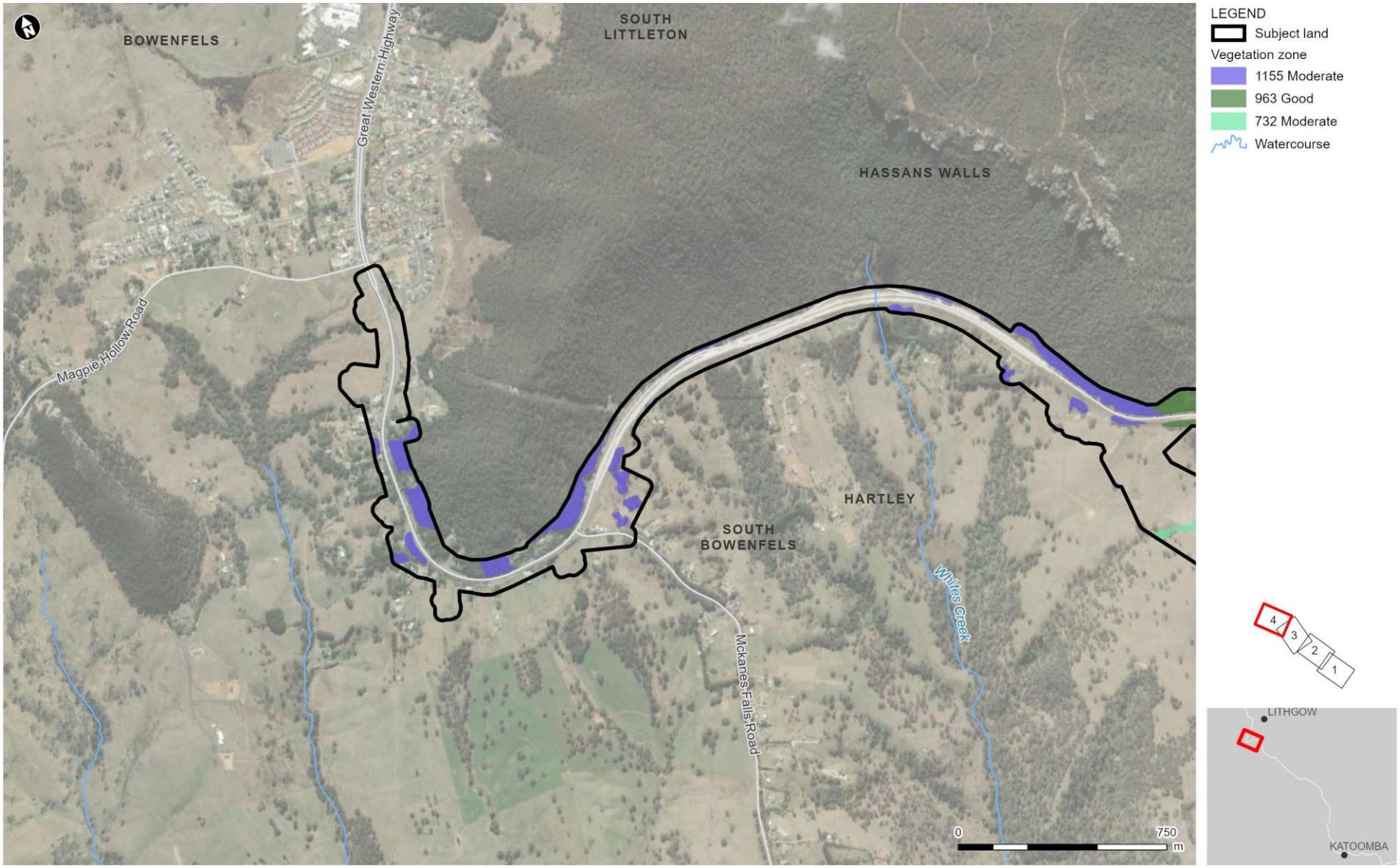


Figure 6-2 d Vegetation types

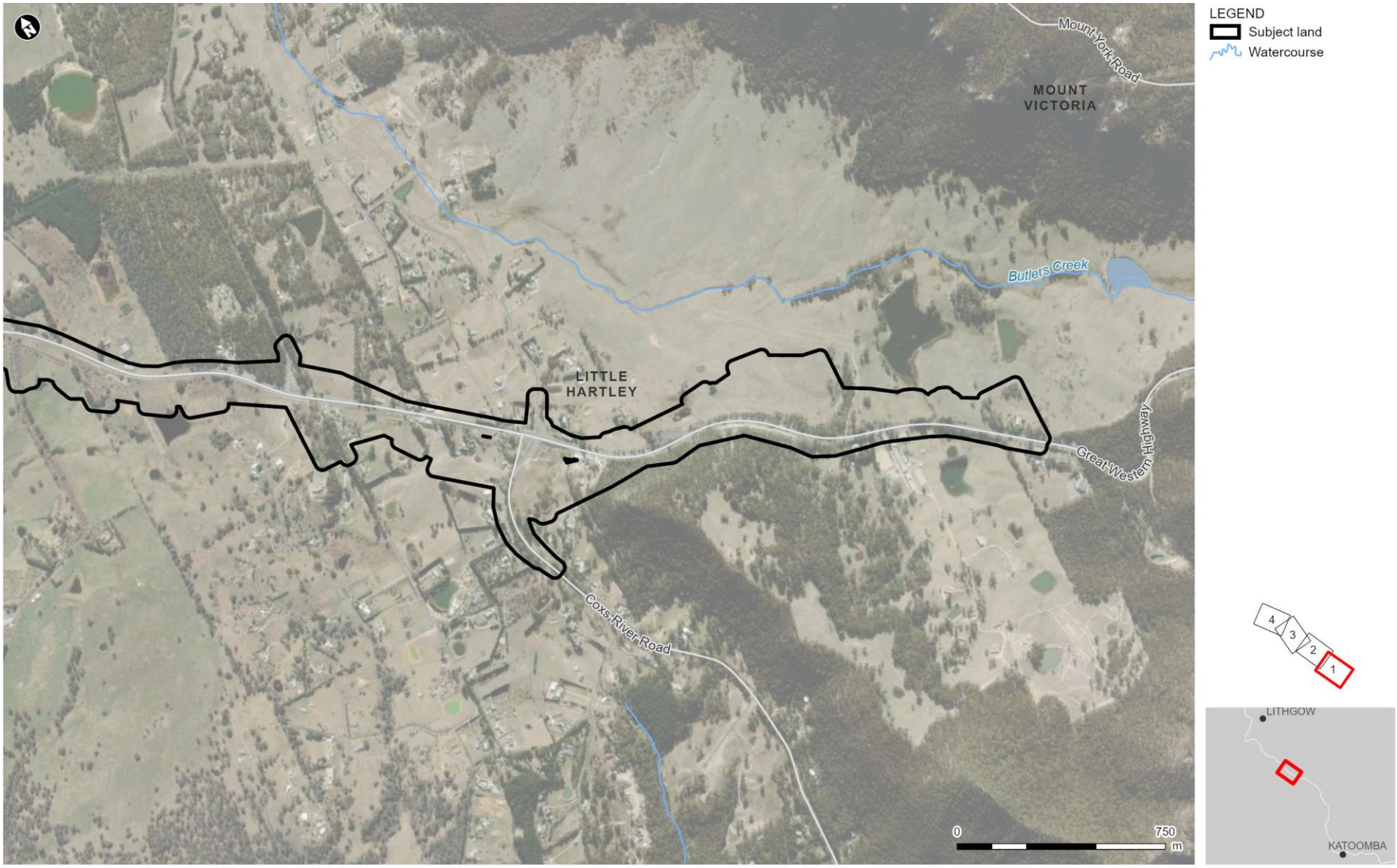


Figure 6-3 a TECs

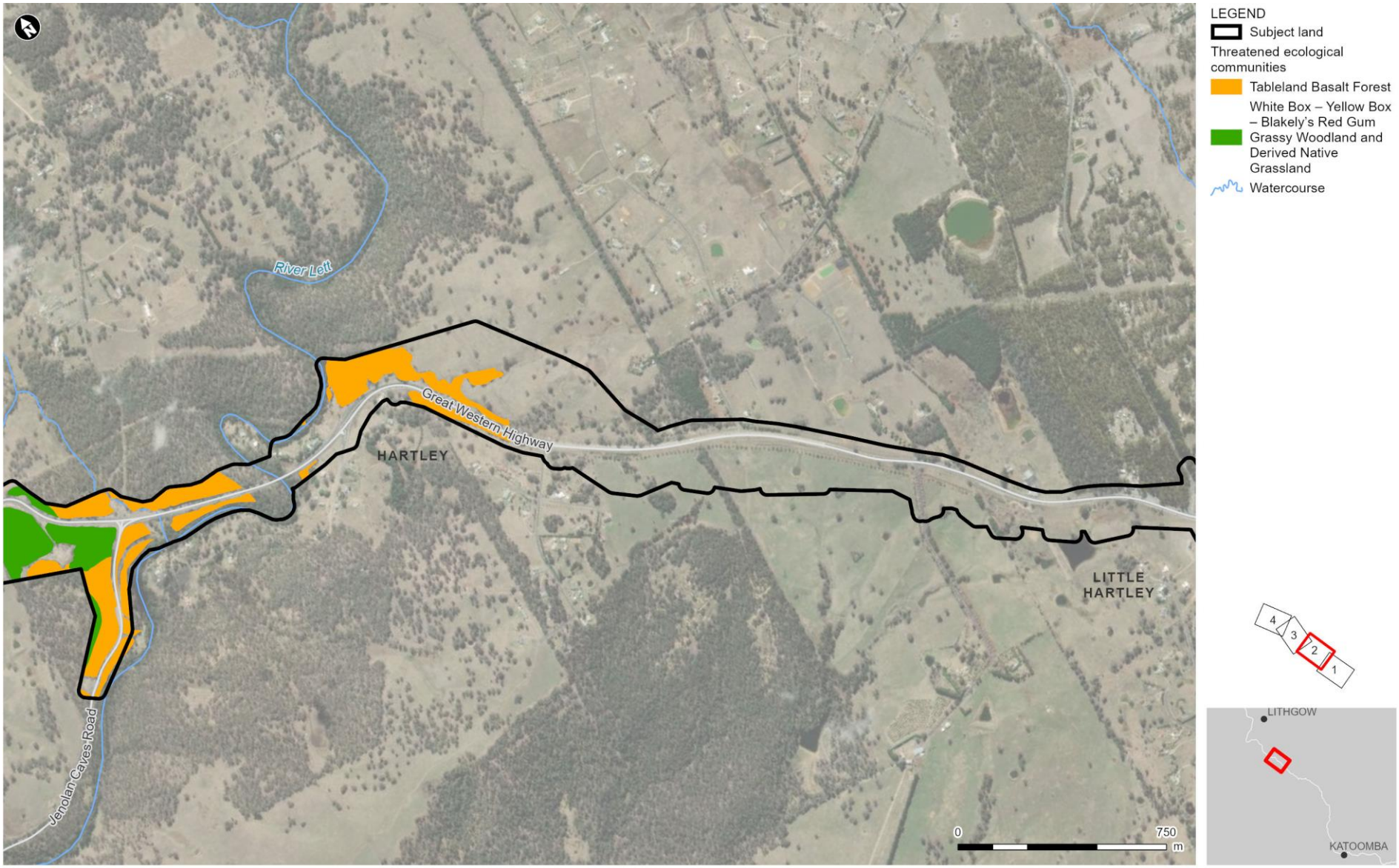


Figure 6-3 b TECs

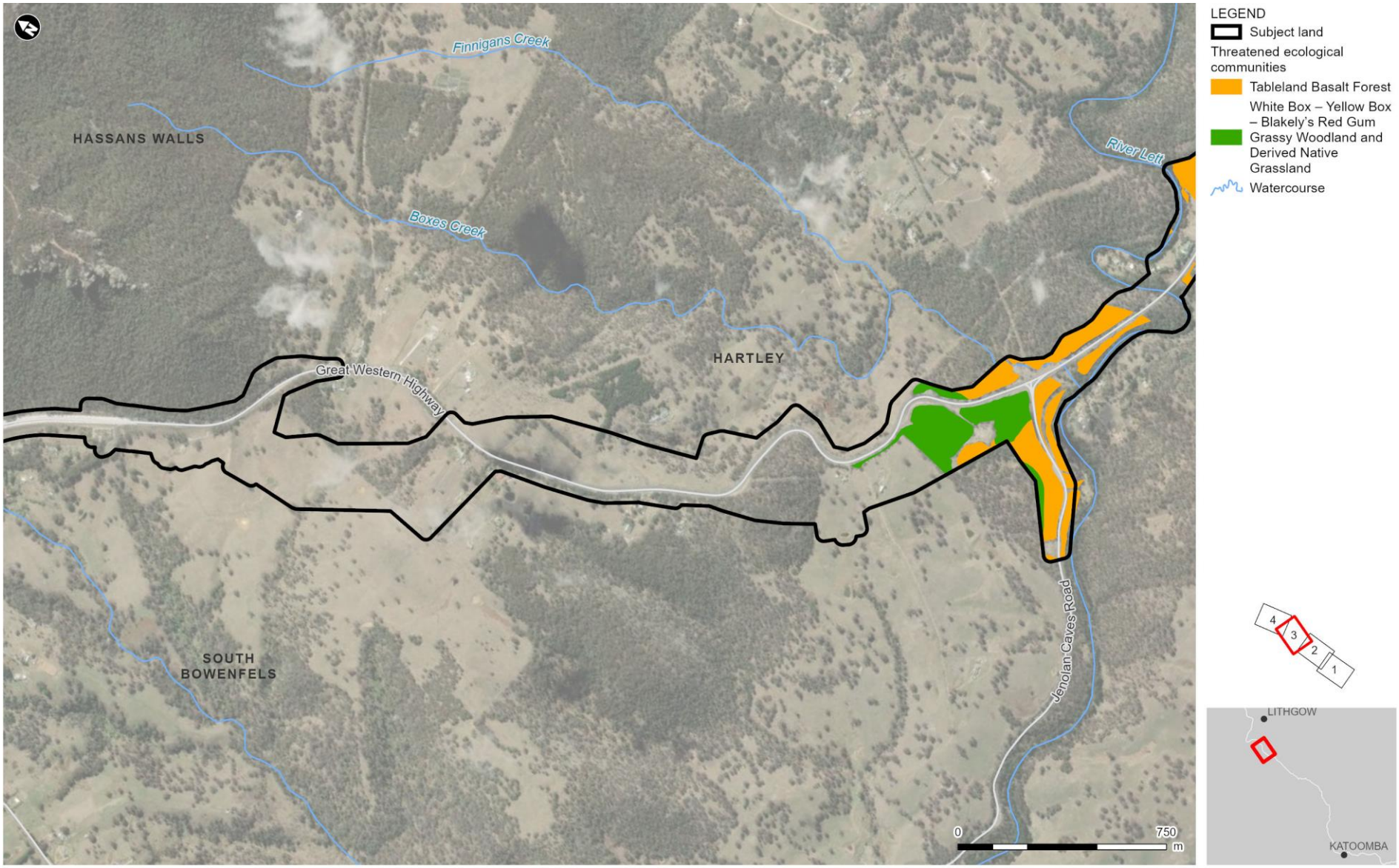


Figure 6-3 c TECs

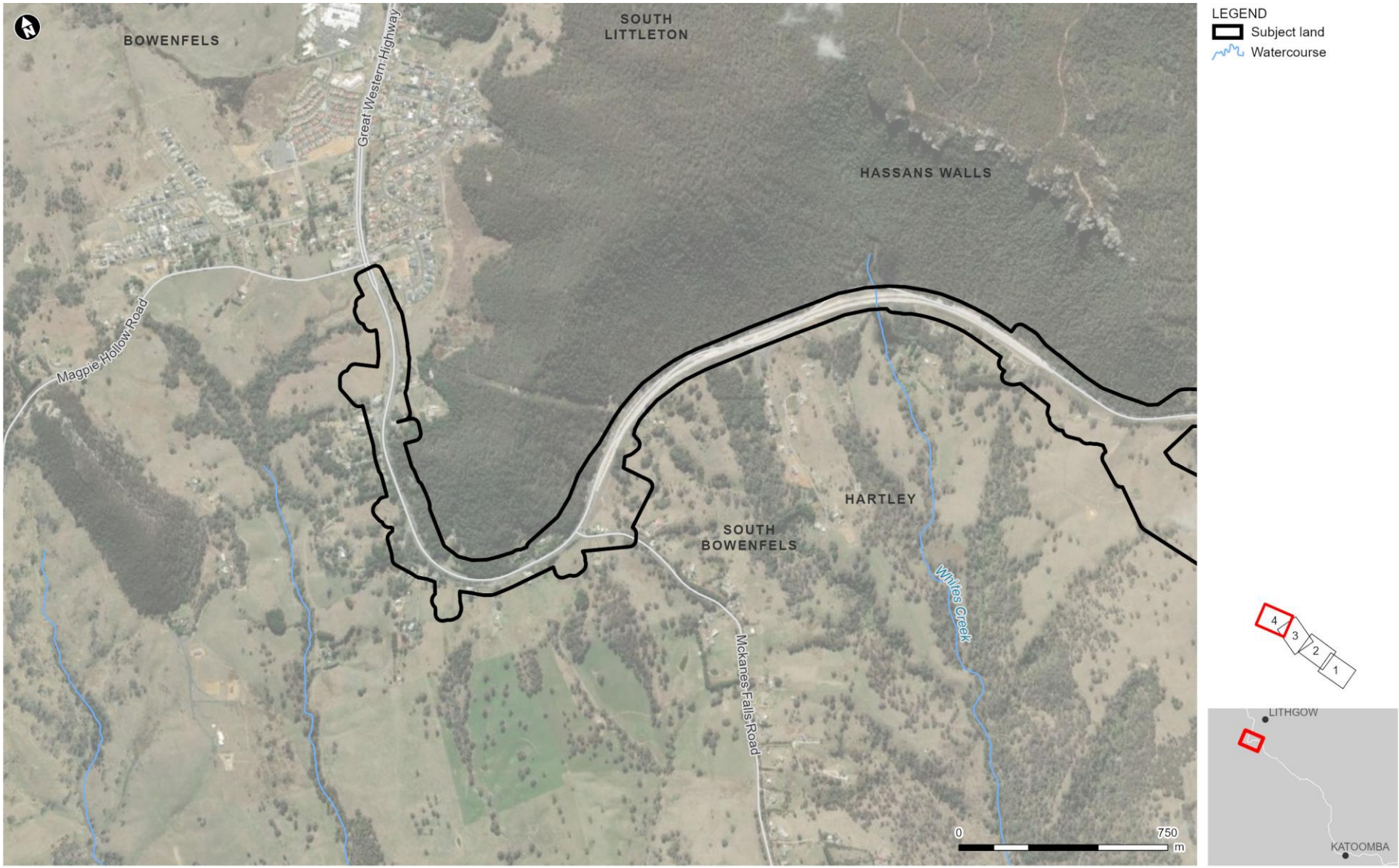


Figure 6-3 d TECs

Threatened flora species

No threatened flora species have been identified within the construction footprint during general flora surveys. Targeted threatened flora surveys would be carried out in spring 2021 to meet the recommended survey periods as listed in the TBDC (DPIE (EES), 2021a) for the target flora species to maximise the chance of detection. The findings from these targeted surveys will be included in the Response to Submissions report prepared for the proposal.

Groundwater dependent ecosystems

About 42.85 hectares of ecosystems with low, moderate and high potential to be interactive with groundwater have been recorded within the construction footprint. Figure 6-4 identifies potential groundwater dependent ecosystems within the construction footprint.

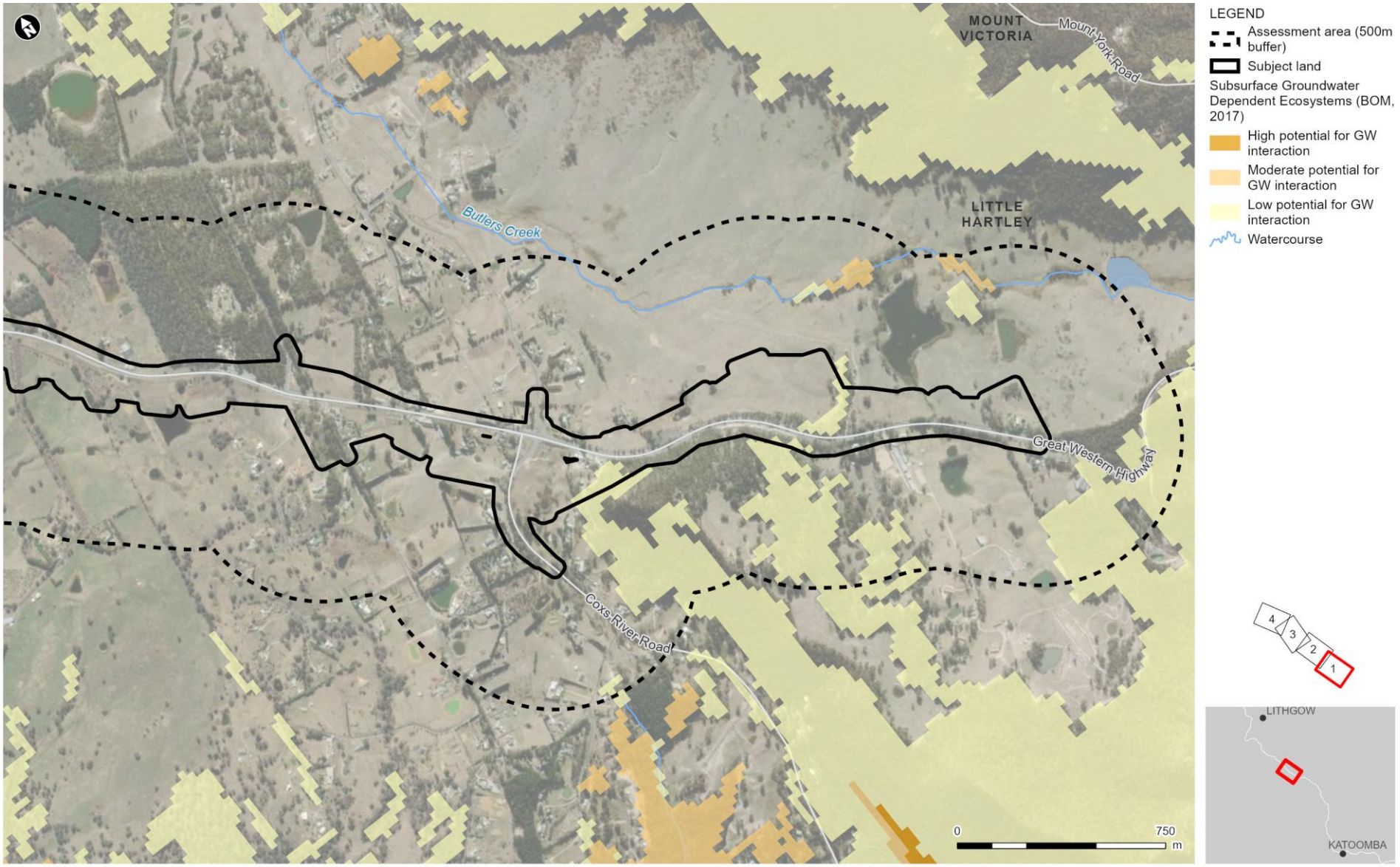


Figure 6-4 a Potential groundwater dependent ecosystems

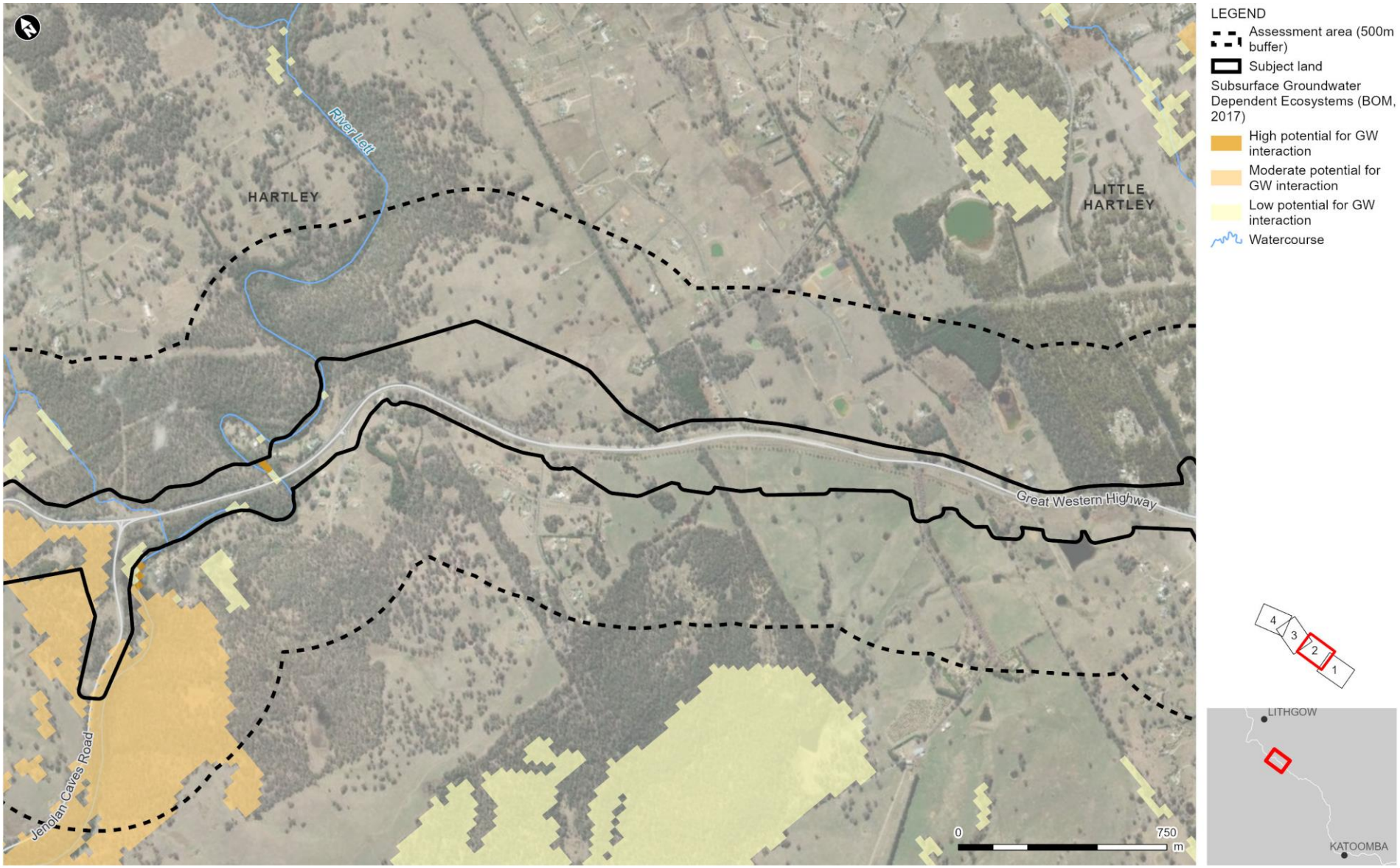


Figure 6-4 b Potential groundwater dependent ecosystems

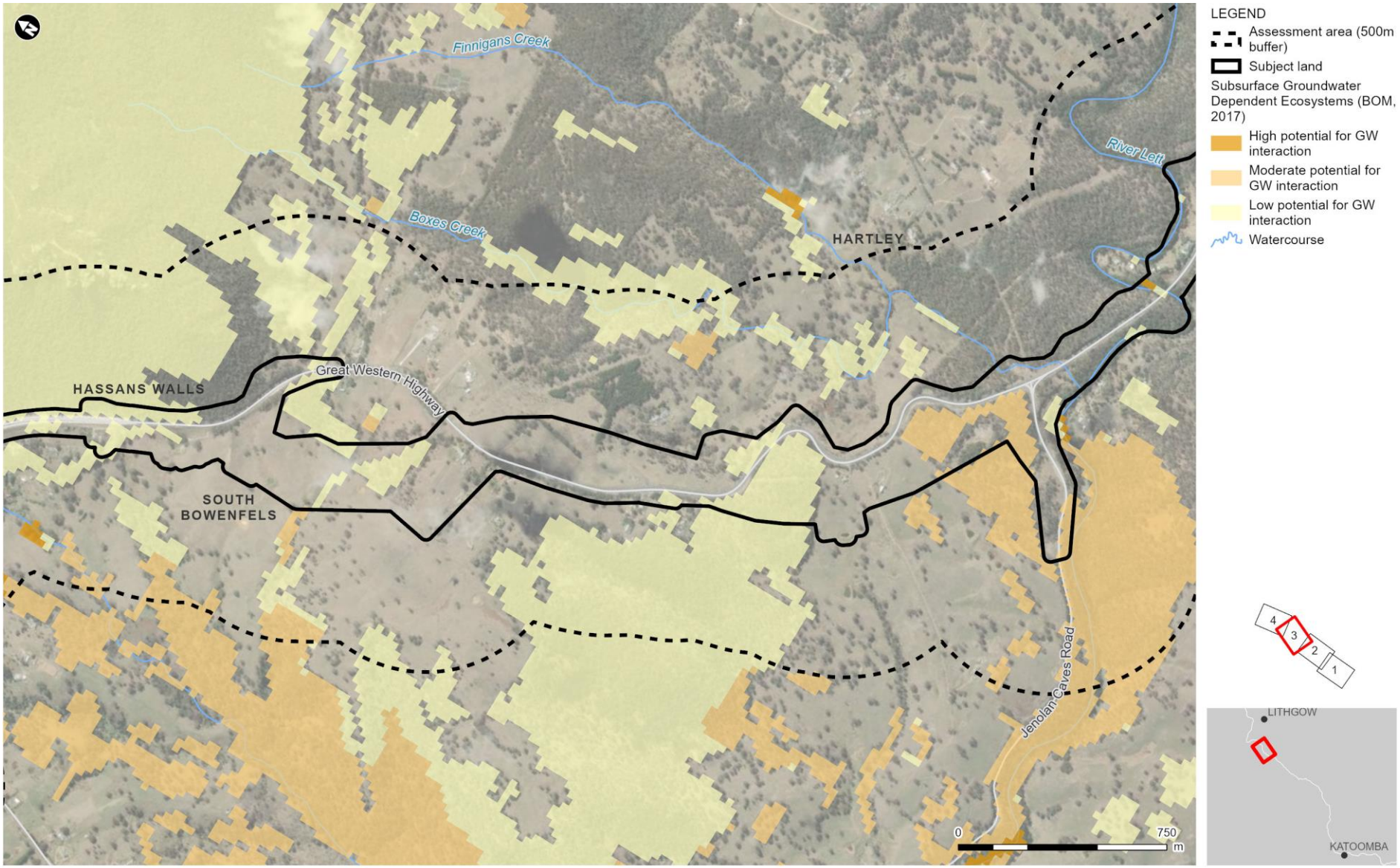


Figure 6-4 c Potential groundwater dependent ecosystems

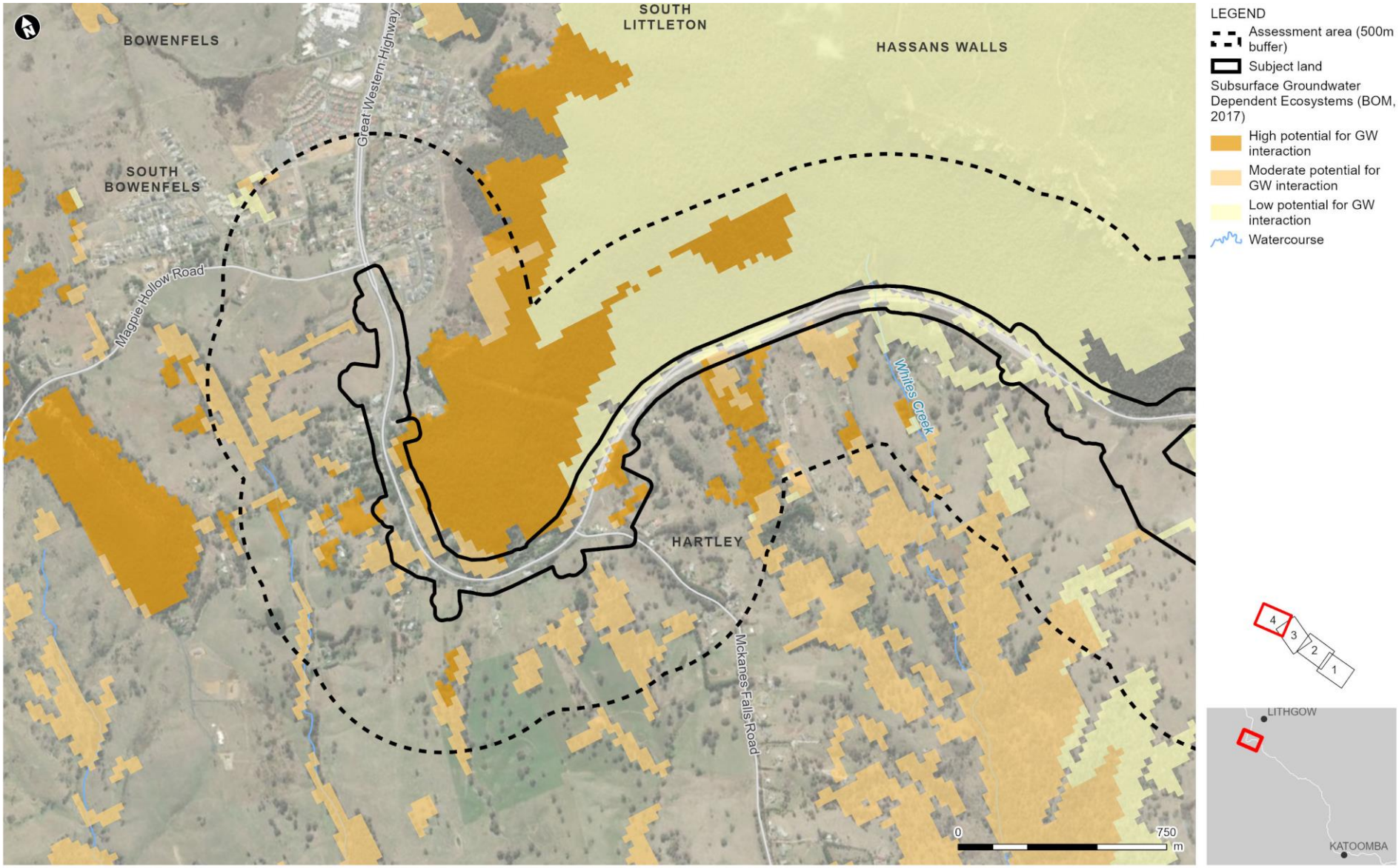


Figure 6-4 d Potential groundwater dependent ecosystems

Weeds

Surveys identified 49 exotic species within the construction footprint, of which six are listed as Priority Weeds for the Central Tablelands region under the *Biosecurity Act 2015*. Four of these six species are also included on the Commonwealth list of Weeds of National Significance. (WoNS).

Nineteen exotic species recorded within the construction footprint are considered to be high threat weeds (DPIE, 2020c). The names, classification and legal requirements for high threat weed species identified in the site investigation area are listed in Table 6-4.

Table 6-4 High threat weeds recorded in the construction footprint

Species	WoNS	Priority Weed	*Biosecurity Act 2015* status
Bidens pilosa Cobblers' Pegs	No	No	N/A
Cotoneaster sp.	No	No	N/A
Cyperus eragrostis Umbrella Sedge	No	No	N/A
Cytisus scoparius Scotch Broom	Yes	Yes	Prohibition on certain dealings: Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Protect conservation and natural environments that are free of Scotch broom
Ehrharta erecta Panic Veldtgrass	No	No	N/A
Eragrostis curvula African Lovegrass	No	No	N/A
Hedera helix English Ivy	No	No	N/A
Hypericum perforatum St Johns Wort	No	Yes	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be

Species	WoNS	Priority Weed	*Biosecurity Act 2015* status
			bought, sold, grown, carried or released into the environment. Protect grazing land that is free of St. John's wort
Ligustrum sinense Small-leaved Privet	No	Yes	Regional Recommended Measure Exclusion zone: urban areas of Bathurst Council, Blayney Council, Lithgow Council, Oberon Council, and Orange City Council Whole region: The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant is prevented from flowering and fruiting. Land managers should mitigate spread from their land. Land managers should mitigate the risk of the plant being introduced to their land. Outside exclusion zone: Land managers reduce impacts from the plant on priority assets.
Lonicera japonica Japanese Honeysuckle	No	No	N/A
Nassella trichotoma Serrated Tussock	Yes	Yes	Prohibition on certain dealings Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Protect conservation areas, natural environments and primary production lands that are free of serrated tussock
Paspalum dilatatum Paspalum	No	No	N/A
Pinus radiata Radiata Pine	No	No	N/A
Pyracantha angustifolia Orange Firethorn	No	No	N/A
Rosa rubiginosa Sweet Briar	No	No	N/A
Rubus anglocandicans	Yes	Yes	Prohibition on certain dealings

Species	WoNS	Priority Weed	*Biosecurity Act 2015* status
Blackberry			Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Protect conservation areas, natural environments and primary production lands that are free of blackberry
Rumex acetosella Sheep Sorrel	No	No	N/A
Rumex sagittatus Turkey Rhubarb	No	No	N/A
Senecio madagascariensis Fireweed	Yes	Yes	Prohibition on certain dealings Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure Exclusion zone: Whole region except for the core infestation area of Bylong Valley and Kanimbla Valley (lower Cox River Catchment) Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should mitigate spread from their land. Land managers reduce impacts from the plant on priority assets.

Fauna

Threatened fauna species

Thirty-eight threatened fauna species were identified as having potential to occur within the construction footprint and were targeted during field surveys. Eleven threatened fauna species listed under the EPBC Act and/or BC Act were recorded during surveys carried out for the proposal. These include:

- Squirrel Glider (*Petaurus norfolcensis*) (Vulnerable – BC Act)
- Greater Glider (*Petauroides volans*) (Vulnerable – EPBC Act)
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) (Vulnerable – BC Act)
- Little Bent-winged Bat (*Miniopterus australis*) (Vulnerable – BC Act)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) (Vulnerable – BC Act)
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable – BC Act, Vulnerable – EPBC Act)
- Brown Treecreeper (*Climacteris picumnus victoriae*) (Vulnerable – BC Act)

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (Vulnerable – BC Act)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (Vulnerable – BC Act)
- Scarlet Robin (*Petroica boodang*) (Vulnerable – BC Act)
- Purple Copper Butterfly (*Paralucia spinifera*) (Endangered – BC Act, Vulnerable – EPBC Act).

The location of threatened fauna species is shown in Figure 6-5. Potential impacts to threatened fauna species are detailed in Section 6.1.3.

Additional targeted surveys for Purple Copper Butterfly and Booroolong Frog, and surveys to detect breeding of Gang-gang Cockatoo, will be carried out while the REF is on public display, with findings being included in the Response to Submissions stage of the proposal.

Squirrel Glider

Squirrel Glider was recorded on remote camera at five locations within the construction footprint. All individuals were recorded on the northern side of the Great Western Highway. Individuals were recorded within larger patches (more than five hectares) of native vegetation opposite Jenolan Caves Road and at Forty Bends, inhabiting PCTs 1155, 1103 and 963.

Squirrel Glider is a species credit species known to inhabit mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range. This species forages on invertebrates, pollen, Acacia gum, eucalypt sap, nectar, honeydew and manna, and requires abundant tree hollows for refuge and nest sites (DPIE, 2017b).

Suitable foraging, sheltering and breeding habitat is present for Squirrel Glider throughout the construction footprint, particularly in patches of vegetation where it has been recorded. Eucalypts trees including *Eucalyptus viminalis* are abundant and occasional stands of Acacias (*Acacia falciformis*, *Acacia melanoxylon*) in the midstorey constitutes preferred foraging habitat. Hollow-bearing trees are common within larger patches of vegetation across the construction footprint which this species would utilise for breeding and nesting.

A species polygon has been prepared to include all PCTs associated with Squirrel Glider and the additional PCT where this species was recorded during surveys: PCT 85, 731, 963, 1103 and 1155. Patch size was not considered when reviewing suitability of habitat however patches were only included in the species polygon if hollow-bearing trees or nest boxes were present. Potential habitat (associated PCTs) unable to be investigated due to property access arrangements was conservatively included in the species polygon despite the presence of tree hollows not being verified.

Greater Glider

Two individuals of Greater Glider were recorded within the construction footprint near Forty Bends in PCT 1155 during spotlighting surveys. There are an additional 24 records for this species within 10 kilometres of the subject land, the most recent from 2019.

Greater Glider is a species credit species because it occurs across a broad range of vegetation types and can be reliably detected from survey (DPIE, 2020c). Suitable habitat for this species includes all associated PCTs which contain hollow-bearing trees. Hollow-bearing trees provided sheltering and nesting habitat and are is essential for breeding.

The construction footprint provides foraging and breeding habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of Greater Glider as they are listed as associated vegetation communities and contain hollow-bearing trees.

A species polygon has been prepared for potential habitat of Greater Glider. Potential habitat for this species is considered present in patches of native vegetation with a total patch size greater than five hectares that have a Vegetation Integrity Score (DPIE EES 2020) of 17 or higher and are listed as

associated PCTs of the species (DPIE EES 2021). Further, these patches of native vegetation must contain hollow-bearing trees or nest boxes. Potential habitat (associated PCTs) unable to be investigated due to property access arrangements was conservatively included in the species polygon despite the presence of tree hollows not being verified.

Gang-gang Cockatoo

Three flocks of Gang-gang Cockatoo were observed within the construction footprint. Two flocks of between six and 10 individuals were observed on two separate occasions at the eastern extent of the subject land in private property near The Lolly Bug. A small flock of two birds was observed flying over the site in private property nearest Carroll Drive, and the species has been observed in the area surrounding the subject land. Individuals were heard calling at each observation.

Gang-gang Cockatoo is a dual credit species. The species credit component is based on the presence of suitable breeding habitat (eg tree hollows with a diameter of 10 centimetres or larger which are at least nine metres above the ground). Gang-gang Cockatoo utilise a variety of habitats including tall mountain forests, open eucalypt forests, sub-alpine woodlands and temperate rainforests. This species favours old growth forest and woodlands for nesting and roosting, and forages on a range of eucalypt seed capsules and fruiting shrubs (i.e *Persoonia* sp.) (Recher, 2016; DPIE, 2017c).

The construction footprint contains vegetation that constitutes suitable foraging and breeding habitat for this species. A suite of eucalypts species including *Eucalyptus macrorhyncha* (Red Stringybark), *Eucalyptus sparsifolia* (Narrow-leaved Stringybark) and *Eucalyptus cypellocarpa* (Monkey Gum) are present which offer foraging habitat as well as fruit bearing shrubs like *Persoonia linearis* (Narrow-leaved Persoonia). Hollows suitable for Gang-gang breeding are relatively abundant, particularly in larger patches of native vegetation around Jenolan Caves Road and Forty Bends.

No species polygon has been prepared for Gang-gang Cockatoo as the species credit component (breeding) is yet to be identified within the construction footprint and the potential for breeding is considered to be low. Surveys are scheduled for October 2021 to determine whether the construction footprint is being used by this species for breeding. The findings from surveys will be included in the Response to Submissions report prepared for the proposal.

Little Bent-winged Bat and Large Bent-winged Bat

Little Bent-winged Bat was recorded at one location and Large Bent-winged Bat was recorded at four locations within the construction footprint during targeted Anabat surveys. There are 25 separate records for both species within a 10 kilometre radius of the construction footprint. None of the records included microhabitat code ‘IC – in cave’ or observation type code ‘E nest-roost’, indicating potential breeding habitat within the construction footprint or nearby.

Little Bent-winged Bat and Large Bent-winged Bat are dual credit species with the species credit component relating to specific breeding habitat. Potential breeding habitat includes caves, tunnels, mines or other structures known or suspected to be used by these threatened microbat species (DPIE, 2019). Little Bent-winged Bat and Large Bent-winged Bat are listed as Serious and Irreversible Impact (SAII) species. A SAII for these two species is any impact to breeding habitat as defined above.

The construction footprint contains culverts and bridge structures that could be inhabited by these species over-wintering periods and in the breeding season. Targeted searches were conducted within culverts and for bridge structures to detect the presence of either species and to make an assessment of the habitat suitability. These species share similar roosting and breeding habitat requirements and are known to share sites during breeding to provide the high temperatures needed to rear young (DPIE, 2021b). These species are known to breed in maternity caves for which they show high fidelity.

Microbats and signs of microbat presence (guano etc.) were identified at two culverts beneath the upgraded section of Great Western Highway between Forty Bends and Lithgow. Microbats observed within

culverts were unable to be positively identified during inspections, however there is potential for individuals to be Little Bent-winged Bat and/or Large bent-winged Bat. An additional four structures were considered to provide suitable habitat to these bat species and Southern Myotis however no signs of inhabitation were observed.

No caves have been identified in the construction footprint. Based on habitat within structures and the number of microbats observed during inspections, Little Bent-winged Bat and/or Large Bent-winged Bat are considered to use the construction footprint for temporary roosting and over wintering.

A species polygon has not been prepared for these species as the construction footprint does not contain breeding habitat of these species.

The ecosystem credit component applies to all PCTs associated with this species within the construction footprint which may be used for foraging and dispersal (DPIE, 2021b).

Large-eared Pied Bat

Large-eared Pied Bat was recorded at one location within the construction footprint during targeted Anabat surveys. There are nine records of the species within a 10 kilometre radius of the construction footprint, the most recent from 2019.

Large-eared Pied Bat is a species credit species because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features. Potential breeding habitat includes PCTs associated with the species within 100 metres of rocky areas containing caves, overhangs or crevices, cliffs or escarpments, old mines, tunnels, or culverts and/or derelict concrete buildings. Potential foraging and dispersal habitat includes PCTs listed within the Threatened Biodiversity Data Collection (TBDC) that are within two kilometres of caves, scarps, cliffs, rock overhangs and disused mines (DPIE, 2021b). The Large-eared Pied Bat is listed as a SAII species. A SAII for the species is any impact to breeding habitat as defined above.

A species polygon has been established to include all habitat on the subject land (aligned with PCTs listed within the TBDC) that is within two kilometres of caves, scarps, cliffs, rock overhangs and disused mines (DPIE (EES), 2021a)

Purple Copper Butterfly

Purple Copper Butterfly is a species credit species. This species has niche habitat requirements relying exclusively on *Bursaria spinosa* subsp. *lasiophylla* and the attendant ant species *Anonychomyrma itenerans* to complete its lifecycle. Purple Copper Butterfly is restricted geographically, only occurring at elevations above 850 metres above mean sea level. (DPIE, 2021b).

Habitat assessment identified *Bursaria spinosa* species at multiple locations on the subject land. *Bursaria spinosa* species in the eastern half of the subject land is not considered habitat of Purple Copper Butterfly due to being located below the geographic elevation constraint of 850 metres amsl (DPIE (EES), 2021a). In the northern half of the subject land, around Forty Bends, intact bushland contains regular occurrence of *Bursaris spinosa* species, and scattered occurrences of *Bursaria spinosa* species also exist within private agricultural land holdings at Forty Bends. Only areas with a low canopy cover and *Bursaris spinosa* species above an elevation of 850 metres is considered high quality potential habitat of Purple Copper Butterfly.

A total of eight individuals of Purple Copper Butterfly were found in one patch of *Bursaria spinosa* subsp. *lasopphylla* at the eastern extent of Forty Bends within the subject land during targeted surveys conducted in October 2021. Previous surveys conducted by Niche (2020) during options assessment stage for the proposal identified this species at the western extent of Forty Bends within the subject land and in adjoining areas of bushland below Hassans Walls. A total of 14 individuals of Purple Copper Butterfly were identified during the survey, one of these was in the subject land (Niche, 2021d).

A species polygon has been established to include all areas of occupied habitat and high quality habitat of Purple Copper Butterfly on the subject land.

Brown Treecreeper

The Brown Treecreeper was heard calling on two occasions within the construction footprint. There is one additional record of the species within 10 kilometres of the construction footprint from 2006.

The species is an ecosystem credit species. Brown Treecreeper inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. They can also be found in mallee and River Red Gum (*Eucalyptus camaldulensis*) forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Fallen timber is an important habitat component for foraging. The species nests in hollows of dead or live trees or tree stumps.

The construction footprint provides habitat for this species. PCTs 731 and 1103 are considered habitat of Brown Treecreeper as they are listed as associated vegetation communities. Hollow bearing trees are found within the construction footprint and provide potential breeding habitat within these vegetation communities. Fallen timber is found throughout the construction footprint varying in abundance providing potential foraging habitat within associated PCTs.

Eastern False Pipistrelle

Eastern False Pipistrelle were captured in targeted Anabat surveys within the construction footprint, near Jenolan Caves Road and on properties to the west. The observation is recorded as possible indicating uncertainty of identification from Anabat analysis. For the purpose of this assessment the species has been assumed present due to this record, and availability of suitable habitat within the construction footprint. There are nine additional records of the species within 10 kilometres of the construction footprint, the most recent from 2019.

Eastern False Pipistrelle are an ecosystem credit species. The species prefers moist habitats, with trees over 20 metres tall. The Eastern False Pipistrelle generally roosts in eucalypt hollows but has also been found under loose bark on trees, or in buildings.

The construction footprint provides habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of Eastern False Pipistrelle as they are listed as associated vegetation communities. Hollow bearing trees present which provides potential roosting habitat.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat was recorded in the construction footprint during targeted Anabat surveys near Jenolan Caves Road. The observation is listed as possible indicating a lower level of confidence due to quality of recording. For the purpose of this assessment the species has been assumed present due to this record and availability suitable habitat within the construction footprint. There are a further four records of the species within 10 kilometres of the construction footprint with the most recent record from 2014.

The Greater Broad-nosed Bat is an ecosystem credit species. The species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although the species predominantly roosts in tree hollows, it has also been recorded roosting in buildings.

The construction footprint provides habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of the Greater Broad-nosed Bat as they are listed as associated vegetation communities. Hollow bearing trees present which provides potential roosting habitat.

Scarlet Robin

Scarlet Robin was recorded at one location within the construction footprint during remote camera surveys on a property west of Jenolan Caves Road. There are 16 records of the species within 10 kilometres of the construction footprint, with the most recent from 2020.

The Scarlet Robin is an ecosystem credit species. The species inhabits dry eucalypt forests and woodlands usually with an open and grassy understory with few scattered. The species lives in both mature and regrowth vegetation, occasionally occurring in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are key components of the species habitat. In autumn and winter, the Scarlet Robin may occupy open grassy woodlands and grasslands or grazed paddocks with scattered trees.

The construction footprint provides habitat for this species. PCTs 85, 731, 732, 963, 1103 and 1155 are considered habitat of the Scarlet Robin as they are listed as associated vegetation communities. Fallen timber and logs are found throughout the construction footprint varying in abundance.

Non-native fauna species

Four non-native fauna species were recorded within the construction footprint:

- European Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*)
- Feral Cat (*Felis catus*)
- Common Myna (*Acridotheres tristis*).

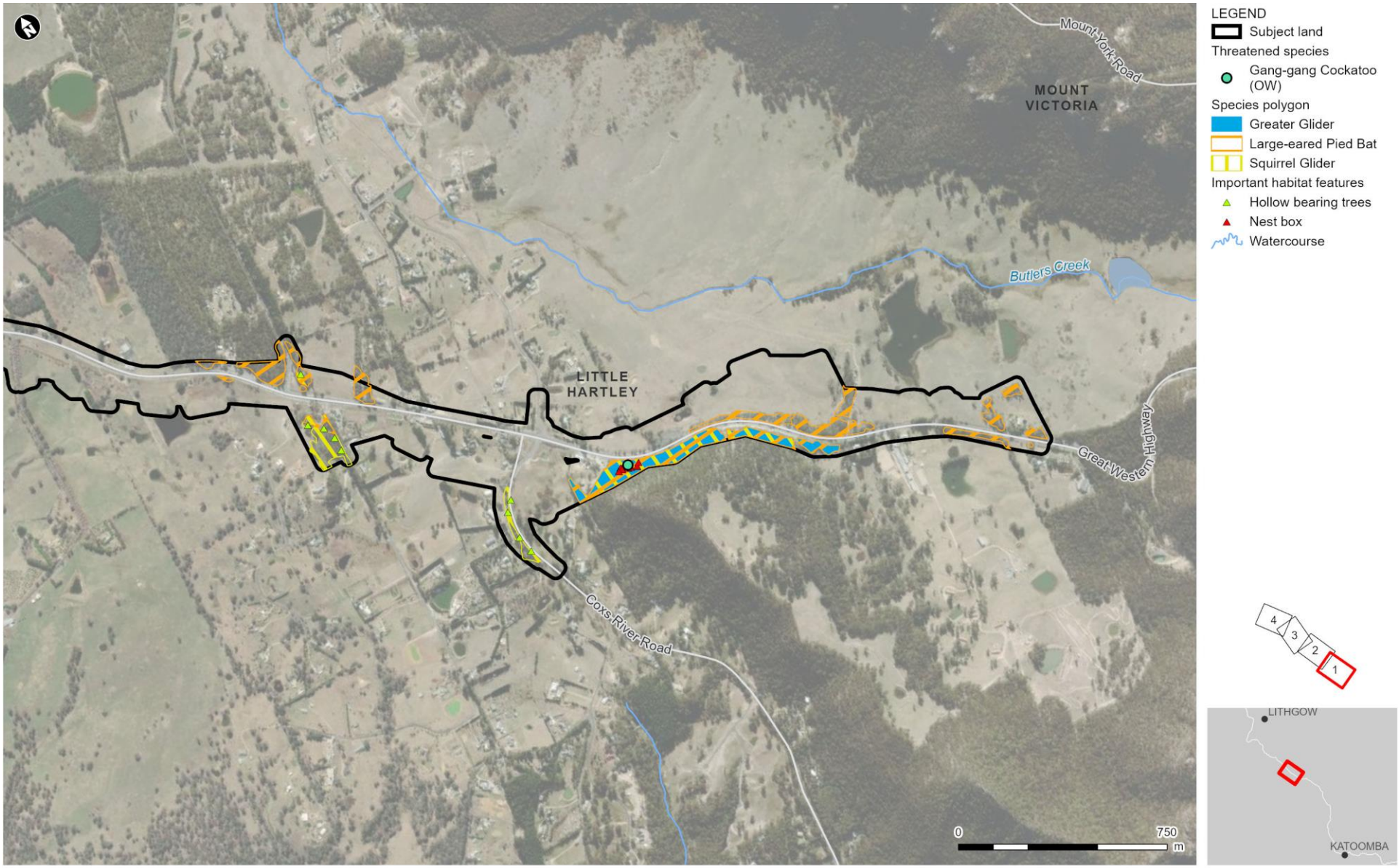


Figure 6-5 a Recorded threatened fauna species

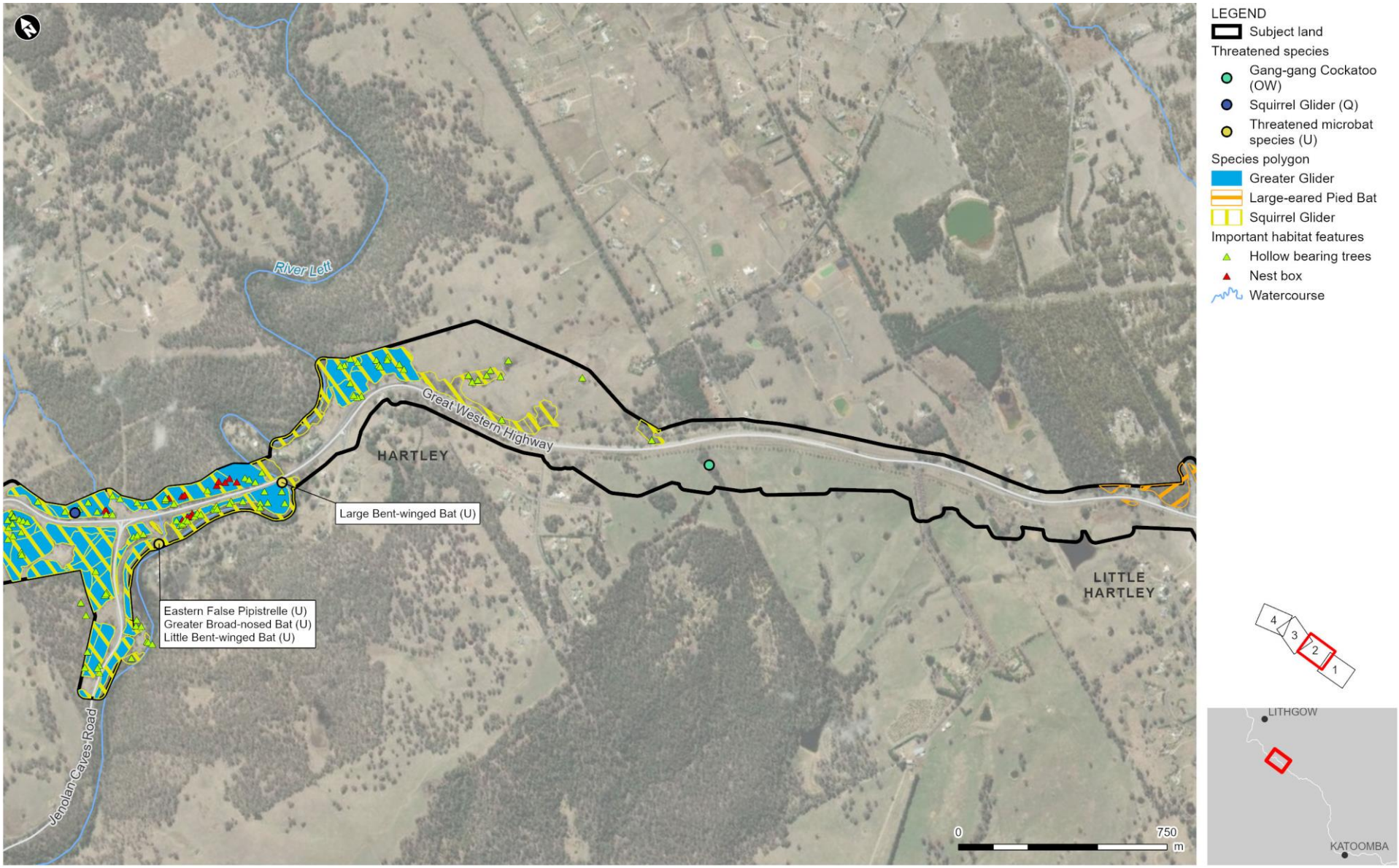


Figure 6-5 b Recorded threatened fauna species

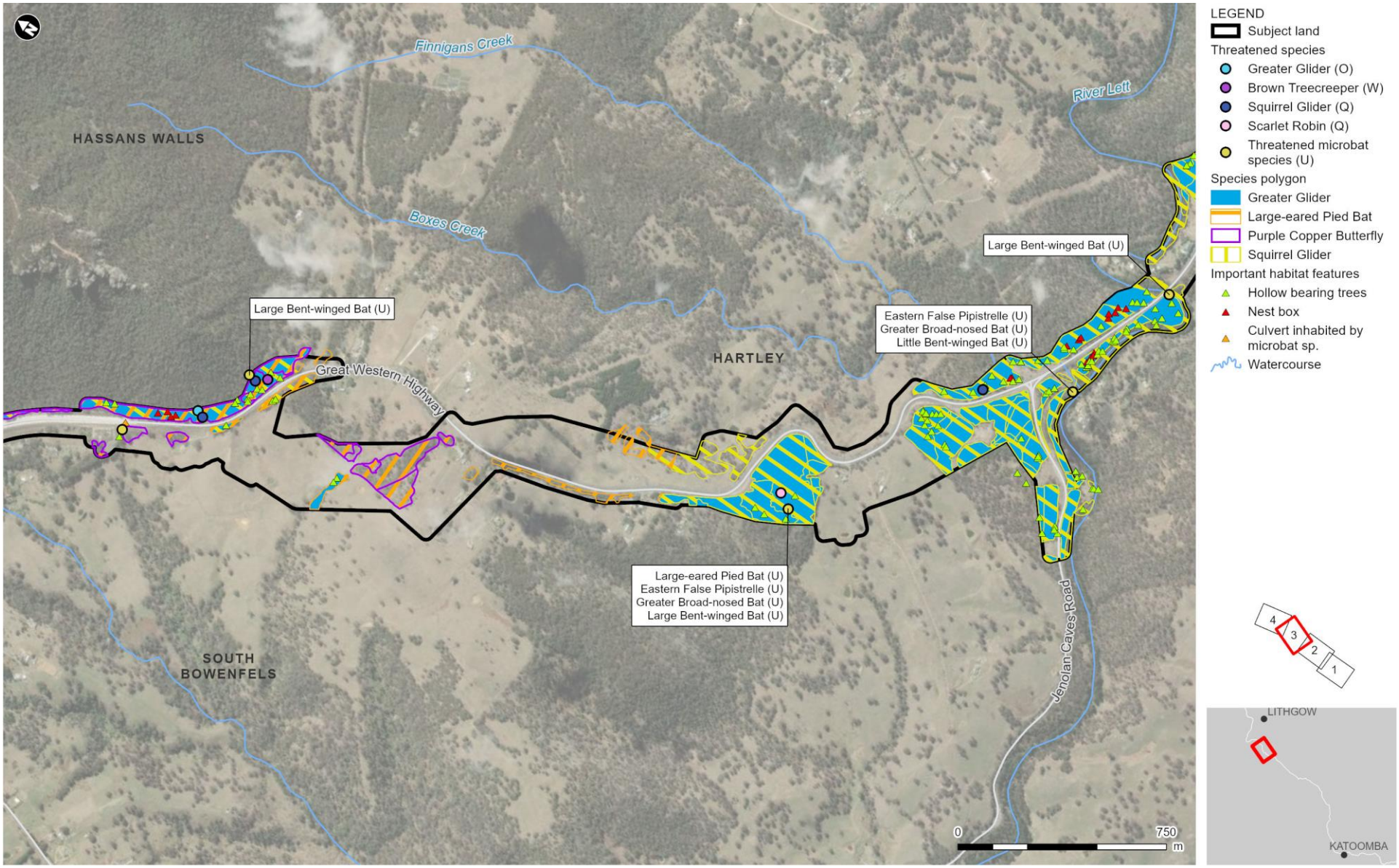


Figure 6-5 c Recorded threatened fauna species

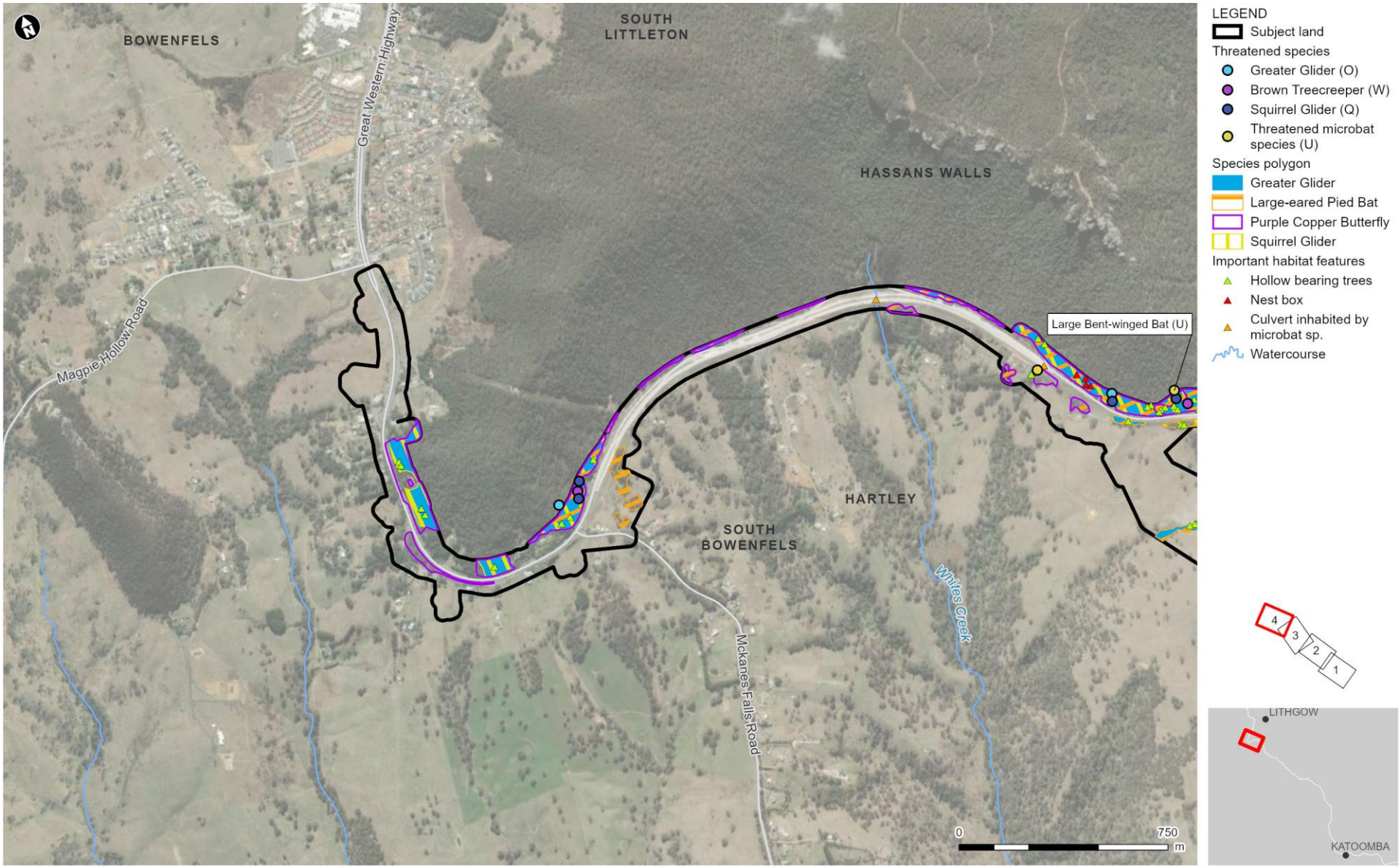


Figure 6-5 d Recorded threatened fauna species

Aquatic habitat and species

The proposal transects several named and unnamed waterways, including River Lett, Boxes Creek and associated unnamed tributaries, tributaries of Butlers Creek (Rosedale Creek) and Whites Creek and several other first and second order streams.

No mapped habitat for any threatened fish species listed under the *Fisheries Management Act 1994* (FM Act) is identified within the construction footprint. The closest mapped habitat is for the Purple Spotted Gudgeon eight kilometres west and Macquarie Perch nine kilometre east. Mapped habitat for both species are not connected to waterways that intersect the proposal. No threatened species listed under the FM Act are likely to occur in any waterways that intersect or occur directly downstream of the proposal.

Key Fish Habitat is mapped where the subject land crosses the intersection of Jenolan Caves Road along Boxes Creek and the River Lett and tributaries of Butlers Creek (Rosedale Creek) and Whites Creek (Figure 6-6). A summary of the aquatic habitat values identified during surveys at key waterways are in Table 6-5

Table 6-5 Aquatic habitat assessment

Feature	Description
River Lett	
Description	Major river flowing west/southwest, a tributary of the Coxs River. Crossing the proposal east of the Jenolan Caves Road intersection through a large concrete bridge under the Great Western Highway. Flows parallel to the Great Western Highway then heads southwest following Jenolan Caves Road beyond the subject land for about 1.5 kilometres to the headwaters of the Coxs River.
Stream order	Sixth order
Ecosystem type	Freshwater river
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI 2021) Type 1 – highly sensitive key fish habitat (DPI 2013) Class 1 – major key fish habitat (DPI 2013)
Dimensions of waterway and depth of water	Five to eight metres wide 1.5 to two metres deep
Flow characteristics and hydrological features	Fast flowing river with deep channel and large boulders and sandbanks creating riffles and pools.
Bed substrate	Sandy bed with gravel and large boulders
Habitat features	Pools and riffles, undercut grassy banks, large woody debris (snags). Channel largely free of aquatic vegetation with sedges and grasses on the creek banks.
Existing infrastructure and barriers to fish movement	A disused bridge of the Old Great Western Highway contains piles that have led to the formation of sandbanks such that several channels and pools are located off the main channel around this location. The channels reform downstream of the bridge into a single channel. Fish movement would be affected by the bridge in the smaller channels in periods of low flow.

Feature	Description
	The main bridge over the Great Western Highway crossing maintains fish passage with some minor impacts on flow characteristics from the pile on the right bank.
Riparian vegetation	15 metre wide riparian zone with open grassy woodland dominated by Casuarina cunninghamiana subsp. cunninghamiana (River Oak). Minimal shrubs are present and the groundlayer contains sedges and grasses such as Lomandra longifolia, Microlaena stipoides and large matted areas of Lonicera japonica (Japanese Honeysuckle).
Water quality	Water quality impacted by local agriculture and highway run off. High turbidity in shallows and side pools and streams adjacent to the main channel. Algae present.
Boxes Creek	
Description	Creek at bottom of descending valley north of the highway at the intersection of Jenolan Caves Road. Flowing southwest, crosses Blackmans Creek Road then under the highway through a four cell concrete box culvert to meet River Lett southeast of the Jenolan Caves Road intersection.
Stream order	Fourth order
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI 2021) Type 1 – highly sensitive key fish habitat (DPI 2013) Class 2 – moderate key fish habitat (DPI 2013)
Dimensions of waterway and depth of water	One to two metres wide 0.5 metres deep
Flow characteristics and hydrological features of aquatic habitat	Meandering ephemeral creek at with well-defined channel that opens to pooled water.
Bed substrate	Sandy substrate with fine gravel on creek bed.
Habitat features (eg pools, riffles, billabongs, reefs)	Pools, overhanging vegetation on undercut banks, large woody debris (snags). Occasional patches of emergent aquatic vegetation instream including Persicaria sp, Phragmites australis, Juncus sp..
Existing infrastructure and barriers to fish movement (natural or artificial)	Culverts under Blackmans Creek Road and Great Western Highway have modified flow but maintain fish passage.
Riparian vegetation	Narrow riparian zone with open grassy eucalypt woodland dominated by Eucalyptus viminalis. Grassy groundlayer with Rubus fruticosus sp. aggregate (Blackberry) infestation on banks shading sections of the creek.

Feature	Description
Water quality	Water quality impacted by local agriculture and highway run off. Water clear at survey location.
Rosedale Creek	
Description	Creek passing through cleared paddocks with intermittent pools. Flowing north under the highway through a two cell concrete box culvert. The waterway channel is not well defined, particularly upstream of the highway
Stream order	3
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 1 – highly sensitive key fish habitat (DPI, 2013) Class 3 – minimal key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	Six metres wide downstream of culvert 30 centimetres deep at time of survey
Flow characteristics and hydrological features of aquatic habitat	Flowing ephemeral creek with an undefined channel and intermittent pools.
Bed substrate	Silty substrate with evidence of cattle trampling.
Habitat features (eg pools, riffles, billabongs, reefs)	Juncus sp. in stream and Rubus fruticosus sp. Aggregate (Blackberry) infestation. Some intermittent pools. Snags present
Existing infrastructure and barriers to fish movement (natural or artificial)	A two cell box culvert (2.4 metre by three metres) has modified flow, altering fish passage though not blocking it.
Riparian vegetation	Grassy banks and a cleared riparian zone (pasture)
Water quality	Water quality appears poor. High turbidity and some bubbles on surface
Tributary to Whites Creek 1	
Description	Narrow creek through grassy paddock that has cattle grazing. Sits in a large valley, below the Great Western Highway. Runoff from road, surrounding agricultural land and bushland in adjacent private property.
Stream order	1
Ecosystem type	Freshwater creek

Feature	Description
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 3 – minimally sensitive key fish habitat (DPI, 2013) Class 4 – unlikely key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	Three to four metres wide 0.5 metres deep
Flow characteristics and hydrological features of aquatic habitat	Ephemeral creek at with well-defined channel that features pools and riffles.
Bed substrate	Silty substrate and granite rock bed, brown/orange clay, silt-like soils, and algae.
Habitat features (eg pools, riffles, billabongs, reefs)	Large pools, riffles, floating aquatic weeds. Undercut banks with grass growing over. Erosion on sides deep and severe in places and large snags present.
Existing infrastructure and barriers to fish movement (natural or artificial)	Nil.
Riparian vegetation	Riparian vegetation narrow, approximately 3.5 metres and large remnant Eucalyptus sp. present on the banks with grassy understorey.
Water quality	Water quality impacted by local agriculture and highway run off. Water appears poor quality, is clear but with oil slicks and brown algae
Whites Creek	
Description	Creek line passing through a large constructed culvert under the highway lined with rock then forming narrow channel in grassy paddock grazed by sheep.
Stream order	3
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 1 – highly sensitive key fish habitat (DPI, 2013) Class 2 – moderate key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	0.6 to 1 metre metres wide 0.2 metres deep
Flow characteristics and hydrological	Ephemeral creek, fast flowing at time of survey.

Feature	Description
features of aquatic habitat	
Bed substrate	Silty substrate with rocks and pebbles on bed.
Habitat features (eg pools, riffles, billabongs, reefs)	No visible aquatic vegetation, undercut banks.
Existing infrastructure and barriers to fish movement (natural or artificial)	Some fallen timber, large culvert with rock at northern entrance flowing into small sandstone pipe culvert underneath service road.
Riparian vegetation	*Eucalyptus viminalis* and exotic shrubs present on eastern side of the creek only.
Water quality	Water quality affected by road runoff. Algae visible.

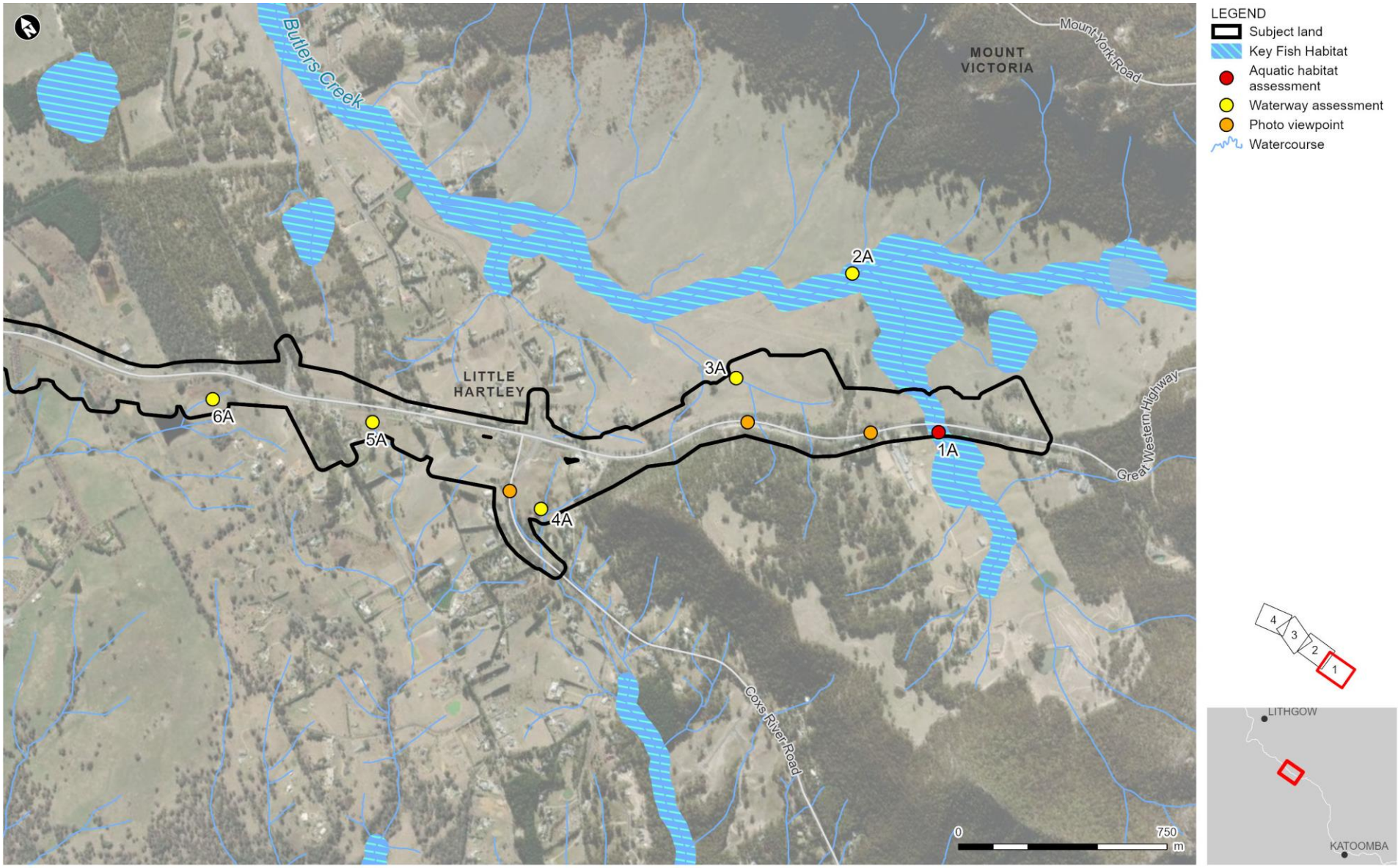


Figure 6-6 a Aquatic habitat

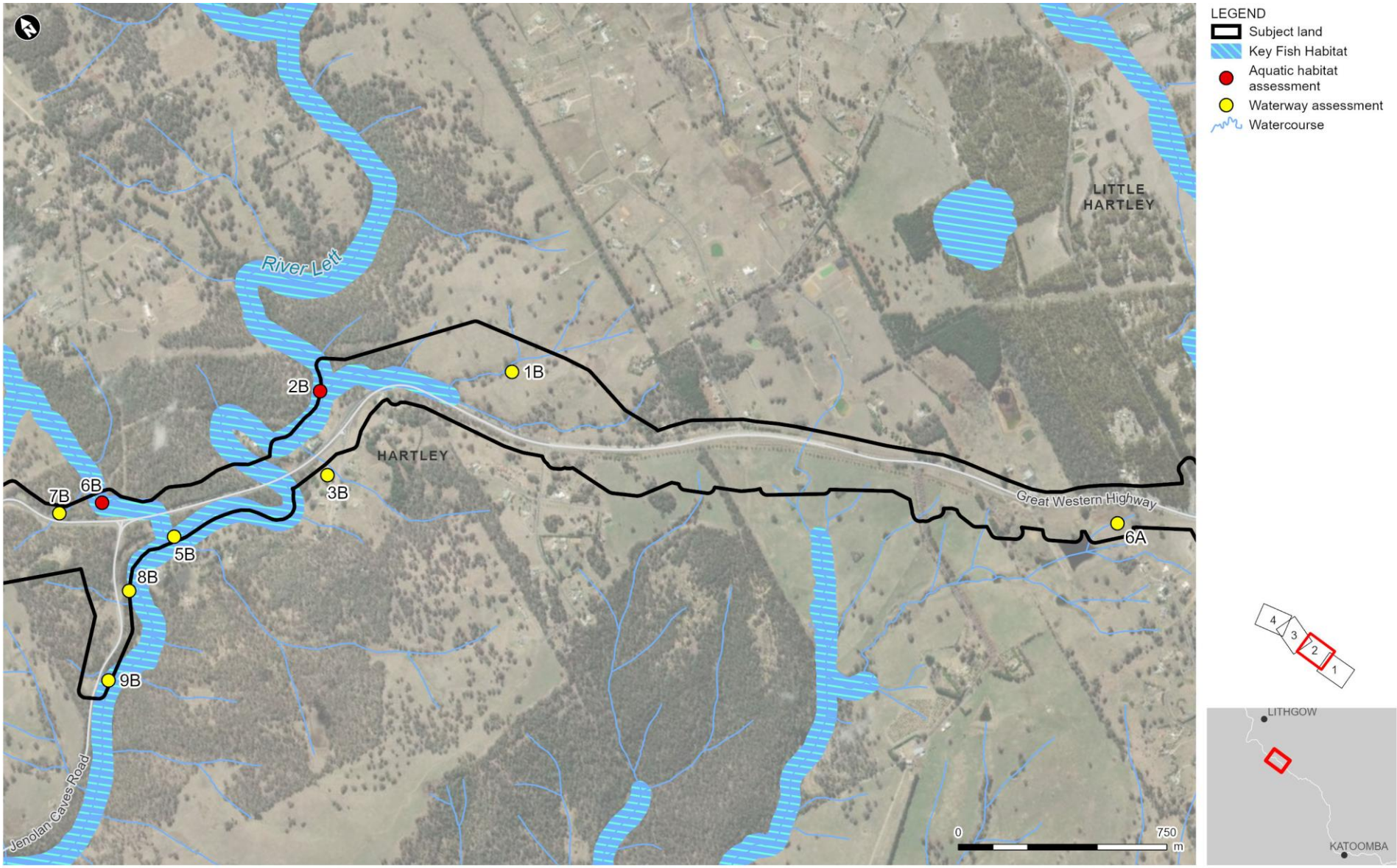


Figure 6-6 b Aquatic habitat

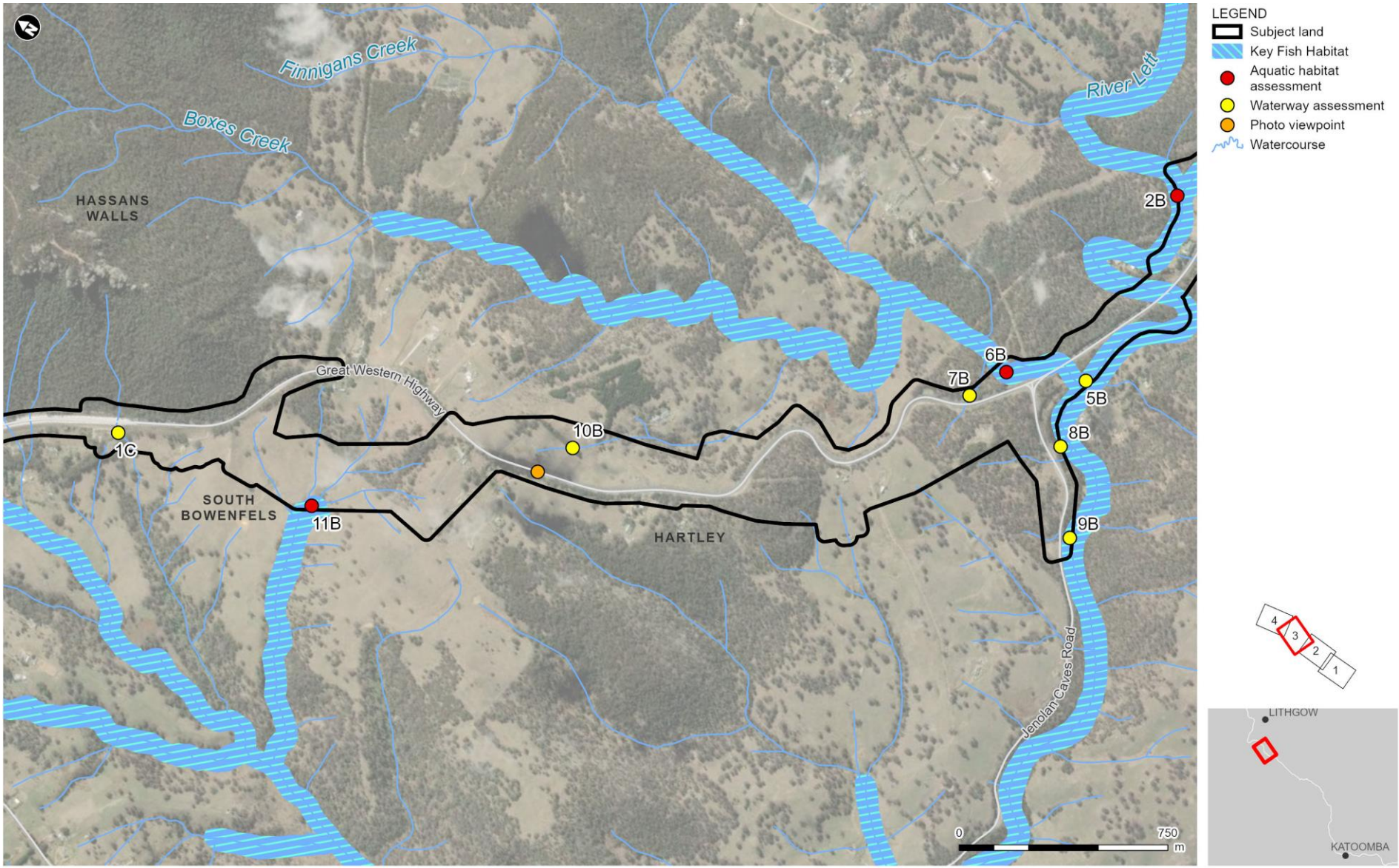


Figure 6-6 c Aquatic habitat

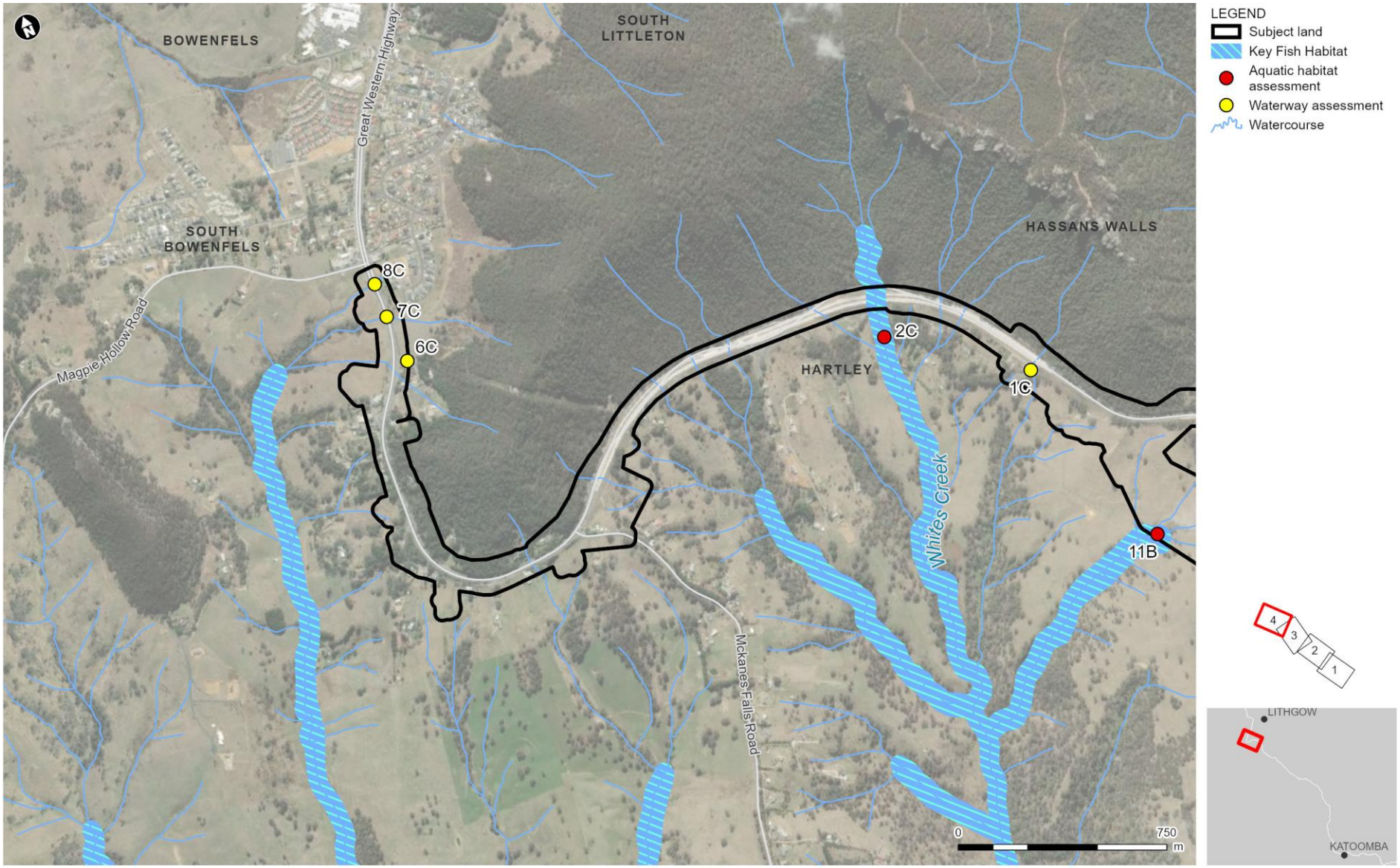


Figure 6-6 d Aquatic habitat

6.1.3 Potential impacts

Avoidance and minimisation of impacts

Section 2 considered describes the corridor options in detail that were considered and explains how and why the proposal was selected as the preferred option. Biodiversity considerations were considered through the corridor and route options assessment and the design refinement process. Direct and indirect biodiversity impacts were avoided or minimised through:

- Selection of a route option with lower native vegetation clearing required
- Selection of a route option that largely follows the existing highway alignment and therefore has the least impact to habitat connectivity
- Siting of ancillary facilities in areas of cleared land where feasible
- Provision of a number of fauna crossings to provide fauna connectivity across the highway
- Provision of fauna fencing in selected areas of wildlife connectivity to reduce the risk of vehicle strike and fauna mortality as well as guide fauna towards fauna crossing structures
- Making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat within the construction footprint.

Construction

Removal of native vegetation

Construction of the proposal would require the removal of 75.19 hectares of native vegetation that occurs in the construction footprint. Vegetation from eight PCTs would be removed, one of which (PCT 1103) falls within the definition of two TECs listed under the BC Act and one TEC listed under the EPBC Act.

A total of 142 hollow-bearing trees were identitfied on the subject land and will be removed by the Proposal, 129 of which are located within patches of native vegetation. The remaining 13 hollow-bearing trees are non-native trees which have not been mapped as native vegetation.

The area of vegetation zones to be cleared are listed in Table 6-6.

Table 6-6 Direct impacts to native vegetation

Plant community type (PCT)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)	Number of hollow bearing trees impacted
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85 (moderate)	3.95	3.95	2
	85 (disturbed)	0.35	0.35	2
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (732)	732 (moderate)	6.42	6.42	11
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the	963 (good)	2.34	1.2	10

Plant community type (PCT)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)	Number of hollow bearing trees impacted
upper Blue Mountains; Sydney Basin Bioregion (963)*				
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103 (disturbed)	1.85	1.71	0
	1103 (good)	11.62	10.72	41
	1103 (low – moderate	4.79	4.79	10
	1103 (moderate)	6.94	6.20	27
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731 (good)	12.44	12.44	4
	731 (moderate)	14.61	14.61	4
	731 (variant – good)	3.08	3.08	5
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (1155)	1155 (moderate	10.52	9.72	13
Total		**78.91**	**75.19**	**129**

Removal of threatened ecological communities

The 75.19 hectares of native vegetation to be cleared for the proposal includes 23.41 hectares of vegetation that meets the criteria for a threatened ecological community under the BC Act. These areas are listed in Table 8 2.

Table 6-7 Direct impacts to threatened ecological communities

Threatened ecological community (TEC)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion (Endangered)	1103 (good)	6.62	6.62
	1103 (moderate)	5.68	5.68
	1103 (low – moderate)	3.97	3.97
	1103 (disturbed)	1.32	1.32
	Total	**17.59**	**17.59**

Threatened ecological community (TEC)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (Critically Endangered)	1103 (good)	5.00	4.10
	1103 (moderate)	1.26	0.52
	1103 (low – moderate)	0.82	0.82
	1103 (disturbed)	0.52	0.38
	Total	**7.60**	**5.82**

Removal of threatened flora

As discussed in Section 6.1.2, threatened flora surveys would be carried out in Spring 2021 to meet the recommended survey periods for the targeted flora species. The findings from these targeted surveys, including any required removal, will be included in the Response to Submissions report prepared for the proposal.

Removal of threatened fauna habitat

A total of 290.51 hectares of vegetation would be removed for the proposal of which 75.19 hectares is native.

A total of 142 hollow-bearing trees were identitfied on the subject land and will be removed by the Proposal, 129 of which are located within patches of native vegetation. The remaining 13 hollow-bearing trees are non-native trees which have not been mapped as native vegetation.

The proposal has will impact 4.3 hecatares of specialist habitat (*Bursaria spinosa* subsp. *lasiophylla*) of the Purple Copper Butterfly. Of this, 0.33 hectares is known breeding and foraging habitat of this species. The quality and occupancy of the remaining 3.97 hectares of habitat is unknown due to the area not being surveyed. Following removal of habitat within the subject land it is considered unlikely that the proposal will have indirect impacts on retained habitat adjacent to Great Western Highway. Retained habitat will remain upslope of road and is unlikely to be significantly impacted by edge effects.

Species credit species

Of the 11 threatened fauna species recorded during surveys, four are identified as species credit species. Potential impacts on species credit species are summarised in Table 6-8. Additional targeted surveys are required for Booroolong Frog, and to detect breeding of Gang-gang Cockatoo, which if identified would require additional offsetting as a species credit. The findings from these targeted surveys will be included in the Response to Submissions report prepared for the proposal.

Table 6-8 Impacts on species credit threatened fauna

Threatened fauna species	Status		Associated PCT	Area within subject land (ha)	Potential area of habitat to be impacted (ha)	Likely significant impact?
	BC Act	EPBC Act				
Squirrel Glider	Vulnerable	-	731, 963, 1155	54.14	50.87	No
Greater Glider	-	Vulnerable	731, 732, 963, 1103, 1155	43.52	40.24	No
Large-eared Pied Bat	Vulnerable	-	731, 732, 963, 1155	25.86	24.22	No
Purple Copper Butterfly	Endangered	Vulnerable	732, 963,1155	5.94	4.3	No

Ecosystem credit species

The removal of native vegetation and anticipated removal of 142 hollow bearing trees would also remove potential foraging and/or roosting habitat for multiple ecosystem credit species, including:

- Gang-gang Cockatoo
- Glossy Black-Cockatoo
- Large-eared Pied Bat
- Little Bent-winged Bat
- Large Bent-winged Bat
- Koala
- Grey-headed Flying-fox
- Diurnal Raptors (Square-tailed Kite, White-bellied Sea-Eagle, Little Eagle)
- Large forest owls (Masked Owl, Powerful Owl, Barking Owl, Sooty Owl)
- Brown Treecreeper
- Scarlet Robin
- Eastern False Pipistrelle
- Greater Broad-nosed Bat.

Aquatic habitat impacts

The proposal would not result in any impacts to threatened species or communities listed under the FM Act. However, the proposal would impact waterways with fish habitat, including mapped Key Fish Habitat at several locations including River Lett, Boxes Creek and associated unnamed tributaries, Rosedale Creek and Whites Creek. A total of 16.26 hectares of mapped Key Fish Habitat lies within the subject land. Key Fish habitat mapping is conservative and estimates a considerably wider area of waterway than actual. As such, impacts to actual habitat would be considerably less.

During construction there is a potential for waterways to be temporarily blocked or diverted. Blocking or diversion of drainage lines will block fish passage, though is unlikely to affect any threatened species and would be temporary in nature.

Water quality impacts associated with the construction phase include increased turbidity from sedimentation which can reduce visual amenity and increased nutrients which can lead to algal blooms and affect the quality of fish habitat. Water quality impacts would be managed through an erosion and sediment control strategy.

Fauna injury and mortality

The primary cause of increased fauna injury and mortality during the construction stage of the proposal would be as a result of vegetation clearing activities (particularly during the felling of hollow-bearing trees or trees containing undetected arboreal mammals (eg gliders, reptiles or active nests) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works.

The removal of fauna habitat has inherent risks that can, in part, be mitigated through implementing appropriate clearing procedures. The majority of native and threatened fauna species that have habitat within the site investigation area are highly mobile and typically vacate the vegetation in which they reside at the commencement of vegetation clearing. Other, typically ground dwelling, species are less mobile and at higher risk of construction phase mortality. Measures to reduce accidental injury or mortality to fauna are proposed in Section 6.1.4.

Invasion and spread of weeds

Six exotic species recorded within the construction footprint are listed as Priority Weeds in the Central Tablelands region, which includes the Lithgow City LGA:

- Scotch Broom (*Cytisus scoparius*)
- St Johns Wort (*Hypericum perforatum*)
- Small-leaved Privet (*Ligustrum sinense*)
- Serrated Tussock (*Nassella trichotoma*)
- Blackberry (*Rubus anglocandicans*)
- Fireweed (*Senecio madagascariensis*).

Invasive exotic grasses such as *Eragrostis curvula,* also represent a threat to native vegetation.

An increase in the movement of people, vehicles, machinery, vegetation waste and soil during and following construction of the proposal may facilitate the introduction or spread of exotic weeds that currently occur within the construction footprint.

Disturbed areas, such as those in which earthworks are to be carried out, would be particularly susceptible to weed establishment. Management measures would be required to minimise the risk of introduction and spread of weeds.

Invasion and spread of pests

Activities such as vegetation clearing, habitat removal, increased noise and human presence as a result of the proposal have the potential to disperse pest species across the surrounding landscape and increase the ability of such species to utilise habitats during construction and operational phases. Vegetation clearing, and consequent fragmentation can result in the establishment of predator pest species such as the European Red Fox, which pose a high risk to birds and small terrestrial fauna. The proposal is not considered to increase pest animal populations more than what already exists.

Invasion and spread of pathogens

The proposal has the potential to increase the spread of pathogens that threaten native biodiversity values, such as the soil-borne pathogen Phytophthora (*Phytophthora cinnamomi*). Phytophthora infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of Phytophthora may also be dispersed by vehicles (eg cars and earth moving equipment), animals, walkers and movement of soil. It is listed as a Key Threatening Process (defined as a process which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community) under BC Act. There may be an increased risk of dispersal of Phytophthora as a result of the construction activities that involve soil disturbance.

Noise, light, and vibration

While the construction phase of the proposal may cause temporary disturbance, the impact of noise and vibration on fauna would likely be localised to the construction footprint and would be unlikely to have a significant, long-term impact on fauna.

Additionally, while the proposal is likely to increase the amount of artificial lighting within the site investigation area and surrounds during the construction, roads within the locality already currently experience light exposure. These impacts are not considered to have a significant, long-term impact on fauna, including threatened fauna, as fauna within construction footprint would already be adapted to light pollution, and the increased artificial lighting associated with the proposal is unlikely to have a substantial effect.

Most locally occurring fauna would likely relocate from areas adjacent to the highway which are indirectly impacted by noise and light spill to more suitable areas of habitat further afield for the duration of construction.

Unidentified species of microbats and signs of microbat presence (guano etc.) were identified at two culverts beneath the upgraded section of Great Western Highway between Forty Bends and Lithgow. Indirect impacts to microbats inhabiting the culverts could occur during construction from noise and vibration and increased disturbance from human activity.

Assuming microbats are roosting at the time of the works, microbats would either seek alternative roosting habitat or tolerate the noise and continue to roost. Given the short duration of works, and small numbers of microbats observed roosting in the culvert (three individuals) it is unlikely that the disturbance would impact the local and bioregional persistence of the species present. Given the uncertainty around the response of microbats to the works, culvert 3 would be monitored and environmental management measures to minimise impacts on the species would be developed in response to any observable impacts using an adaptive management strategy.

Groundwater dependent ecosystems

A total of 42.85 hectares mapped by the Bureau of Meteorology (2020) as potential GDEs would be removed for the proposal.

The groundwater assessment technical working paper (JAJV, 2021) concluded that predicted changes to groundwater levels are small and localised to the vicinity of the proposal. As such, no impacts to GDEs as a result of predicted groundwater drawdown are anticipated. Furthermore, the assessment found that in most areas, the existing water table is likely within rock and at a sufficient depth such that it is not significantly used by the potential GDEs in the vicinity of the proposal.

Potential groundwater contamination is considered to be unlikely to occur as a result of the proposal, as the proposal is not likely to intersect the water table.

Operation

Wildlife connectivity and habitat fragmentation

There are no mapped wildlife corridors in the subject land, however the Blue Mountains Western Escarpment wildlife corridor between Mount Victoria and Little Hartley is located east of the proposal. More broadly, the proposal is located to the south and west of expansive vegetation of the Greater Blue Mountains area. The Blue Mountains National Park lies to the east and Newnes Plateau to the north. Narrow remnants of native vegetation cross the proposal in a north-south orientation linking vegetation in these expanses to more fragmented vegetation on rural land and riparian corridors. These corridors are important for habitat connectivity to native vegetation remnants to the immediate south and conservation areas further on such as Kanangra-Boyd National Park, particularly around the Jenolan Caves Road intersection which also connects to riparian vegetation of the Coxs River.

The proposal includes the provision of a fauna exclusion fence on both sides of the highway. This fauna exclusion fence would prevent fauna from accessing the road and being subjected to vehicle strike (discussed further below).

The fauna exclusion fence would also guide animals to move along the fence toward a number of fauna underpasses that would be provided beneath the highway. These underpasses (ie concrete box culverts) would facilitate the safe crossing of fauna beneath the road. Underpasses would be designed to convey surface water flows as well as facilitate fauna crossings. These would include a raised bench on one side of the base of the culvert, to allow for the dry passage of animals during periods of high flow. All are single cell concrete box culverts 3.3 metres by 3.3 metres to allow for crossing of large mammals such as Common Wallaroos (*Osphranter robustus*) and Eastern Grey Kangaroos (*Macropus giganteus*). Additionally, two existing large box culverts would be maintained and extended at Boxes Creek and Rosedale Creek, which would include fauna friendly design elements to encourage fauna crossing.

Design of underpasses would be in accordance with *Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects (draft)* (Roads and Maritime, 2011) and best available knowledge from other Transport projects.

Maintenance of any fencing and underpasses is critical to the efficacy of these measures and would be detailed in an Operational Environmental Management Plan or existing Environmental Management System that incorporates the proposal.

Edge effects on adjacent native vegetation and habitat

The proposal would result in indirect impacts on some areas of native vegetation adjoining the construction footprint, mainly due to the creation of new edges in native vegetation adjacent to the widened and/or realigned Great Western Highway, which may result in edge effects.

Edge effects occur when environmental conditions are altered (ie light levels, wind speed and temperature) and consequently can promote the growth of different vegetation types (including weeds), invasion by feral fauna, or change the behaviour of resident fauna. Most of the subject land adjoins cleared land or small, fragmented patches of vegetation within cleared pasture. This vegetation is often already situated adjacent to an existing cleared edge, such as a road, and is subject to ongoing disturbance and edge effects.

Larger areas of native vegetation which occur along the margins of the Great Western Highway are currently subject to edge effects, including weed incursion at the road margin. The realignment and upgrade of Great Western Highway would result in additional edge effects in some areas through the creation of new edges in previously undisturbed vegetation. Indirect impacts to this vegetation could include the introduction and spread of weeds, soil disturbance and trampling, though impacts are likely to be minor and contained to the edge of subject land.

The analysis of potential for edge effects found a total of 8.5 hectares of native vegetation would be subject to increased edge effects as a result of the proposal due to the creation of one or more new edges within previously unfragmented vegetation. These new edges could be subject to degradation by the establishment and spread of weeds, enriched runoff from road pavement and dumping of rubbish. However, the proposal would include the provision of drainage infrastructure that would appropriately manage surface water flows.

Aquatic impacts

Instream impacts would occur at culvert extensions at Boxes Creek and Rosedale Creek about 55 metres and 51 metres, respectively. Culvert extensions would result in the permanent removal of aquatic vegetation, rock and snags over a small area. Culvert extensions would result in alterations to the flows of these two creeks. They are both highly modified from the existing highway and surrounding roads/land use practices and flow alteration impacts are expected to be minor.

Additionally, twin bridges over the River Lett would be installed which would change hydrology of the river and increase shading. Shading impacts would be over a relatively small area and hydrological changes are expected to be minor. There would be no permanent structures instream (under normal flow conditions).

Riparian vegetation would be permanently removed at each waterway. Impacts would be limited to small areas around each crossing structure and disturbed areas would be revegetated upon completion of construction.

Fauna injury and mortality

The primary cause of increased fauna injury and mortality during the operational stage of the proposal is anticipated to be vehicle collisions. Existing cases of fauna injury and mortality are dispersed across the proposal alignment and not concentrated in any particular area.

Fauna connectivity measures, including combined fauna culverts and fauna fencing would be constructed across the proposal alignment which would direct species across the road corridor and prevent vehicle strike to susceptible fauna species. The main vehicle strike risk area at Jenolan Caves Road comprises a bridge that would allow for safe crossing. As such, it is considered unlikely that any species would be impacted by vehicle strike such that the persistence of the species is impacted at a local or bioregional scale.

The design specifications of the culverts and fauna exclusion fencing would be developed during further design development.

Conclusion on significance of impacts

The proposal is likely to have a significant impact on the critically endangered ecological community White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as critically endangered under the BC Act, therefore a BDAR has been prepared (Appendix D).

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the FM Act.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

6.1.4 Safeguards and management measures

Table 6-9 Safeguards and management measures – biodiversity

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
BI01	Biodiversity	A Flora and Fauna Management Plan will be prepared in accordance with Transport's *Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects* (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • requirements set out in the *Landscape Guideline* (RMS, 2008) • pre-clearing survey requirements • procedures for unexpected threatened species finds and fauna handling • procedures addressing relevant matters specified in the *Policy and guidelines for fish habitat conservation and management* (DPI Fisheries, 2013) • Protocols to manage weeds and pathogens.	Transport/ Contractor	Detailed design Prior to construction	Section 4.8 of QA G36 Environment Protection
BI02	Removal of native	Native vegetation and habitat removal will be	Contractor	Detailed design	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
	vegetation, threatened species habitat, habitat features and threatened plants	minimised through detailed design.			
BI03		Further consideration for the placement of ancillary facilities (including drainage and sediment basins) currently positioned in native vegetation and high value areas will be considered during the detailed design stage.	Transport/ Contractor	Detailed design	Appendix D
BI04		Pre-clearing surveys will be undertaken in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI05		Vegetation and habitat removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI06		Native vegetation will be re-established in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI07		The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		biodiversity on RTA projects (RTA, 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site.			
BI08		Habitat removal will be minimised through detailed design.	Contractor	Construction	Appendix D
BI09		Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI10		Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). Modified limbs salvaged from removed vegetation in the subject land would be preferenced over nest boxes for artificial hollow construction.	Contractor	Construction	Appendix D
BI11		Vegetation removal will be minimised around mapped Purple Copper Butterfly habitat.	Contractor	Construction	Appendix D
BI12		A Purple Copper Butterfly management plan will be developed within the Flora and Fauna Management Sub-plan which will include measures to minimise	Transport/ Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		impacts to the species including consideration of construction activity timing/scheduling to minimise mortality in areas of mapped habitat and a monitoring strategy to detect efficacy of management measures.			
BI13	Aquatic impacts	Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) and 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	Contractor	Construction	Appendix D
BI14		Creek works and bridges would be designed in accordance with the Policy and Guidelines for Fish Friendly Waterway Crossings (DPI, 2003)	Contractor	Detailed design	Appendix D
BI15		Instream works would be undertaken during periods of low flow where possible. Where not possible, any creek diversions would require a permit from DPI (Fisheries).	Contractor	Construction	Appendix D
BI16		A Construction Soil and Water Management Plan (CSWMP) would be developed as a subplan to the CEMP and will outline measures to	Transport/ Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		manage water quality impacts associated with construction work.			
BI17		A surface water quality monitoring program will be developed in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA, 2003) as part of the Soil and Water management Sub-plan of the CEMP. The program will monitor surface water prior to construction, during construction and during operation.	Transport/ Contractor	Construction Operation	Appendix D
BI18	Groundwater dependent ecosystems	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI19	Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI20	Fragmentation of identified habitat corridors	Connectivity measures will be implemented in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RTA, 2011). This will include retrofitting culverts with fauna friendly design features suitable for target species.	Contractor	Construction	Appendix D
BI21		Any connectivity measures implemented will be installed under the supervision of an experienced ecologist	Transport	Operation	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		and maintained during proposal operation.			
BI22		Revegetation of unused pavement beneath the bridge at Jenolan Caves Road would be investigated as a potential option to increase fauna connectivity in this area. This would need to consider risk of road strike and feasibility of fauna fencing at this intersection.	Contractor	Detailed design	Appendix D
BI23		Riparian zone under the twin bridges at River Lett would be revegetated, where feasible, to ensure habitat connectivity is retained.	Contractor	Detailed design	Appendix D
BI24	Indirect impacts on native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI25	Invasion and spread of weeds	Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI26	Invasion and spread of pests	Pest species will be managed within the construction footprint.	Contractor	Construction	Appendix D
BI27	Invasion and spread of	Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
	pathogens and disease	Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).			
BI28	Noise, light and vibration	Works in proximity to cuvert 2 and 3 would be undertaken at night to minimise impacts to roosting microbats	Contractor	Construction	Appendix D
BI29		Permanent shading and artificial light impacts will be minimised through detailed design.	Contractor	Detailed design Construction	Appendix D
BI30		Construction lighting impacts would be minimised as follows: • Lighting would only be used as necessary to conduct construction activities at night. Lights would be turned off when not needed • Adaptive light controls to manage light timing, intensity and colour would be installed • Only the object or area intended would be lit where feasible • Lights would be kept close to the ground, directed and shielded to avoid light spill • The lowest intensity lighting appropriate for the task would be used • Use non-reflective, dark-coloured surfaces where possible	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Use lights with reduced or filtered blue, violet and ultra-violet wavelengths where possible.			
BI31	Impacts to habitat in human made structures	A Microbat Management Plan would be prepared as a part of the Fauna and Flora Management Sub-Plan to manage impacts to microbats. It would include pre-clearance checks of culverts, monitoring of microbats during noisy works and stop works procedures.	Contractor	Construction	Appendix D
BI32		Permanent roost habitat for cave-dwelling microbats should be considered for inclusion in the design of new bridges and culvert structures. This may include pre-casting roosting chambers on the underside of bridges or in the roof of culverts, and/or retrofitting/modifying standard structures to make them more suitable for microbats ie leaving grab holes and section joins unsealed, scabbling of concrete surfaces to make structures more suitable, particularly in recesses and potential roosting sites.	Transport/ Contractor	Detailed design Construction	Appendix D
BI33		Access to Culvert 2 and 3 would be restricted during construction to minimise impacts to roosting microbats. If access to either culvert is required, consultation with an	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		ecologist would be undertaken and/or an ecologist would supervise activities/access.			
BI34	Vehicle strike	Fauna fencing would be installed at targeted locations along the highway to minimise vehicle strike where reasonable and feasible. Fauna fencing would be designed to minimise impacts to threatened fauna species and species subject to vehicle strike. Locations selected would consider connectivity requirements of fauna and proposed structures. A monitoring strategy would be developed to detect efficacy of fauna fencing and maintenance requirements would be detailed as part of the Flora and Fauna Management Sub-plan of the CEMP.	Transport/ Contractor	Detailed design Construction Operation	Appendix D

6.1.5 Biodiversity offsets

Ecosystem and species credits

Subject to vegetation clearing minimisation efforts, preparation of a biodiversity offset strategy (BOS) would be required in accordance with the *Guideline for Biodiversity Offsets* (Roads and Maritime Services, 2016) for potential impacts to the BC Act and EPBC Act listed TEC and threatened species habitat. Offsets may be delivered through a range of mechanisms, including securing offset properties under an appropriate legal instrument, purchasing and retiring biodiversity credits, paying into the Biodiversity Conservation Fund or progressing stewardship Site Agreements on suitable properties in accordance with the *Guideline for Biodiversity Offsets* (Roads and Maritime, 2016).

To determine the likely biodiversity credit requirements for the impacts of the proposal, the data collected in the proposal construction footprint was entered into the BAM Calculator. The biodiversity credit values of the native vegetation and threatened species habitat within the proposal construction footprint are presented in Table 6-10 and Table 6-11.

For indirect impacts resulting in new edges, offsets were calculated outside the BAM calculator based on a percentage of the biodiversity credit value of the affected patches, and assuming the vegetation integrity values present in the same zones within the construction footprint. Ecosystem credits for potential indirect impacts of the proposal are presented in Table 6-12.

Table 6-10 Ecosystem credit values for impacts in vegetation zones identified within the construction footprint

Plant community type (PCT)	Vegetation zone code	Area to be impacted (hectares)	Ecosystem credits required
Bathurst Subregion / South Eastern Highlands Bioregion			
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85_Moderate	3.95	112
	85_Disturbed	0.35	6
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (732)	732_Moderate*	6.42	180
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (963)	963_Good*	1.20	37
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103_Disturbed	1.71	0
	1103_Good	10.72	543
	1103_Low-Moderate	4.79	128
	1103_Moderate	6.20	259
Burragorang subregion / Sydney Basin Bioregion			
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731_Good	12.44	516
	731_variant_Good	3.08	129
	731_Moderate	14.61	388
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (1155)	1155_Moderate	9.72	230
Total (Bathurst Subregion / South Eastern Highlands Bioregion)		35.34	1,265
Total (Burragorang subregion / Sydney Basin Bioregion)		39.85	1,263
Total (all bioregions)		75.19	2,528

*Although all areas of this PCT in the subject land are within the Sydney Basin Bioregion, the BAM calculator does not allow selection of this PCT within the bioregion; therefore the PCT has been included in the calculator for the South East Highlands bioregion.

Table 6-11 Species credit values for the species identified in the construction footprint

Species	Loss of habitat (ha)		Total loss of habitat (hectares)	Total species credits required
	Bathurst Subregion / South Eastern Highlands Bioregion	Burragorang subregion / Sydney Basin Bioregion		
Chalinolobus dwyeri Large-eared Pied Bat	5.60	18.62	24.22	1,215
Paralucia spinifera Purple Copper Butterfly	3.97	0.33	4.30	137
Petauroides volans Greater Glider	20.81	19.44	40.25	1,484
Petaurus norfolcensis Squirrel Glider	25.16	25.72	50.88	1,787

*Some areas of habitat in the subject land located within the Sydney Basin Bioregion have been included in the BAM calculator for the South Eastern Highlands, due to associated PCTs.

Table 6-12 Ecosystem credits required for indirect impacts of the proposal

Plant community type (PCT)	Vegetation zone code	Area to be impacted (hectares)	Ecosystem credits required
Bathurst Subregion / South Eastern Highlands Bioregion			
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85 (moderate)	2.67	15
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (963)	963 (good)*	0.14	1
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103 (disturbed)	0.11	0
	1103 (good)	0.74	8
	1103 (moderate)	1.31	11
Burragorang subregion / Sydney Basin Bioregion			
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731 (good)	1.20	10
	731 (variant – good)	1.12	10
	731 (moderate)	1.30	7

Total (Bathurst Subregion / South Eastern Highlands Bioregion)		4.97	35
Total (Burragorang subregion / Sydney Basin Bioregion)		3.62	27
Total (all bioregions)		8.59	62

*Although some or all areas of this PCT in the subject land are within the Sydney Basin Bioregion, the BAM calculator does not allow selection of this PCT within the bioregion; therefore the PCT has been included in the calculator for the South East Highlands bioregion

Aquatic offsets

The offsets for aquatic habitat are limited to the area of Key Fish Habitat impacted and are considered separately from impacts offset under the BAM. Aquatic offsets would be provided for in accordance with Section 3.3.3 Rehabilitation and compensation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013. DPI (2013) calculates habitat compensation on a minimum 2:1 basis for all Key Fish Habitat lost; a greater compensation ratio may be considered if offsets cannot be sourced near the impact, or are not of the same habitat type as that impacted.

The proposal intersects four mapped areas of Key Fish Habitat: Boxes Creek, River Lett and tributaries of Butlers Creek and Whites Creek. About 228,000 square metres of mapped Key Fish Habitat at these creeks falls within the construction footprint. However, this is considerably overestimated due to width of Key Fish Habitat being well beyond the actual instream habitat. The impacts would be accurately calculated during detailed design to reflect instream habitat impacts only. Final offset calculations will be carried out following detailed design and avoidance of Key Fish Habitat impacts would be undertaken.

6.2 Traffic and transport

This section provides a summary of the assessment of potential traffic and transport impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of traffic and transport impacts is presented in the technical working paper – traffic and transport (Appendix E).

6.2.1 Methodology

The traffic and transport assessment involved the following:

- A review of existing conditions within the proposal area including the road network, road performance, intersection layouts, road safety concerns, public transport amenity, pedestrian and cyclist facilities and residential access
- A review of the traffic model of future conditions within the proposal area without the Great Western Highway being upgraded between Little Hartley and Lithgow
- A review of the traffic model of future conditions within the proposal area with the Great Western Highway being upgraded between Little Hartley and Lithgow
- Assessment of the likely impacts of construction traffic and works during the construction of the proposal and the impacts on the local community and residential access
- A review of the road safety objectives and the necessary mitigation measures and strategies to improve road safety and to reduce or minimise impacts.

Traffic modelling

The following three stage approach was used to complete traffic modelling of future year scenarios with and without the proposal:

- AIMSUN (version 8.2.3) was used for operational traffic modelling. The AIMSUN modelling predicted travel times with and without upgrades to the Great Western Highway. Modelling was carried out for future years 2026 and 2036
- SIDRA Network (version 9) was used to analyse the intersection performance (delay and level of service) of key intersections on the Great Western Highway between Little Hartley and Lithgow. SIDRA modelling was undertaken for future years 2026 and 2036 for the AM peak hour (8.15am to 9.15am) and PM peak hour (3.45pm to 4.45pm). A sensitivity growth scenario of two per cent per annum was used in the assessment of intersection performance. The 2021 intersection turning volumes collected in March 2021 were grown by 0.4 per cent per annum for light vehicles and 1.3 per cent per annum for heavy vehicles to estimate the 2026 and 2036 peak hour traffic volumes
- Austroads Guide and Highway Capacity Manual were used to analyse the Great Western Highway's midblock road performance (level of service) between Little Hartley and Lithgow. Midblock level of service analysis was undertaken for future years 2026 and 2036 for the AM peak hour (8.15am to 9.15am) and PM peak hour (3.45pm to 4.45pm). The 2021 traffic volumes collected in March 2021 were grown by 0.4 per cent per annum for light vehicles and 1.3 per cent per annum for heavy vehicles to estimate the 2026 and 2036 peak hour traffic volumes.

The main performance indicators for intersection are delays (measured in seconds) and level of service. Level of service provides a grading for the performance of the intersection from A to F with A meaning that intersection performance is considered to be operating well and F meaning intersection performance is unsatisfactory with excessive queuing. Similarly, for midblock performance an A grading would indicate that motorists are experiencing high operating speeds and free flowing conditions. An F grade would indicate that motorists are experiencing heavy congestion and unstable flows.

Further details on the approach to traffic modelling, intersection and midblock level of service criteria and key modelling assumptions are provided in Section 3 of the technical working paper – Traffic and transport provided in Appendix E.

6.2.2 Existing environment

Existing road network

The Great Western Highway is the major arterial road through the proposal area, carrying local, intra-regional and inter-regional travel. The general alignment of the Great Western Highway between Little Hartley and Lithgow is mostly a two-way undivided carriageway with one lane in each direction. There are limited overtaking lanes. Speed limit along this section of Great Western Highway is generally 80 kilometres per hour with speeds reduced to 40 kilometres per hour for trucks and buses in some locations.

Local roads connection with the Great Western Highway between Little Hartley and Lithgow include:

- Coxs River Road
- Ambermere Drive
- Baaners Lane
- Browns Gap Road
- Mid Hartley Road
- Carroll Drive
- Old Great Western Highway
- Kelly Street
- Jenolan Caves Road
- Blackmans Creek Road
- Forty Bends Road
- Daintree Close
- McKanes Fall Road
- Old Bathurst Road
- Mudgee Street.

These roads are generally two-way undivided roads with one lane in each direction that provides access to local residential properties. The post speed limits range between 40 and 80 kilometers per hour.

Currently, there are 14 sign-controlled intersections with the Great Western Highway between Little Hartley and Lithgow:

- Coxs River Road / Ambermere Drive
- Baaners Lane
- Browns Gap Road (I-3)
- Mid Hartley Road
- Carroll Drive
- Kelly Street
- Old Great Western Highway
- Jenolan Caves Road / Blackmans Creek Road
- Forty Bends Road
- Daintree Close
- McKanes Falls Road
- Old Bathurst Road
- Mudgee Street
- Quarry Place

The 2016 journey to work data shows the importance of cars for residents' mode of travel to their work in both Lithgow and the Lithgow Region with cars accounting for around 90 per cent of commuter trips.

Public transport

There are currently no regular public bus services (including the local Lithgow Buslines services) that connect Mount Victoria and Lithgow. Consequently, residents rely on private vehicles for business or leisure travel within the proposal area.

Lithgow Buslines operates school bus which utilise the Great Western Highway between Mount Victoria and Lithgow. Some of these operate as express services between Mount Victoria and Lithgow, while others pick up and set down along the highway and on side roads.

Greyhound coaches and tour buses travel along Great Western Highway however there are no regular stops within the proposal area.

Active transport

Active transport movements along and across the Great Western Highway in the proposal area are restricted by a lack of dedicated bicycle or pedestrian paths. There is currently an on-road cycleway on the Great Western Highway between McKanes Falls Road and Lithgow. However, narrow shoulder lanes restrict the use of the highway for cyclists.

Freight and heavy vehicles

The Great Western Highway is currently restricted to general access vehicles only which includes 19 metre long B-double heavy vehicles. Traffic volume data, recorded on the Great Western Highway between Little Hartley and Lithgow, shows that between 1,900 and 2,400 heavy vehicles travelled along the road corridor on an average weekday in 2021, which equates to a respective 18 to 22 per cent of total traffic during the 24-hour period.

Traffic crash history

A summary of traffic crash history is provided in Section 2.2.

Traffic volumes

A summary of daily traffic volumes at six locations on the Great Western Highway between Little Hartley and Lithgow is provided in Table 6-13.

Table 6-13 Average weekday traffic volumes on the Great Western Highway between Little Hartley and Lithgow (2021)

Location on Great Western Highway	Average weekday daily traffic		Average weekend daily traffic	
	Total vehicles	Heavy vehicle per cent to total vehicle	Total vehicles	Heavy vehicle per cent to total vehicle
East of Coxs River Road	11,840	19 per cent	12,060	7 per cent
West of Coxs River Road	12,140	19 per cent	12,430	8 per cent
East of Carroll Drive	11,060	22 per cent	11,400	11 per cent
East of Jenolan Caves Road	10,530	20 per cent	11,460	8 per cent
East of Daintree Close	10,390	19 per cent	11,560	8 per cent
South of Quarry Place	10,640	18 per cent	11,750	7 per cent

Weekday AM and PM peak hour directional and total traffic volumes on the Great Western Highway in the proposal area are shown in Table 6-14.

During the weekday AM peak hour, the Great Western Highway carried marginally higher traffic volumes in the westbound direction towards Lithgow. Specifically, traffic volumes peaked at 454 vehicles per hour in the westbound direction, and 444 vehicles per hour in the eastbound direction towards Little Hartley.

By comparison, traffic volumes were higher in the PM peak, with a maximum flow of 678 vehicles per hour in the westbound direction towards Lithgow, and 599 vehicles per hour in the eastbound direction towards Little Hartley. In general, PM peak hour traffic volumes were between 45 per cent and 49 per cent higher than the corresponding AM peak hour volumes.

Table 6-14 AM and PM peak hour traffic volumes on the Great Western Highway between Little Hartley to Lithgow in 2021

Location on Great Western Highway	AM peak one hour (vehicles/hr)			PM peak one hour (vehicles/hr)		
	West	East	Two-way	West	East	Two-way
East of Coxs River Road	429	444	873	678	588	1266
West of Coxs River Road	454	411	865	658	599	1257
East of Carroll Drive	387	357	744	571	534	1105
East of Jenolan Caves Road	355	353	708	544	514	1058
East of Daintree Close	350	348	698	537	507	1044
South of Quarry Place	378	365	743	559	536	1095

Sunday peak hour traffic volumes on Great Western Highway are shown in Table 6-15. During the Sunday peak hour, the Great Western Highway carried substantial higher traffic volumes than the weekday AM and PM peak, with a maximum flow of 850 vehicles per hour in the westbound direction towards Lithgow, and 793 vehicles per hour in the eastbound direction towards Little Hartley. In general, Sunday peak hour traffic volumes were around 36 per cent higher than the corresponding weekday PM peak hour volumes.

Table 6-15 Sunday peak hour traffic volumes on the Great Western Highway, Little Hartley to Lithgow in 2021

Location on Great Western Highway	Sunday peak one hour (vehicles/hr)		
	West	East	Two-way
East of Coxs River Road	837	766	1,603
West of Coxs River Road	850	771	1,621
East of Carroll Drive	739	780	1,519
East of Jenolan Caves Road	733	780	1,513
East of Daintree Close	739	787	1526
South of Quarry Place	754	793	1,547

The forecast weekday daily traffic volumes on the Great Western Highway between Little Hartley and Lithgow for the 2026 and 2036 future year periods are shown in Table 6-16.

Average weekday traffic volumes on the Great Western Highway are predicted to grow from 11,100 vehicles per day in 2021 to 11,400 vehicles per day in 2026, equivalent of about 103 per cent of current (2021) traffic volumes. In 2036, traffic volumes on the Great Western Highway are predicted to increase to 12,100 vehicles per day, equivalent to about 109 per cent of current (2021) traffic volumes. The proportion of heavy vehicles in the proposal area is forecast to increase from 20 per cent in 2021 to 22 per cent in 2036.

Table 6-16 Forecast daily traffic volumes on the Great Western Highway in 2026 and 2036

Location on Great Western Highway	Average weekday daily traffic volume			Heavy vehicle per cent to total vehicle		
	2021	2026	2036	2021	2026	2036
East of Coxs River Road	11,840	12,190	12,910	19 per cent	19 per cent	21 per cent
West of Coxs River Road	12,140	12,500	13,250	19 per cent	20 per cent	21 per cent
East of Carroll Drive	11,060	11,400	12,110	22 per cent	22 per cent	24 per cent
East of Jenolan Caves Road	10,530	10,850	11,520	22 per cent	22 per cent	24 per cent
East of Daintree Close	10,390	10,700	11,330	20 per cent	21 per cent	23 per cent
South of Quarry Place	10,640	10,950	11,590	18 per cent	19 per cent	20 per cent
Average	11,100	11,440	12,120	20 per cent	21 per cent	22 per cent

Mid-block level of service on Great Western Highway

The existing 2021 midblock level of service D for all locations in the proposal area during the weekday AM and PM and Sunday peak periods is shown in Table 6-17. This indicates that a high percentage of vehicles travelled in platoons, resulting in limited opportunities to overtake.

Table 6-17 Existing 2021 midblock level of service on the Great Western Highway

Location on Great Western Highway	Level of service		
	2021 base case	2026 base case (Do nothing)	2036 base case (Do nothing)
East of Coxs River Road	D	E	E
West of Coxs River Road	D	E	E
East of Carroll Drive	D	D	E
East of Jenolan Caves Road	D	D	E
East of Daintree Close	D	D	E
South of Quarry Place	D	D	E

Intersection performance

Details of existing (2021) operational performance levels for the AM peak and PM peak hour periods and the modelled future (2026 and 2036) intersection performance levels for the AM peak and PM peak without the proposal (base case/'do nothing') are provided in Table 6-18. Intersection delay and level of service is reported for each of the14 sign-controlled intersections in the proposal area.

Currently (2021), 13 of 14 intersections in the proposal area except for the intersection with Coxs River Road/Ambermere Drive operate with a level of service from A to C during weekday AM or PM peak periods. The modelled intersection delay ranges between 7 seconds and 41 seconds per vehicle, which is primarily contributed by traffic on side roads. The intersection with Coxs River Road/Ambermere Drive currently operates with a level of service E during weekday PM peak periods.

Overall, the existing (2021) level of service analysis does not indicate any significant operational capacity issues at 14 intersections in the proposal area except for Coxs River Road/Ambermere Drive in the PM peak period.

As shown in Table 6-18, by 2026 an unsatisfactory level of service F is predicted at the Great Western Highway intersection with Coxs River Road/Ambermere Drive during the PM peak, with average delay of 77 seconds per vehicles. By 2036, an unsatisfactory level of service E or F is predicted at seven of the 14 intersections in the proposal area during the PM peak. This includes the Great Western Highway intersections with Coxs River Road/Ambermere Drive, Banners Lane, Mid Hartley Road, Carroll Drive, Old Great Western Highway, Jenolan Caves Road/Blackmans Creek Road and Daintree Close.

Table 6-18 Existing and future intersection level of service during the weekday AM and PM peak in 2021, 2026 and 2036 without the proposal (base case/'do nothing')

Intersections with Great Western Highway	2021 AM (existing)		2021 PM (existing)		2026 AM (base case)		2026 PM (base case)		2036 AM (base case)		2036 PM (base case)	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Coxs River Road/ Ambermere Drive	26	B	62	E	29	C	77	F	51	D	>250	F
Baaners Lane	14	A	28	B	15	B	31	C	21	B	59	E
Browns Gap Road	12	A	17	B	12	A	18	B	15	B	27	B
Mid Hartley Road	21	B	39	C	21	B	44	D	28	B	70	E
Carroll Drive	21	B	41	C	23	B	46	D	32	C	86	F
Kelly Street	10	A	16	B	10	A	17	B	12	A	25	B
Old Great Western Highway	16	B	30	C	17	B	34	C	24	B	61	E
Jenolan Caves Road/ Blackmans Creek Road	24	B	39	C	26	B	47	D	42	C	194	F

Intersections with Great Western Highway	2021 AM (existing)		2021 PM (existing)		2026 AM (base case)		2026 PM (base case)		2036 AM (base case)		2036 PM (base case)	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Forty Bends Road	9	A	10	A	9	A	10	A	9	A	11	A
Daintree Close	11	A	18	B	11	A	64	E	15	B	131	F
McKanes Falls Road	13	A	20	B	14	A	21	B	17	B	32	C
Old Bathurst Road	7	A	7	A	9	A	7	A	9	A	7	A
Mudgee Street	9	A	10	A	9	A	11	A	10	A	15	B
Quarry Place	9	A	10	A	9	A	11	A	9	A	14	A

During the Sunday peak period, five intersections operate with a level of service E to F (Table 6-19). These include Coxs River Road/Ambermere Drive, Mid Hartley Road, Carroll Drive, Kelly Street, and Jenolan Caves Road/ Blackmans Creek Road. Motorists on the side roads experience a delay up to 145 seconds during the Sunday peak period.

Intersection performance during the Sunday peak would continue to deteriorate with delays per vehicle at the worst performing intersection (Coxs River Road/ Ambermere Drive) increasing from 145 seconds currently to 163 seconds in 2026 and to 225 seconds in 2036. In 2036, six intersections will be performing at an unsatisfactory E or F level of service. These would include Coxs River Road/ Ambermere Drive, Baaners Lane, Mid Hartley Road, Carroll Drive, Old Great Western Highway, and Jenolan Cave Road/ Blackmans Creek Road.

Table 6-19 Existing and future intersection level of service during the Sunday peak in 2021, 2026 and 2036 without the proposal (base case/'do nothing')

Intersections with Great Western Highway	2021 Sunday peak (existing)		2026 Sunday peak (base case)		2036 Sunday peak (base case)	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Coxs River Road/ Ambermere Drive	145	F	163	F	225	F
Baaners Lane	50	D	54	D	65	E
Browns Gap Road	29	C	31	C	35	C
Mid Hartley Road	58	E	62	E	73	F
Carroll Drive	99	F	109	F	132	F
Kelly Street	34	C	36	C	42	C
Old Great Western Highway	79	F	86	F	104	F
Jenolan Caves Road/ Blackmans Creek Road	72	F	79	F	95	F

Intersections with Great Western Highway	2021 Sunday peak (existing)		2026 Sunday peak (base case)		2036 Sunday peak (base case)	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Forty Bends Road	11	A	11	A	12	A
Daintree Close	40	C	43	D	50	D
McKanes Falls Road	41	C	43	D	50	D
Old Bathurst Road	7	A	7	A	8	A
Mudgee Street	18	B	18	B	20	B
Quarry Place	16	B	17	B	19	B

Travel times

The average weekday peak period journey time for vehicles travelling on the 38.5 kilometre section of the Great Western Highway between Katoomba and Lithgow was around 43 minutes.

6.2.3 Potential impacts

Construction

Traffic

The proposal would generate between 200 and 850 vehicles movements per day. The distribution of these movements on the road network would depend on the particular construction activities being undertaken at the time, the destination of the workforce, the source of imported material and the destination of exported material. It is assumed that most of the construction traffic would travel to and from the east via the Great Western Highway.

Daily construction vehicle movements and existing average weekday daily traffic on the Great Western Highway in the vicinity of the package of works are shown in Table 6-20.

Construction traffic would increase volumes on the Great Western Highway of between two per cent to eight per cent depending on package of works and locations. These increases would be minor and not impact the operational performance of the Great Western Highway. The proposal would aim to maintain one travel lane in each direction. However, there will be some instances during off peak times that lane closures or contraflow arrangements are required to complete works such as pavement resurfacing on the Great Western Highway.

Table 6-20 Impacts of construction traffic on Great Western Highway

Package	Existing average weekday traffic on Great Western Highway	Daily construction vehicle movements on Great Western Highway	Per cent increase on Great Western Highway
Little Hartley to River Lett Hill	11,845	520 - 620	4 - 5 per cent
Coxs River Road	11,845	367- 687	3 - 6 per cent
River Lett Hill to Forty Bends	11,060	618 - 850	6 - 8 per cent

Package	Existing average weekday traffic on Great Western Highway	Daily construction vehicle movements on Great Western Highway	Per cent increase on Great Western Highway
Forty Bends to Lithgow	10,393	288 - 650	3 - 6 per cent

Intersection performance

The intersections listed below would require temporary road treatments to facilitate construction works and maintain local access:

- Coxs River Road. Grade separation of the new Great Western Highway and Coxs River Road would require a temporary connection to maintain connectivity for local properties
- Browns Gap Road. A road closure would be required at Browns Gap Road to construct the new pavement at the intersection of Service Road 2 and Browns Gap Road. To facilitate the closure, a detour to Browns Gap Road would be provided at Mid Hartley Road
- Banners Lane. Temporary connection to Baaners Lane would be constructed to maintain connectivity with the existing Great Western Highway and local properties
- Kelly Street. A temporary connection to Kelly Street would be constructed to maintain connectivity with the existing Great Western Highway and local properties
- Jenolan Caves Road. A temporary connection and turnaround would be constructed to maintain connectivity with the existing Great Western Highway
- Blackmans Creek Road. A temporary connection and turnaround would be constructed to maintain connectivity with the existing Great Western Highway
- Intersections with Forty Bends Road, McKanes Falls Road, Old Bathurst Road, Mudgee Street require temporarily reduced lane widths during construction.

During construction, these intersections would experience a deterioration in performance. Vehicles using these intersections may at times experience increased delays and congestion. These impacts would be temporary.

Active transport

Cyclists travelling on Great Western Highway would be required to share lanes with traffic in locations during construction where the shoulder width is insufficient. Shared paths in the vicinity of the proposal would be further investigated during future design development. The alignment and structure of the future shared paths would be developed in consultation with Lithgow City Council and other relevant stakeholders. An indicative route is provided in Appendix R.

Public transport

The construction of the proposal would not have a direct impact on any public transport networks or facilities. Construction of the proposal may have an indirect impact on buses travelling along Great Western Highway as a result of the deterioration in performance experienced at the intersections listed above. This could result in an increase in travel time for some services.

Property access

Several access points to properties on the Great Western Highway may be temporarily impacted during construction. The proposal would be manage to limit potential impacts on property access. Any unavoidable temporary access closures would involve an appropriate level of engagement with the property owners prior to construction.

Operation

Midblock performance

A comparison of the mid-block performance with the proposal and without the proposal for the years 2026 and 2036 with the proposal is provided in Table 6-21.

Table 6-21 Midblock level of service

Package	Level of service (without the proposal)			Level of service (with the proposal)	
	2021	2026	2036	2026	2036
Little Hartley to River Lett Hill (L2R	D	E	E	A	C
Coxs River Road (CRR)	D	E	E	A	C
River Lett Hill to Forty Bends (R2F)	D	D	E	A	B[1]
Forty Bends to Lithgow (F2L)	D	D	E	A	B

Note 1: R2F is a steep uphill carriageway in the westbound direction. The westbound climbing lane is predicted operate at a level of service C in both future year periods.

Intersection performance

Little Hartley to River Lett

A summary of the predicted level of service and delays at five intersections with the new Great Western Highway in the Little Hartley to River Lett section in the 2026 and 2036 future year AM peak and PM peak hour periods is provided in Table 6-22.

For both future year periods, the proposed intersection layouts and control measures are predicted to operate at a level of service A during weekday AM and PM peak and Sunday hours. Additionally, with only minor delays at all intersections, traffic modelling indicates good operational performance levels and hence the proposal would provide a reliable and efficient road network in this section.

Table 6-22 Modelled intersection level of service in 2026 and 2036 with the proposal – Little Hartley to River Lett

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday peak		2036 AM peak		2036 PM peak		2036 Sunday peak	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Service Road 3 / Connecting Road 4	7	A	8	A	7	A	7	A	8	A	7	A
New Great Western Highway / Connecting Road 4	9	A	9	A	9	A	9	A	9	A	9	A
Mid Hartley Road/ Service Road 3	7	A	8	A	7	A	7	A	8	A	7	A
Service Road 3 / Connecting Road 5	7	A	8	A	7	A	7	A	8	A	7	A

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday peak		2036 AM peak		2036 PM peak		2036 Sunday peak	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
New Great Western Highway / Connecting Road 5	9	A	9	A	9	A	9	A	9	A	9	A

Coxs River Road

The predicted level of service and delays at seven intersections with the new Great Western Highway within the Coxs River Road section in the 2026 and 2036 future year AM peak and PM peak hour periods are summarised in

Table 6-23.

For both future year periods, the proposed intersection layouts and control measures are predicted to operate between a level of service A and a level of service C during typical weekday AM and PM peak and Sunday hours. The associated intersection delays are predicted to range from seven to 32 seconds per vehicles due to geometry delay; particularly for left-turn vehicles. In summary, traffic modelling indicates that the proposal would provide a reliable and efficient road network in this section.

Table 6-23 Modelled intersection level of service in 2026 and 2036 with the proposal – Coxs River Road

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday peak		2036 AM peak		2036 PM peak		2036 Sunday peak	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Coxs River Road / Ambermere Drive / Service Road 1	9	A	13	A	11	A	10	A	16	B	13	A
Coxs River Road / Connecting Road 2	7	A	7	A	7	A	7	A	7	A	7	A
Service Road 2 / Connecting Road 3	7	A	7	A	7	A	7	A	7	A	7	A
New Great Western Highway / Connecting Road 3	9	A	9	A	9	A	9	A	9	A	9	A
New Great Western Highway / Connecting Road 2	8	A	8	A	8	A	8	A	8	A	8	A

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday peak		2036 AM peak		2036 PM peak		2036 Sunday peak	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
New Great Western Highway / Banners Lane	13	A	18	B	23	B	15	B	23	B	32	C
Browns Gap Road / Service Road 2	7	A	7	A	7	A	7	A	7	A	7	A

River Lett to Forty Bends

The predicted level of service and delays at two intersections with the new Great Western Highway within the River Lett to Forty Bends section in the 2026 and 2036 future year AM peak and PM peak hour periods are summarised in Table 6-24.

For both future year periods, the proposed intersection layouts and control measures are predicted to operate between level of service A and level of service C during the respective weekday AM and PM peak and Sunday hours. The associated intersection delays range from 13 to 40 seconds per vehicle. In summary, traffic modelling indicates that the proposal would provide a reliable and efficient road network in this section.

Table 6-24 Modelled intersection level of service in 2026 and 2036 with the proposal –River Lett to Forty Bends

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday		2036 AM peak		2036 PM peak		2036 Sunday	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
New Great Western Highway / Service Road 8	13	A	17	B	24	B	15	B	21	B	34	C
New Great Western Highway / Service Road 10	13	A	16	B	27	B	15	B	20	B	40	C

Forty Bends to Lithgow

A summary of the predicted level of service and delays at six intersections with the new Great Western Highway within the Forty Bends to Lithgow section in the 2026 and 2036 future year AM peak and PM peak hour periods is provided in

Table 6-25.

For both future year periods, the proposed intersection layouts and control measures are predicted to operate between a level of service A and level of service C during typical weekday AM and PM peak and Sunday peak hours. The associated intersection delays range from seven to 29 seconds per vehicle. In summary, traffic modelling indicates that the proposal would provide a reliable and efficient road network in this section.

Table 6-25 Modelled intersection level of service in 2026 and 2036 with the proposal – Forty Bends to Lithgow

Intersections with Great Western Highway	2026 AM peak		2026 PM peak		2026 Sunday peak		2036 AM peak		2036 PM peak		2036 Sunday peak	
	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
New Great Western Highway / Forty Bends Road	7	A	7	A	7	A	7	A	7	A	8	A
New Great Western Highway / Daintree Close	12	A	17	B	21	B	13	A	21	B	28	B
New Great Western Highway / McKanes Falls Road	12	A	15	B	21	B	14	A	19	B	29	C
New Great Western Highway / Old Bathurst Road	7	A	7	A	7	A	7	A	7	A	7	A
New Great Western Highway / Mudgee Street	10	A	14	A	19	B	12	A	18	B	27	B
New Great Western Highway / Quarry	12	A	16	B	21	B	13	A	20	B	29	C

Travel time savings on Great Western Highway

In 2036, the proposal would reduce travel time by up to 10 minutes between Katoomba and Lithgow from about 40 minutes in the base case/'do nothing' scenario to around 29 minutes with the proposal.

Crash reductions on Great Western Highway

Crash reduction analysis was undertaken on the Great Western Highway by comparing with and without proposal conditions to estimate potential crash reductions based on crash data recorded from 2014 to 2020.

The number of crashes predicted for base case/'do nothing' and without the proposal conditions are shown in Table 6-26. The analysis suggests that the proposal would reduce the total potential number of crashes on the Great Western Highway from 89 crashes to 38.7 crashes, which equates to a 57 per cent reduction.

Table 6-26 Predicted crashes and crash reduction on the proposal

Crash description	Base case/'do nothing'	With the proposal	Change	per cent change
Intersection, from adjacent approaches	2.0	1.0	-1.0	-50 per cent
Head-on	7.0	0.0	-7.0	-100 per cent
Opposing vehicles; turning	1.0	0.5	-0.5	-50 per cent
Rear end	10.0	4.0	-6.0	-60 per cent
Lane change	5.0	4.4	-0.6	-12 per cent
Vehicle leaving driveway	1.0	0.0	-1.0	-100 per cent
Hit animal	1.0	-	-	-
Off carriageway, on straight	1.0	0.6	-0.5	-45 per cent
Off carriageway on straight, hit object	11.0	6.1	-5.0	-45 per cent
Off carriageway, on curve	5.0	2.0	-3.0	-60 per cent
Off carriageway on curve, hit object	39.0	15.6	-23.4	-60 per cent
Out of control on curve	4.0	1.6	-2.4	-60 per cent
Other	2.0	-	-	-
Total	89.0	38.7	-50.3	-57 per cent

Active transport

The proposal would improve conditions for pedestrians and cyclists by providing a range of improvements to the existing active transport network and facilities by providing:

- A 2.5 metre nearside sealed shoulder has been provided on Great Western Highway. It is anticipated that the sealed shoulders are sufficient to accommodate on road cyclists on both sides of each carriageway of Great Western Highway
- A two metre nearside sealed shoulder has been provided on Service Road 2 and Coxs River Road for on road cyclists
- A two metre nearside sealed shoulder has been provided on Service Roads 1 and 3 for on road cyclists.
- Design development has considered the future development of shared paths in the vicinity of the proposal. The alignment and structure of the future shared paths would be developed and finalised during future design development and in consultation with Lithgow City Council and other relevant stakeholders. An indicative route is provided in Appendix R.

Public transport

The operation of the proposal is not expected to impact on any public transport networks.

6.2.4 Safeguards and management measures

Table 6-27 Safeguards and management measures – traffic and transport

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
TT01	Construction traffic	A Traffic Management Plan (TMP) will be prepared for the construction phase of the proposal. This will adhere to Traffic Control at Worksites, Technical Manual, Issue No. 6, Transport, September 2020 and QA Specification G10 Traffic Management (Transport, August 2020). This will include details on: • Measures to maintain access to properties and local roads • Site specific traffic control measures to manage and regulate traffic movement • Requirement and methods to consult and inform the local community of impacts on the local road network • Measures to maintain pedestrian and cyclist access • Access to ancillary sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads	Contractor	Prior to and during construction	Appendix E	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• A response plan for any construction road traffic incident • Consideration of other developments which may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • Monitoring, review and amendment mechanisms.				
TT02	Construction traffic staging	Traffic management plans would be prepared for the construction area and progressively updated as the works progress. The plans would be prepared and implemented by suitably qualified personnel	Contractor	Prior to and during construction	Appendix E	All
TT03	Construction traffic staging	Schedule partial road closures to maintain 2 lanes at all times except for blasting periods. Full road closures would be required for short periods of time (approximately 15 minutes) however this would be conducted at non-peak times.	Contractor	Prior to and during construction	Appendix E	All
TT04	Consultation	Undertake consultation with local and regional bus companies prior to and during construction	Contractor	Prior to and during construction	Appendix E	All
TT05	Consultation	Undertake consultation with emergency services prior to and during construction to confirm any diversions during construction and any operational road network changes	Contractor	Prior to and during construction	Appendix E	All
TT06	Consultation	Undertake consultation with property owners and occupiers regarding	Contractor	Prior to and during construction	Appendix E	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		changes to access arrangements				
TT07	Consultation	Undertake consultation with local councils regarding potential impacts to parking during the construction period.	Contractor	Prior to and during construction	Appendix E	All
TT08	Operational traffic management	Review incident management plan in the event the highway may be temporarily closed due to scheduled maintenance or accident	Transport	Operation	Appendix E	All
TT09	Operational traffic management	Consult with residents who may be affected by the temporary closure of the highway closed due to scheduled maintenance or accident.	Transport	Operation	Appendix E	All

Other safeguards and management measures that would address traffic impacts are identified in Section 6.10 Socio-economic.

6.3 Noise and vibration

This section provides a summary of the assessment of potential noise and vibration impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. This summary is based on the the technical working paper – noise and vibration (Appendix F).

6.3.1 Methodology

Guidelines

The guidelines used to assess noise and vibration impacts from the proposal are listed in Table 6-28.

Table 6-28 Construction noise and vibration guidelines

Guidelines / policy name	Where guideline is used
Interim Construction Noise Guideline (ICNG) (DECC, 2009)	Assessment of airborne noise impacts on sensitive receivers
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces
Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999)	Contains guidance for assessing potential sleep disturbance impacts
Guideline for Child Care Centre Acoustic Assessment Version 2.0 (GCCCAA), Association of Australasian Acoustical Consultants (AAAC), 2013	Contains criteria for child care centres
Road Noise Policy (RNP) (DECCW, 2011)	Assessment of construction traffic impacts
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts (structural damage) to non-heritage sensitive structures
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999	Screening assessment of vibration impacts (structural damage) to heritage sensitive structures, where the structure is found to be unsound
Assessing Vibration: a technical guideline (DEC, 2006)	Assessment of vibration impacts on sensitive receivers
Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime Services, 2016)	Assessment and management protocols for airborne noise and vibration impacts for road infrastructure proposals
AS2187.2:2006 Explosives – Storage and use Part 2: Use of explosives	Assessment of impacts from blasting activities
Road Noise Policy (RNP) (DECCW, 2011)	Operational road traffic noise assessment
Noise Criteria Guideline (NCG) (Roads and Maritime, 2015)	Defines Transport's interpretation of the RNP and details how criteria are applied to sensitive receivers
Noise Mitigation Guideline (NMG) (Roads and Maritime, 2015)	Details how additional mitigation measures are to be applied to road infrastructure proposals

Guidelines / policy name	Where guideline is used
Model Validation Guideline (Roads and Maritime, 2018)	Contains procedures for validating operational road traffic noise models
Environmental Noise Management Manual (ENMM) (Roads and Traffic Authority, 2001)	Additional information for operational road traffic noise assessment, including maximum noise assessments
Preparing an Operational and Construction Noise and Vibration Assessment Report (Roads and Maritime, 2016)	Defines how to complete operational road traffic noise and vibration assessments
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces.
At-Receiver Noise Treatment Guideline (Roads and Maritime, 2017)	Provides an overview and discussion of feasible and reasonable at-receiver noise mitigation measures

Overview

The assessment methodology for noise and vibration impacts generally involved:

- Identifying and classifying sensitive receivers relevant to the proposal
- Characterising the existing noise environment based on attended and unattended noise measurements at specific locations across the proposal
- Determining noise and vibration management levels in accordance with relevant guidelines
- Modelling to quantify potential noise and vibration impacts
- Assessing the significance of potential impacts identified
- Examining the proposed construction methodologies and identifying mitigation measures that are likely to be required to minimise noise and vibration impacts.

Construction scenarios

Representative scenarios have been developed to assess the likely impacts from the various phases of the proposal. In some cases, these representative scenarios have been further separated into ‘typical’ and ‘peak’ scenarios in terms of the noise generated levels.

Construction scenarios associated with construction site activities would include:

- Pre-construction and early work
- Site establishment
- Earthworks and utility work
- Bridge construction
- Road work
- Finishing work
- Compound operation

Detailed descriptions of these scenarios are provided in Section 4.1 of the technical working paper (Appendix F).

The assessment uses realistic worst-case scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG. The impacts represent construction noise levels without mitigation applied.

The noise impact assessment scenarios have been categorized into ‘peak’ and ‘typical’ works which have been used to define the likely range of potential noise impacts:

- ‘Peak’ works represent the noisiest stages and can require the use of noise intensive equipment such as rockbreakers or concrete saws for some construction scenarios. While ‘peak’ works would be required at times in most locations, the noisiest activities would not occur over the full duration of construction. The ‘peak’ scenarios also include the maximum anticipated number of construction faces at each of the various construction sites. The assessment is generally considered conservative as the calculations assume several items of equipment at each construction face are in use at the same time within individual scenarios
- ‘Typical’ works represent typical noise emissions from the proposal when noise intensive equipment is not in use. The ‘typical’ works includes all items of equipment for a given activity except for the loudest item. These items of equipment generally support the ‘peak’ works activity and are referred to as ‘supporting equipment’.

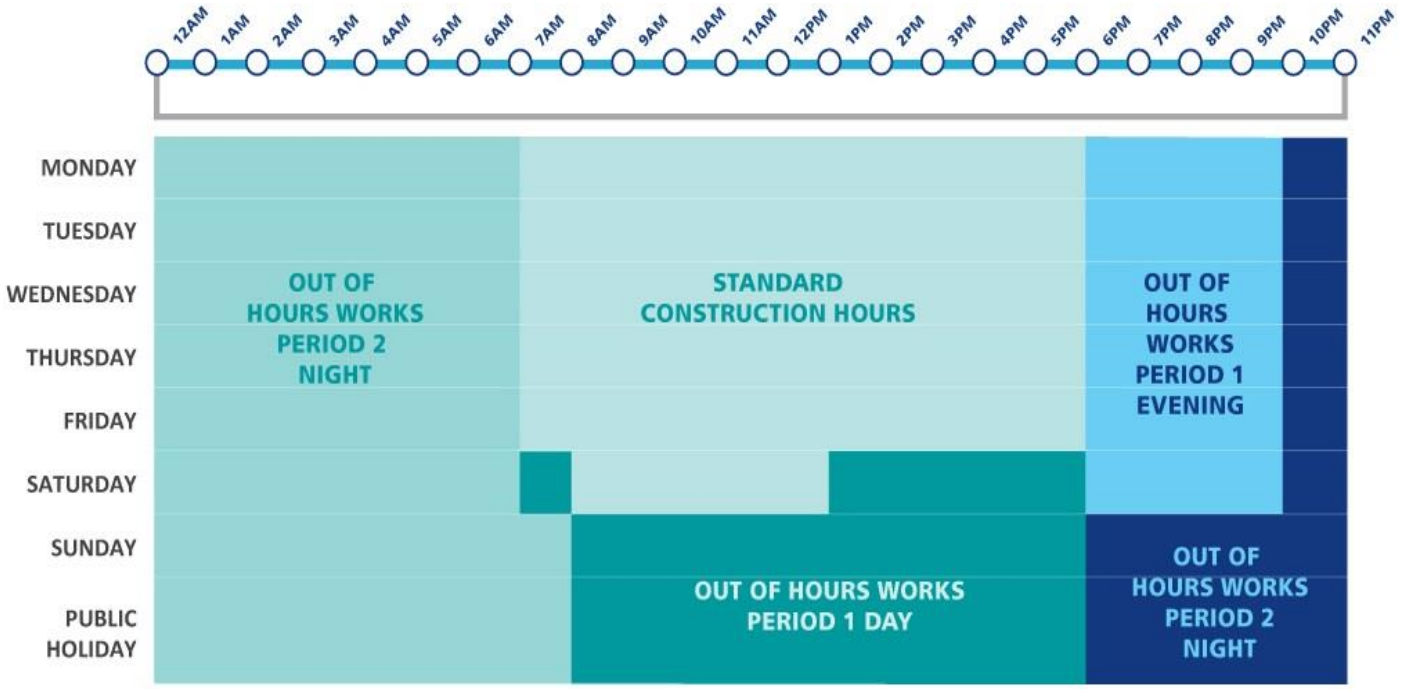
Construction program and hours

Construction of the proposal would be carried out during standard construction hours where possible although evening and night-time work would be required during some periods. Standard construction hours for normal construction activities are:

- 7am to 6pm, Monday to Friday
- 8am to 1pm, Saturday
- No work on Sundays or public holidays

Standard construction hours and other works periods are identified in the ICNG and shown inTable 6-29.

Table 6-29 Standard construction hours



Note 1: Work outside of Standard Construction Hours is defined as ‘out of hours work’ (OOHW) and can be divided into two periods of sensitivity. OOHW Period 1 which relates to evening (and weekend daytime) work, and OOHW Period 2 which relates to night-time (and weekend evening) work.

Construction activities that may result in traffic restrictions are likely to be carried out outside of Standard Construction Hours during evening and night-time periods to minimise disruption to traffic and provide a safer working environment for construction workers. The following work is likely to be carried out as evening and night-time work, some with short term lane closures:

- Tie in work to existing roads
- Work that would require traffic switches outside of peak times as to not disrupt traffic
- Some work required at bridges including use of noise intensive equipment such as concrete saws
- Potential utility and drainage work, including relocations and adjustments.

The expected periods in which the works would be completed are shown in Table 6-30. The expected durations of each scenario are also provided.

Table 6-30 Construction scenarios – working hours

Construction scenario	Estimated duration (weeks) per stage				Hours of work			
	F2L	R2F	L2R	CRR	Std. day	Day OOH	Evening	Night-time
Pre-construction and early works	-[1]	-[1]	-[1]	-[1]	✓	-	-	-
Site establishment - peak	6	10	6	6	✓	-	-	-
Site establishment - typical	6	10	6	6	✓	-	-	-
Earthworks and utility works - peak	37[2]	85[2]	72[2]	37[2]	✓	-	-	-
Earthworks and utility works - typical	37[2]	85[2]	72[2]	37[2]	✓	✓	✓	✓
Bridge construction -peak	N/A	82	30	20	✓	✓	✓	✓
Bridge construction - typical	N/A	82	30	20	✓	✓	✓	✓
Road works - peak	54[3]	57[3]	28[3]	31[3]	✓	-	-	-
Road works - typical	54[3]	57[3]	28[3]	31[3]	✓	-	-	-
Road works OOHW - peak	2	2	1	1	✓	✓	✓	✓
Road works OOHW - typical	2	2	1	1	✓	✓	✓	✓
Finishing works	6	21	6	4	✓	-	-	-
Compounds - operations	74	145	96	59	✓	✓	✓	✓

Note 1: The current tentative early work scope includes all utility adjustments. A detailed program is currently not available.

Note 2: Earthworks takes place in several instances in each proposal stage within each section and does not account for overlaps.

Note 3: Does not account for some simultaneous work. Disregards breaks in construction as other work takes place.

Construction is expected to commence in late 2022. The proposal is anticipated to be open to traffic by 2026. However, these durations are indicative and would be confirmed by the construction contractor.

Construction noise metrics

Noise parameters most relevant to construction noise are described below and were evaluated for daytime (7am-6pm), evening (6-10pm) and night-time (10pm-7am) periods:

- Rating background level (RBL) or L_{A90} – the background noise level in the absence of proposed construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods and is used to set the $L_{Aeq(15\ minute)\ noise}$ management levels (NMLs) for residential receivers
- $L_{Aeq\ (period)}$ – the 'energy average noise level' evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring)
- $L_{Amax\ or\ LA1(1min)}$ – the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods.

Construction noise management levels

The ICNG is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining proposal specific NMLs for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from construction of a proposal are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the proposal.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

Residential receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers by applying the measured $L_{A90(15minute)}$ background noise levels, as described in Table 6-31.

Table 6-31 Determination of NMLs for residential receivers

Time of day	NML $L_{Aeq(15minute)}$	How to apply
Standard Construction Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	RBL + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite

Time of day	NML $L_{Aeq(15minute)}$	How to apply
		periods by restructuring the hours that the very noisy activities can occur, taking into account: – Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences – If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside standard construction hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Sleep disturbance

Where night work is located close to residential receivers, there is potential for sleep disturbance impacts.

The ICNG lists five categories of work that might need to be undertaken outside of Standard Construction Hours:

- The delivery of oversized equipment or structures that require special arrangements to transport on public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services or considerations of worker safety do not allow work within standard hours
- Public infrastructure work that shortens the length of the proposal and is supported by the affected community
- Work where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Where construction work is planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be completed. The ICNG refers to the NSW Environmental Criteria for Road Traffic Noise for assessing the potential impacts, which notes that to limit the level of sleep disturbance, the L1 level (or LAmax) should not exceed the existing L90 background noise level by more than 15 dB.

Other sensitive land uses and commercial receivers

Several non-residential land uses have been identified in the study area. The NMLs for 'other sensitive' receivers are shown in Table 6-32.

Table 6-32 Noise management levels – other sensitive receivers

Land use	Noise management level - LAeq(15minute) dBA	
	Internal	External
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas(characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75
Hotel – daytime & evening[3]	50	70[2]
Hotel – night-time[3]	40	60[2]
Child care centres – sleeping areas4	40	50[1]

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 3: Criteria taken from AS2107.

Note 4: Criteria taken from Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment.

Construction traffic noise

The potential impacts from construction traffic associated with the proposal when travelling on public roads are assessed under the NSW EPA Road Noise Policy (RNP) and Roads and Maritime (now Transport) Construction Noise and Vibration Guideline (CNVG).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than two decibels as a result of construction traffic. Where this is considered likely, further assessment is required using the RNP and Roads and Maritime (now Transport) Noise Criteria Guideline (NCG) base criteria shown in Table 6-33.

Table 6-33 RNP/NCG criteria for assessing construction traffic on public roads

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am – 10am	Night-time (10pm-7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (External)	$L_{Aeq(9hour)}$ 55 (external)

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am – 10am	Night-time (10pm-7am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Construction vibration

The effects of vibration from construction work can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort). People can sometimes perceive vibration impacts when vibration generating construction work is located close to occupied buildings. Vibration from construction work tends to be intermittent in nature and the EPA's Assessing Vibration: a technical guideline (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV), as shown in Table 6-34. While the construction activities for the proposal are generally not expected to result in continuous or impulsive vibration impacts, criteria is provided in Table 6-35.
- Those where building contents may be affected (building contents). People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents. Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes or medical imaging equipment, are in buildings near to construction work. No such equipment has been identified in the study area.
- Those where the integrity of the building may be compromised (structural/cosmetic damage). If vibration from construction work is sufficiently high it can cause cosmetic damage to elements of affected buildings. Industry standard cosmetic damage vibration limits are specified in British Standard BS 7385 and German Standard DIN 4150. The limits are shown in Table 6-36 and Table 6-37.

Table 6-34 Vibration dose values for intermittent vibration

Building type	Assessment period	Vibration dose value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

Table 6-35 Human comfort vibration – preferred and maximum weighted root mean square values for continuous and impulsive vibration acceleration (m/s[1]) 1-80 Hz

Building type	Assessment period	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residential	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Residential	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 6-36 Cosmetic damage – BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Table 6-37 Cosmetic Damage – DIN 4150 Guideline Values for Short-term Vibration on Structures

Group	Type of structures	Guidelines values vibration velocity (mm/s)				
		Foundation, all directions at a frequency of			Topmost flood, horizontal	Floor slabs, vertical
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All frequencies	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified as Group 1 or 2 and are of great intrinsic value (eg heritage listed buildings)	3	3 to 8	8 to 10	8	201

Note 1: It may be necessary to lower the relevant guideline value markedly to prevent minor damage.

Heritage buildings and structures

Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound. Where a heritage building is deemed to be sensitive, the more stringent DIN 4150 Group 3 guideline values in Table 6-37 can be applied.

Heritage listed items identified in the study area are shown in the mapping in Section 6.5 Non-Aboriginal heritage.

Minimum working distances for vibration intensive works

Minimum working distances for typical vibration intensive construction equipment are provided in the CNVG. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Assessing Vibration: a technical guideline (DEC, 2006)). They are calculated from empirical data which suggests that where work is further from receivers than the quoted minimum distances then impacts are not considered likely.

Blasting

The Transport CNVG outlines that ground vibration and blast over pressure should be assessed and limits established based on Australian Standard AS 2187.2-2006, 'Explosives - Storage, transport and use, Part 2: Use of explosives. The potential impacts during blasting have been assessed as per the requirements in the CNVG. A Maximum Instantaneous Charge (MIC) of 54 kg and coefficients for ‘average’ conditions were used. The criteria are summarised in Table 6-38 and the corresponding minimum working distances are presented in Table 6-39 .

Table 6-38 Ground vibration and airblast limits for human comfort (AS 2187.2-2006)

Human comfort		Control of damage to structures		
Peak particle velocity (AS2187)	**Over-pressure (dBL) (AS52187)**	**Peak particple velocity (BS7385)**	**Over-pressure (dBL) (AS2187)**	**Heritage items (DIN 4150 Group 3)**
10 mm/s	120 dB(L) for 95 per cent blasts per year. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply.	7.5 mm/s	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply.	2.5 mm/s

Table 6-39 Blasting minimum working distances

Maximum Instantaneous Charge (Kg)	Minimum Working Distances[1]		
	Human Comfort	**Control of Damage to Structures**	**Heritage Items**
54 kg[2]	145 m	170 m	340 m

Note 1: The corresponding offset distances for air over pressure is greater and the presented values have been based on vibration.

Note 2: If a greater MIC is used, then the corresponding offset distances would increase accordingly.

Operation noise

The RNP is used to assess and manage potential airborne noise impact from new and redeveloped road proposals. This assessment is undertaken with guidance from the Noise Criteria Guideline (NCG) which is Transports interpretation of the RNP and provides a consistent approach to identifying road noise criteria for infrastructure proposals.

The RNP and NCG use the following terms to describe and assess the impacts from road proposals:

- 'No build' – the assessment scenario used to predict noise levels if the proposal were not to go ahead. The 'No Build' scenarios use the existing road alignment geometry, with all existing structures and features within the road corridor included.
- 'Build' – the assessment scenario used to predict noise levels with the proposal. The 'Build' scenarios use the proposed design of the proposal, which includes all new roads and changes to existing ground levels such as cuttings and embankments.

The difference between the 'build' and the 'no build' noise levels is used to determine the impact of the proposal. The RNP and NCG provide non-mandatory criteria for residential and 'other sensitive' land uses. Where a proposal results in road traffic noise levels which are predicted to be above the criteria, the proposal should investigate feasible and reasonable noise mitigation measures to minimise the impacts.

Residential receivers

The proposal would 'redevelop' the Great Western Highway and connections to surrounding roads. A road is 'redeveloped' where work is generally in an existing road corridor. Sections of the Great Western Highway would also be substantially realigned from the existing road and where this occurs the road is considered 'new' and lower road traffic noise criteria is applied.

Table 6-40 NCG criteria for residential receivers

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am to 10pm)	Night time (10pm to 7am)
Freeway/ arterial/ sub-arterial road	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15\ hour)}$ 55 (external)	$L_{Aeq(9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
	Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a transition zone1	Between $L_{Aeq(15\ hour)}$ 55-60 (external)	Between $L_{Aeq(9\ hour)}$ 50-55 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from new freeway/arterial/sub-arterial roads2	Between $L_{Aeq(15\ hour)}$ 42-55 (external)	Between $L_{Aeq(9\ hour)}$ 42-50 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from redevelopment of existing freeway/arterial/sub-arterial roads2	Between $L_{Aeq(15\ hour)}$ 42-60 (external)	Between $L_{Aeq(9\ hour)}$ 42-55 (external)
Local roads	Existing residences affected by noise from new local road corridors	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing local roads		
	Existing residences affected by additional traffic on existing local roads generated by land use developments		

Note 1: The relative increase criterion at each facade is determined from the existing traffic noise level plus 12 dB.

The criteria are lower for the night-time due to the greater sensitivity of communities to noise impacts during this period.

The RNP and NCG require noise to be assessed at proposal opening and for a future design year, which is typically ten years after opening. For this proposal, the opening year is 2026 and the future design year is 2036.

Other sensitive land uses

Several other sensitive non-residential land uses have been identified in the study area. The noise criteria for these receivers are shown in Table 6-41. The NCG does not consider commercial and industrial receivers as being sensitive to operational airborne road traffic noise impacts.

Table 6-41 NCG criteria for other sensitive receivers

Type of proposal / land use	Assessment criteria (dBA)		Additional considerations
	Daytime (7am to 10pm)	Night time (10pm to 7am)	
School classrooms	$L_{Aeq(1\ hour)}$ 40 (internal)1	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Hospital wards	$L_{Aeq(1\ hour)}$ 35 (internal)	$L_{Aeq(1\ hour)}$ 35 (internal)	
Places of worship	$L_{Aeq(1\ hour)}$ 40 (internal)1	$L_{Aeq(1\ hour)}$ 40 (internal)1	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise.
Open space (active use)	$L_{Aeq(15\ hour)}$ 60 (external)	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open space (passive use)	$L_{Aeq(15\ hour)}$ 55 (external)	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg playing chess, reading).
Child care facilities	Sleeping rooms $L_{Aeq(1\ hour)}$ 35 (internal)1 Indoor play areas $L_{Aeq(1\ hour)}$ 40 (internal)1 Outdoor play areas $L_{Aeq(1\ hour)}$ 55 (internal)	-	Multipurpose spaces (eg shared indoor play/sleeping rooms) should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	-	-	The criteria for residential land uses should be applied to these facilities.

Note 1: The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation.

Noise mitigation

The Transport Noise Mitigation Guideline (NMG) provides guidance in managing and controlling road traffic noise and describes the principles to be applied when reviewing noise mitigation. The NMG recognises that the NCG criteria are not always practicable and that it is not always feasible or reasonable to expect that they are achieved.

As proposals progress through the early design stages, various road design features are evaluated to assist with minimising road traffic noise such as adjustments to the vertical and horizontal alignments, road gradient modifications, and traffic management.

Following use of the above measures, site specific 'additional noise mitigation measures' are then required to be investigated for receivers which have residual exceedances of the criteria. When evaluating if a receiver qualifies for consideration of 'additional noise mitigation measures' the NMG considers how far above the criterion the noise level is and also how much a proposal increases noise levels.

The NMG provides three triggers where a receiver may qualify for consideration of 'additional noise mitigation' (beyond the use of 'integrated noise reduction measures'). These are:

- Trigger 1 – the predicted 'Build' noise level exceeds the NCG controlling criterion and the noise level increase due to the proposal (ie the noise predictions for the 'Build' minus the 'No Build') is greater than 2.0 dB
- Trigger 2 – the predicted 'Build' noise level is five decibels or more above the NCG controlling criterion (ie exceeds the cumulative limit) and the receiver is significantly influenced by proposal road noise, regardless of the incremental impact of the proposal
- Trigger 3 – the noise level contribution from the road proposal is acute (daytime LAeq(15hour) 65 dBA or higher, or night-time LAeq(9hour) 60 dBA or higher) even if noise levels are controlled by a non-proposal road.

For receivers that qualify for consideration of 'additional noise mitigation', potential noise mitigation measures are to be considered in the following order of preference:

- At-source mitigation such as quieter road pavement surfaces
- In-corridor mitigation such as noise mounds and noise barriers
- At-receiver mitigation including at-property treatments.

Potential road traffic noise impacts on the surrounding road network

Where a proposal results in traffic redistribution, noise impacts can occur on the surrounding road network due to vehicles using different routes after the proposal is complete. The NCG criteria (see Table 6-40) are therefore to be applied to the surrounding road network where a road proposal generates an increase in road traffic noise of more than two decibels.

6.3.2 Existing environment

Existing noise levels in the study area are generally influenced by road traffic noise from the Great Western Highway, along with general rural and environmental noise.

Receivers in the study area are typically sparsely distributed rural residential properties with a small number of commercial properties at various points along the alignment. Receivers are relatively close to the alignment along the length of the proposal although they are generally few in number.

The assessment uses several Noise Catchment Areas (NCAs) that reflect the land uses in the study area and the existing background noise levels and the likely impacts from the proposal. These are shown in Figure 6-7.

Receivers potentially sensitive to noise and vibration have been categorised as residential dwellings, commercial/industrial buildings, or 'other sensitive' land uses which include hotels, educational facilities and childcare centres.

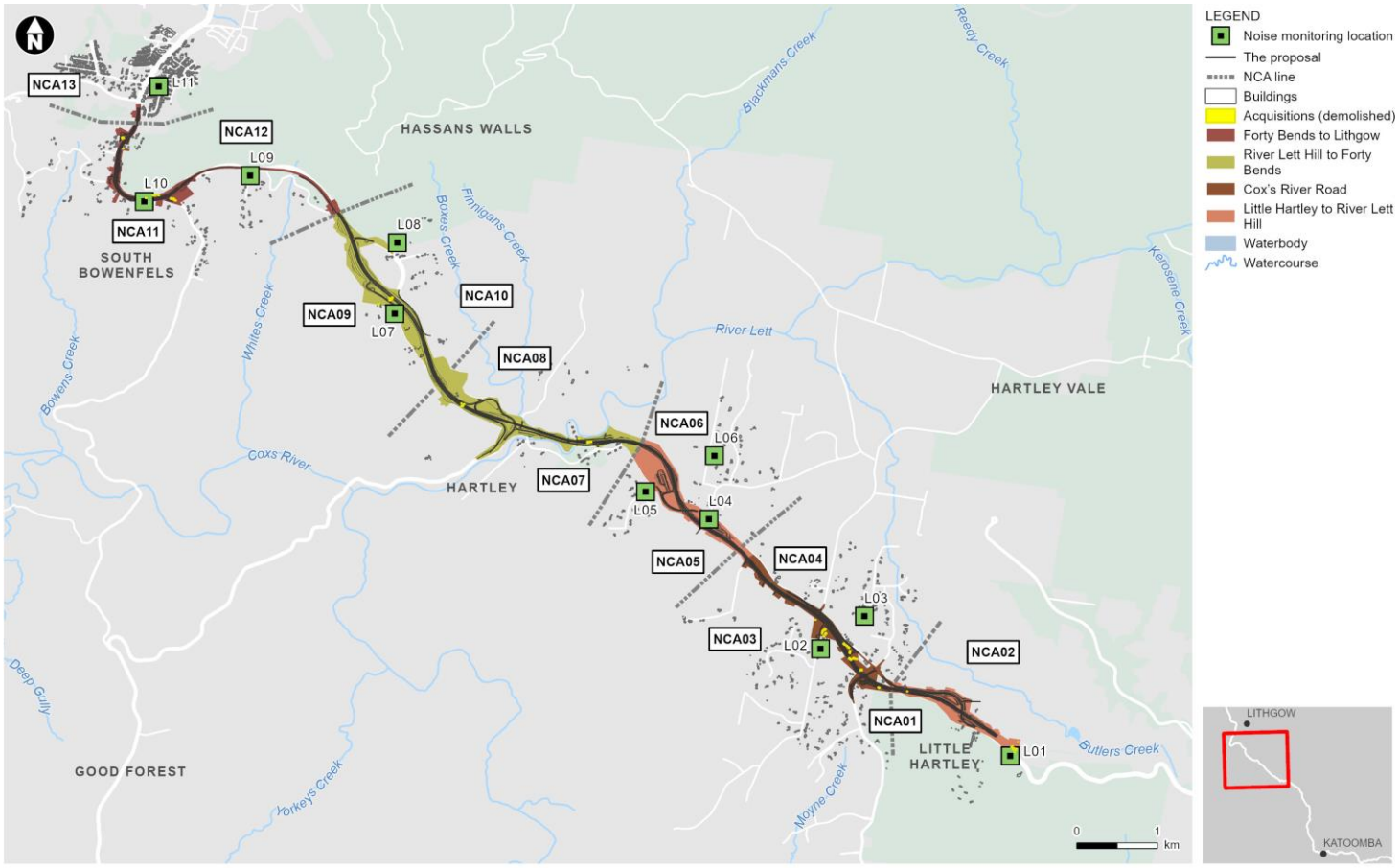


Figure 6-7 Noise catchment areas and noise monitoring locations

Noise monitoring

Long term unattended noise monitoring was completed in the study area between March and May 2021. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal. The measured existing noise levels are representative of the background noise levels at receivers that would likely be most affected by the construction and operation of the proposal in each NCA. Traffic volumes during the monitoring period are considered to be representative of normal conditions and were not adversely affected by COVID 19.

Table 6-42 Summary of unattended noise monitoring results

Ref	Address	Measured noise level (dBA)							
		Construction[1]						Operational[2]	
		Background (RBL)			Average noise (LAeq)			Average noise (LAeq)	
		Day	Eve	Night	Day	Eve	Night	Day	Night
L01	2138 GWH, Little Hartley	47	41	30	61	61	59	60	57
L03	1 Dicker Drive, Little Hartley	41	37	30	51	48	48	-	-
L04	2509 GWH, Hartley	45	40	30	69	66	65	68	65
L05	15 Wheeler Place, Hartley	43	41	32	54	55	52	55	53
L06	39B Franks Place, Hartley	35 (34)[3]	35 (37)[4]	32	46	48	42	-	-

Ref	Address	Measured noise level (dBA)							
		Construction[1]						Operational[2]	
		Background (RBL)			Average noise (LAeq)			Average noise (LAeq)	
		Day	Eve	Night	Day	Eve	Night	Day	Night
L07	3033 GWH, Hartley	45	40	34	60	58	57	60	58
L08	3110 GWH, Hartley[5]	42	42	-	51	53	-	52	-
L11	15 Robinia Drive, South. Bowenfels	42	33	30	52	47	44	-	-

Note 1: Construction noise is assessed during the daytime which is 7 am to 6 pm, the evening which is 6 pm to 10 pm and the night-time which is 10 pm to 7 am. See the NSW EPA Interim Construction Noise Guideline.

Note 2: Operational road traffic noise is assessed during the daytime which is 7 am to 10 pm and the night-time which is 10 pm to 7 am. See the NSW EPA Road Noise Policy. Results correspond to the locations and days used for model validation, as detailed in Section 4.5.6.
Note 3: The monitored level was adjusted to match the minimum background level in the Noise Policy for Industry.

Note 4: The monitored evening level was reduced to match the daytime level as per guidance in the Noise Policy for Industry.

Note 5: Measurements influenced by insect noise during the night-time.

The residential NMLs for the proposal have been determined in accordance with the ICNG using the results from the unattended existing noise monitoring and are shown in Table 6-43.

Table 6-43 Residential receiver construction noise management levels

NCA	Monitoring location	Noise management level ($L_{Aeq(15minute)}$ - dBA				Sleep disturbance screening criteria (RBL+15 dB)
		Standard construction (RBL+10 dB)	Out of hours (RBL+5 dB)			
			Day	Evening	Night	
NCA01	L01	57	52	46	35	45
NCA02	L01	57	52	46	35	45
NCA03	L03	51	46	42	35	45
NCA04	L03	51	46	42	35	45
NCA05	L05	53	48	46	37	47
NCA06	L06	45	40	40	37	47
NCA07	L05	53	48	46	37	47
NCA08	L06	45	40	40	37	47
NCA09	L07	55	50	45	39	49
NCA10	L07	55	50	45	39	49
NCA11	L07	55	50	45	39	49
NCA12	L07	55	50	45	39	49
NCA13	L10	52	47	38	35	45

6.3.3 Potential impacts

Construction

Construction airborne noise impacts

This section provides an overview of the predicted worst-case noise impacts at the most affected receivers in each NCA for each scenario where construction equipment is at the closest point to each receiver. For most works, the construction noise impacts would frequently be lower than predicted as the worst-case situation is typically only apparent for a relatively short period when noisy equipment is in use nearby.

The following assessment shows the predicted noise impacts based on the exceedance of the NML, as per the categories shown in Table 6-44 which are taken from the CNVG.

Table 6-44 NML exceedance bands and corresponding subjective response to impacts

CNVG perception categories	Daytime – standard construction hours		Out of hours periods	
	Symbol	NML exceedance	Symbol	NML exceedance
Noticeable	·	-1	♦	1 to 5 dB
Clearly audible	●	1 to 10 dB	●	6 to 15 dB
Moderately intrusive	◆	11 dB to 20 dB	◆	16 dB to 25 dB
Highly intrusive	■	>20 dB	■	>25 dB

Residential receivers

A summary of the predicted construction noise impacts in each NCA for residential receivers is shown in Table 6-45. Detailed noise level predictions and summaries of the number of receivers predicted to have 'noticeable', 'clearly audible', 'moderately intrusive' and 'highly intrusive' impacts in each NCA are provided in Appendix F.

The predicted construction noise impacts are presented for the most affected receivers. Receivers which are further away from the works and/or shielded from view would have lower impacts. The assessment is generally considered conservative as the calculations assume several items of construction equipment are in use at the same time within individual scenarios. In reality, there would frequently be periods when construction noise levels are much lower than the worst-case levels predicted as well as times when no equipment is in use and no noise impacts occur.

Residential receivers are close to proposed construction in most catchments, however, they are generally sparsely distributed and only a relatively small number of receivers are predicted to be impacted. The highest impacts are expected to occur when noise intensive equipment such as rockbreakers, concrete saws, chainsaws or chippers are being used. These items of equipment would only, however, be required occasionally and would be unlikely to be in use for long periods of time.

The impacts during the daytime are predicted to be 'highly intrusive' or 'moderately intrusive' at the nearest receivers in several NCAs during some of the noisier scenarios such as site establishment, earthworks and utility works and road works.

Only certain work would be completed during the night-time, including work associated with the construction of bridges and road tie-in work where connections to the existing road network are necessary. The predicted night-time impacts vary from 'highly intrusive' to compliant with the NMLs depending on how

close the nearest receivers are. Only a relatively small number of receivers are predicted to have 'highly intrusive' impacts.

The worst-case noise levels are predicted to be around 85 to 90 dBA at the nearest receivers when noise intensive equipment is being used close to receivers. When noise intensive equipment is not used the noise levels are expected to be substantially lower, with worst-case levels of around 70 dBA predicted at the closest receivers. The worst-case predictions represent noise levels when work is near to a particular receiver. As work moves away to other parts of the proposal area the impacts would also substantially reduce.

Table 6-45 Predicted worst-case construction noise exceedances – residential receivers

Period	Construction scenario	L2R		CRR		L2R		R2F				F2L		
		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
Daytime	Pre-construction and early works	●	·	◆	■	·	■	◆	◆	●	·	◆	◆	◆
	Site establishment - peak	■	◆	■	■	◆	■	■	■	■	◆	■	■	■
	Site establishment - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Earthworks and utility works - peak	■	◆	■	■	◆	■	■	■	■	◆	■	■	■
	Earthworks and utility works - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Bridge construction - peak	●	●	◆	●	·	◆	◆	■	·	·	·	·	·
	Bridge construction - typical	·	·	●	·	·	●	·	◆	·	·	·	·	·
	Road works - peak	■	◆	■	■	◆	■	■	■	◆	◆	■	■	■
	Road works - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Road works OOHW - peak	◆	●	■	■	●	◆	◆	●	·	·	·	·	·
	Road works OOHW - typical	●	·	●	◆	·	●	·	·	·	·	·	·	·
	Finishing works	●	·	◆	■	·	■	◆	◆	●	·	◆	◆	◆
	Compounds – operations[1]	·	·	●	◆	·	●	·	·	·	·	·	·	·
Evening	Earthworks and utility works - typical	◆	●	◆	■	♦	■	◆	◆	●	●	■	■	■
	Bridge construction - peak	●	●	◆	●	●	◆	◆	■	·	·	·	·	·
	Bridge construction - typical	·	·	●	♦	·	●	●	◆	·	·	·	·	·
	Road works OOHW - peak	■	◆	■	■	◆	◆	◆	●	·	♦	·	·	·
	Road works OOHW - typical	◆	♦	◆	■	♦	●	●	·	·	·	·	·	·
	Compounds – operations[1]	●	·	◆	◆	♦	●	·	·	●	♦	●	·	·
Night-time	Earthworks and utility works - typical	■	◆	■	■	●	■	■	◆	◆	●	■	■	■
	Bridge construction - peak	◆	◆	■	◆	◆	■	■	■	·	♦	·	·	·
	Bridge construction - typical	●	●	◆	●	♦	●	◆	◆	·	·	·	·	·

Period	Construction scenario	L2R		CRR		L2R		R2F				F2L		
		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
	Road works OOHW - peak	■	■	■	■	■	■	■	●	♦	●	·	·	·
	Road works OOHW - typical	■	●	◆	■	●	●	●	·	·	·	·	·	·
	Compounds – operations[1]	◆	●	◆	■	●	●	●	♦	◆	●	●	♦	·

[1]Excludes batching plants. These will be assessed during detailed design once locations finalised.

Highly noise affected residential receivers

Residential receivers that are subject to noise levels of 75 dBA or greater are considered highly noise affected by the ICNG. The number of residential receivers which could potentially be highly noise affected during the worst-case impacts from the proposal are summarised in Table 6-46.

A relatively small number of the nearest residential receivers are predicted to be highly noise affected when noise intensive work is being carried out nearby. The highest noise levels would only likely be apparent for relatively short periods.

When work is being completed in other more distant parts of the proposal area (i.e. further from an individual receiver), the noise levels would be much lower.

Table 6-46 Predicted number of highly noise affected residential receivers

Construction scenario	L2R		CRR		L2R		R2F				F2L		
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
Pre-construction and early works	-	-	-	-	-	-	-	-	-	-	-	-	-
Site establishment - peak	4	-	4	4	-	2	3	1	2	2	12	6	6
Site establishment - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Earthworks and utility works - peak	4	-	4	4	-	2	3	1	2	2	12	6	6
Earthworks and utility works - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridge construction - peak	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridge construction - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Road works - peak	2	-	3	4	-	2	1	1	2	-	10	6	6
Road works - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Road works OOHW - peak	1	-	-	2	-	-	-	-	-	-	-	-	-
Road works OOHW - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-	-	-	-	-	-	-
Compounds - operations	-	-	-	-	-	-	-	-	-	-	-	-	-

Commercial, industrial and 'other sensitive' receivers

A summary of the predicted construction noise impacts in each NCA for commercial/industrial and other sensitive receivers is shown in

Table 6-47. 'Highly intrusive' or 'moderately intrusive' worst-case impacts are predicted at a small number of the nearest 'other sensitive' and commercial receivers when noisy work is being completed as part of the 'peak' scenarios, these include St Bernard's Presbytery and Saint John's Anglican Church in NCA07, and Bowenfels Presbyterian Church in NCA11.

Table 6-47 Overview of commercial, industrial and 'other sensitive' receivers NML exceedances

Construction scenario	Number of receiver buildings affected								
	Places of worship			Medical			Commercial / industrial		
	When in use			Daytime			When in use		
	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Pre-construction and early works	1	1	-	-	-	-	2	-	-
Site establishment - peak	-	2	1	-	-	-	5	4	1
Site establishment - typical	1	1	-	-	-	-	1	-	-
Earthworks and utility works - peak	-	2	1	-	-	-	5	4	1
Earthworks and utility works - typical	1	1	-	-	-	-	1	-	-
Bridge construction - peak	1	-	-	-	-	-	-	-	-
Bridge construction - typical	-	-	-	-	-	-	-	-	-
Road works - peak	1	1	1	-	-	-	4	3	1
Road works - typical	1	1	-	-	-	-	1	-	-
Road works OOHW - peak	-	-	-	-	-	-	2	1	-
Road works OOHW - typical	-	-	-	-	-	-	1	-	-
Finishing works	1	1	-	-	-	-	2	-	-
Compounds - operations	-	-	-	-	-	-	-	-	-
Key to impacts	Clearly audible			Moderately intrusive			Highly intrusive		

Sleep disturbance

A sleep disturbance screening assessment has been undertaken for the construction work and a summary is tabulated in Appendix F.

Review of the predictions shows that the sleep disturbance screening criterion is likely to be exceeded when night work occurs near residential receivers. The receivers which would potentially be affected by sleep disturbance impacts are generally similar receivers to where night-time impacts have been predicted (refer to Table 6-45).

Construction vibration impacts

The potential impacts during vibration intensive work have been assessed using the CNVG minimum working distances for cosmetic damage and human response. The assessment identifies structures which are within the minimum working distances based the construction scenarios with vibration intensive equipment as shown in Table 6-48.

Table 6-48 Vibration intensive equipment

Scenario	Vibration intensive equipment	Minimum working distances (metres)		
		Cosmetic damage	Heritage	Human comfort
Earthworks and utility works – peak	Excavator – breaker	22	44	73
	Vibratory roller (13-18 tonne)	20	40	100
Roadworks – peak	Vibratory roller (13-18 tonne)	20	40	100
Roadworks – typical	Vibratory roller (13-18 tonne)	20	40	100

Buildings and heritage items within the minimum working distances are shown in Figure 6-8 to Figure 6-11. Certain receivers near to the work are likely to be within the minimum working distances for cosmetic damage and mitigation will be required to be considered. Buildings in other parts of the study area are generally sufficiently distant to be outside the minimum distance.

Certain receivers in the study area are also within the human comfort minimum working distances and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby.

Several heritage items or areas are within the minimum working distance for heritage items (i.e. 44 m). The potential impacts at heritage items should be reviewed as the proposal progresses when detailed construction planning information is available.

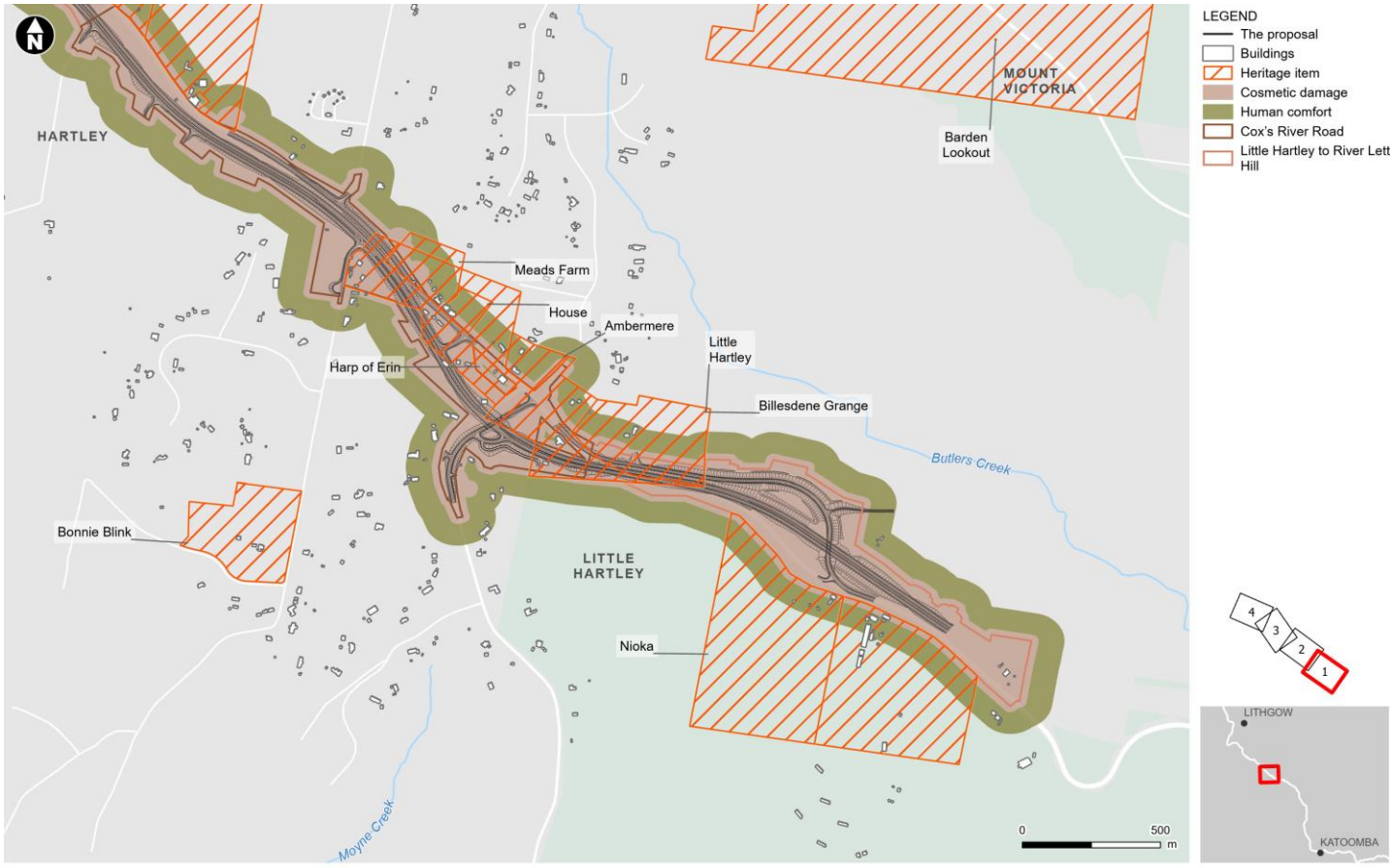


Figure 6-8 Construction vibration assessment – Little Hartley to River Lett and Coxs River Road

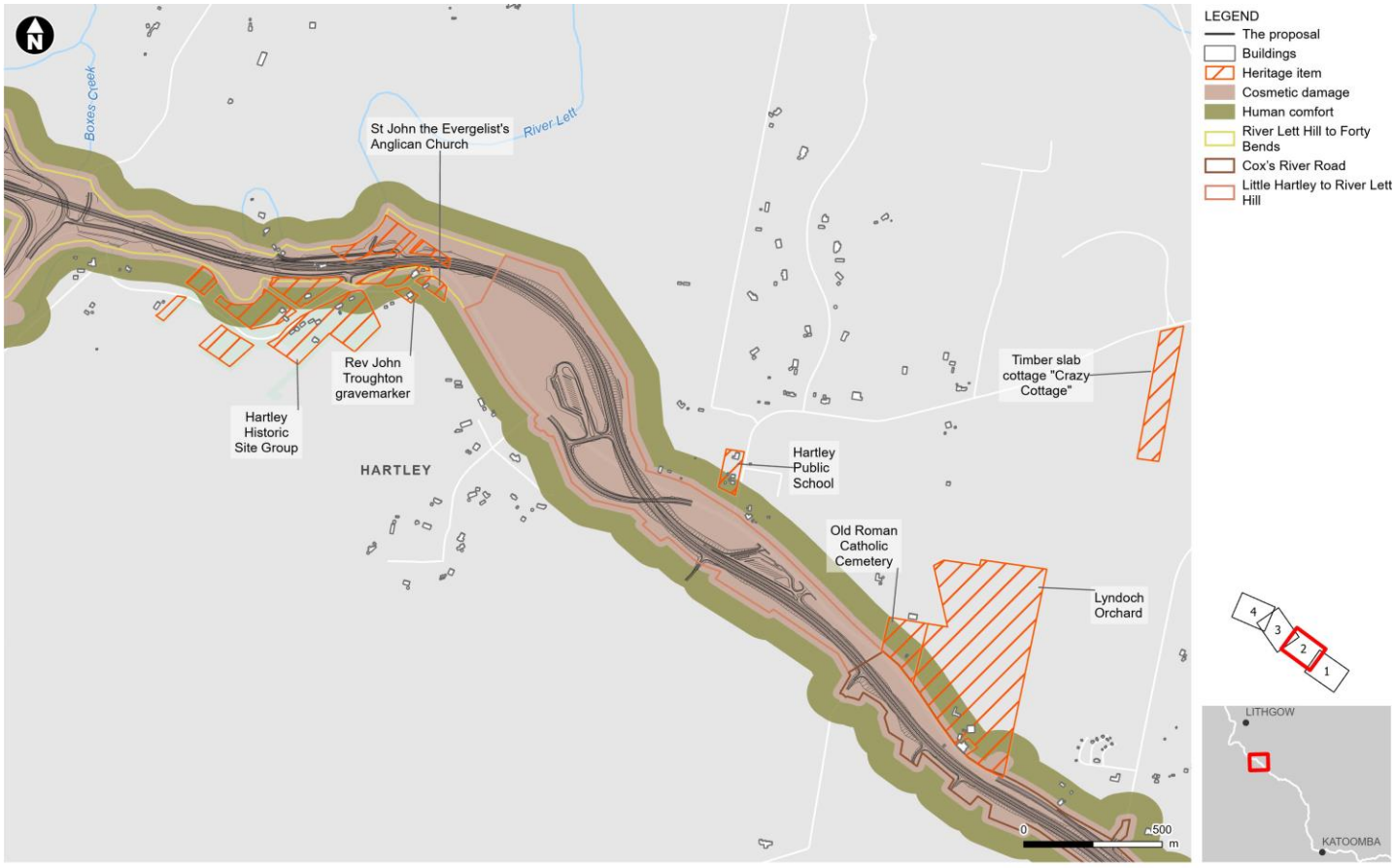


Figure 6-9 Construction vibration assessment – Little Hartley to River Lett and Coxs River Road

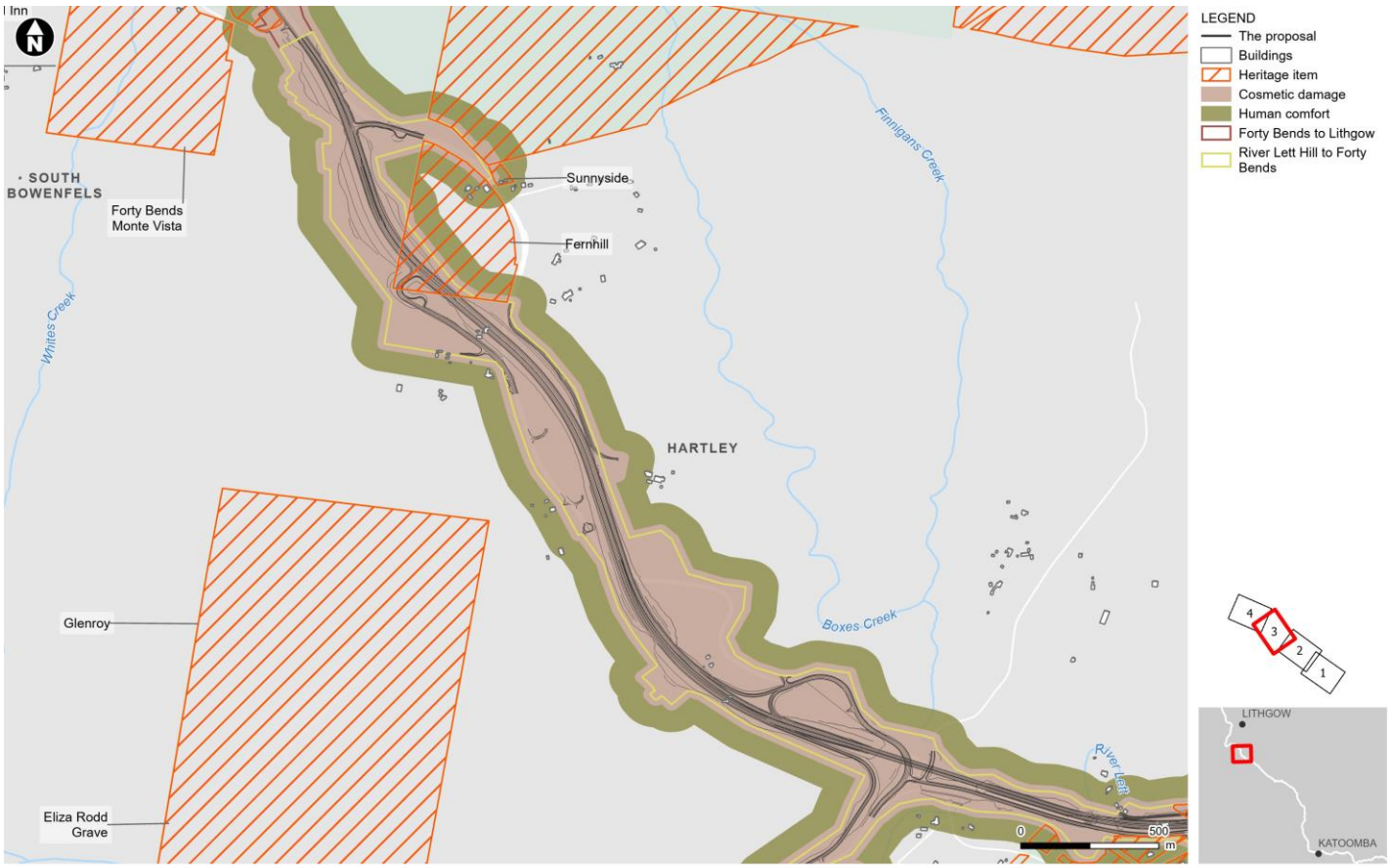


Figure 6-10 Construction vibration assessment – River Lett to Forty Bends

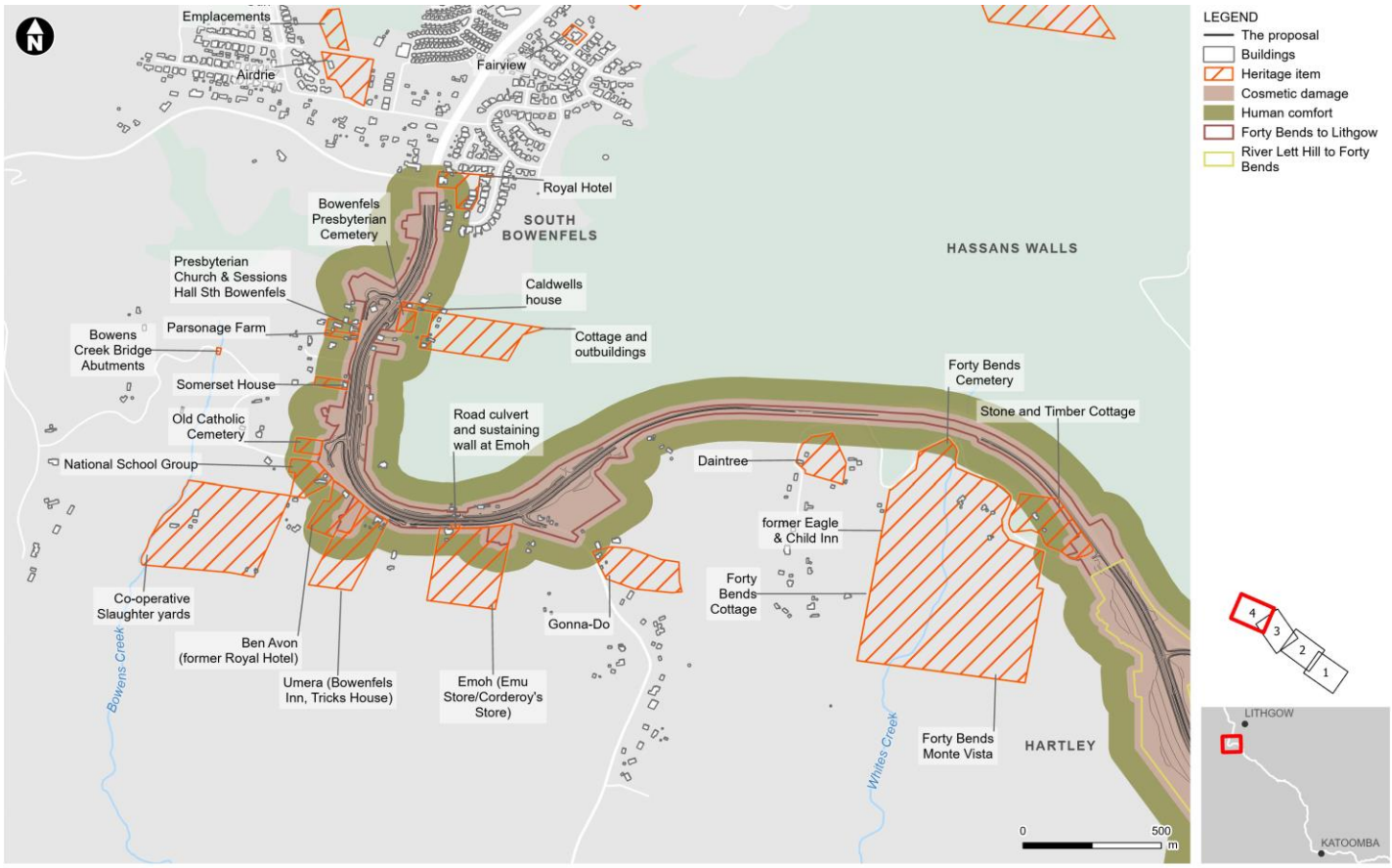


Figure 6-11 Construction vibration assessment – Forty Bends to Lithgow

Construction traffic noise impacts

Construction traffic is not expected result in a noticeable increase in traffic noise (i.e. more than a two decibel increase in existing traffic noise).

Blasting

Minimum working distances for blasting have been determined (see Section 6.3.1). Buildings within the minimum working distances are shown in Figure 6-12.

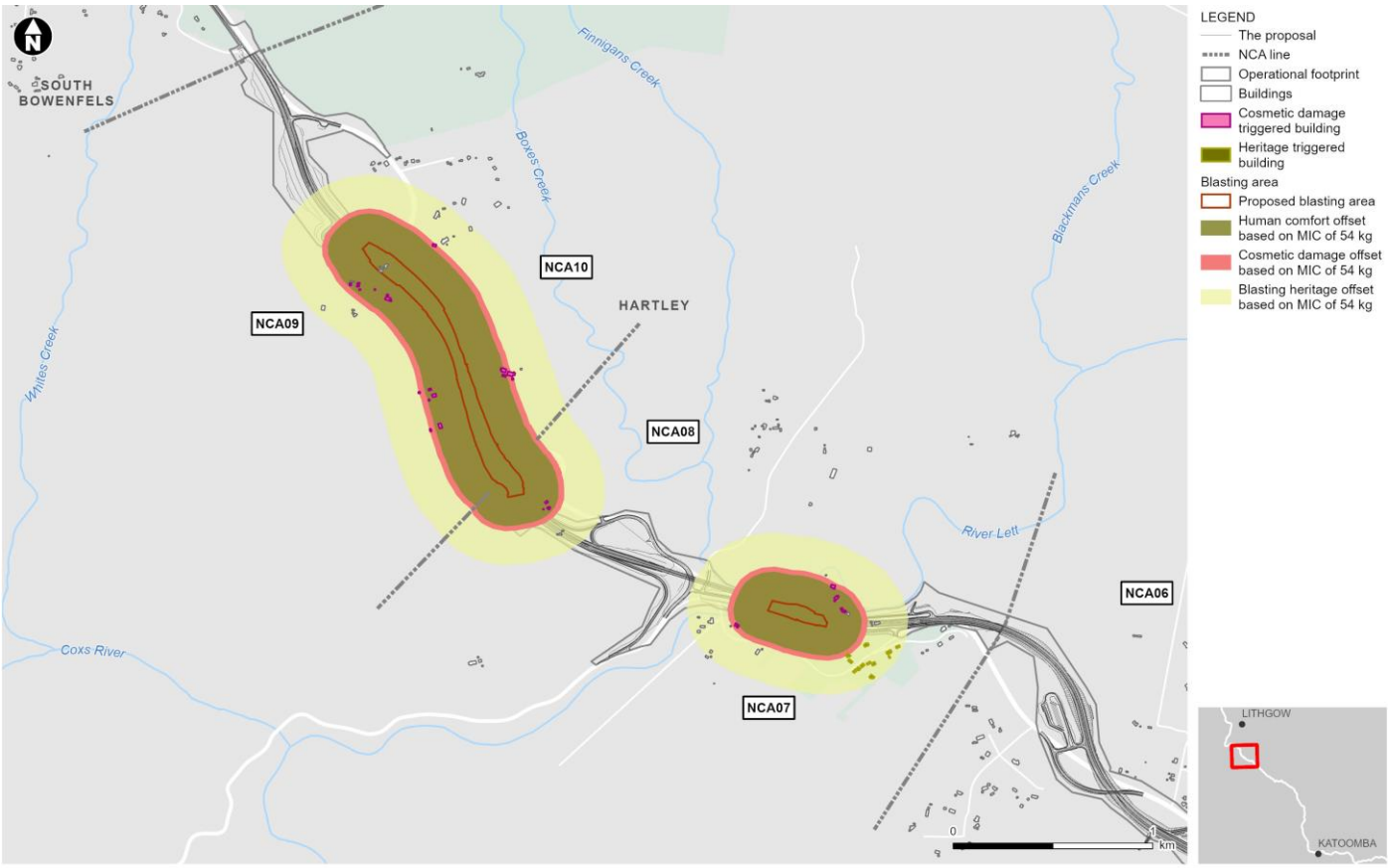


Figure 6-12 Buildings within the blasting minimum working distances

Twenty-seven buildings are within 170 metres of the proposed blasting location and have the potential to be impacted by structural damage and human comfort associated with blasting based on an MIC of 54Kg. Thirteen heritage items or areas are within 340 metres of the proposed blasting location. Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound.

There is also the potential for flyrock to impact areas up to 500 metres from the point of each blast. Flyrock refers to rock that flies beyond the blast site, with the potential to cause injuries to people and damage to property. A flyrock management plan would be developed in consultation with technical specialists prior to construction and would consider measures including temporary evacuation of residents, timing of blasting to minimise disruption to local residents, and use of blast mats and soil cover.

Operation

Operation airborne noise impacts

Residential receivers

The predicted operational road traffic noise levels at residential receivers are summarised in Table 6-49 for the 2026 at opening and 2036 future design scenarios. The table shows the worst-case impacts in each NCA, which are typically experienced by the receivers nearest to the proposal.

Receivers are generally most affected by the proposal in the night-time period in 2036 (due to higher traffic volumes) with respect to the NCG criteria and NMG triggers, and this scenario is considered to control the assessment in terms of determining the worst-case impacts and requirements for mitigation.

The nearest receivers to the proposal are subject to relatively high existing road traffic noise levels, which already exceed the NCG criterion in many cases.

The proposal is predicted to alter operational road traffic noise levels for many receivers in the study area due to the revised alignment of the Great Western Highway. Noise levels are predicted to reduce in locations where the alignment is proposed to be moved away from receivers, however, the alignment is closer in some locations and noise levels are predicted to increase in these areas. Increases of greater than two decibels are predicted at certain receivers in NCA02, NCA03, NCA07, NCA08 and NCA12 where the alignment moves substantially closer.

Exceedances of the NCG cumulative limit criteria (i.e. five decibels or more above the NCG controlling criterion described in Section 6.3.1) are predicted at the nearest receivers in all NCAs, except NCA05, NCA09 and NCA10.

Receivers adjacent the alignment in NCA04, NCA07, NCA08, NCA11, NCA12 and NCA13 are also predicted to be subject to acute noise levels (i.e. daytime noise levels are 65 dBA or higher, or night-time noise levels are 60 dBA or higher).

In summary, the proposal is predicted to result in:

- 15 residential receivers experiencing increases in traffic noise of greater than two decibels
- 37 residential receivers experiencing noise levels above the cumulative limit criteria
- 20 residential receivers experiencing acute noise levels
- In total, 44 residential receivers are considered eligible for consideration of additional noise mitigation, as per the operational road traffic noise criteria.

Table 6-49 Predicted road traffic noise levels at most affected residential receivers in each NCA

NCA	Predicted noise level (dBA)								Number of NMG triggered buildings			
	At opening (2020)				Future design (2036)							
	No build		Build		No build		Build		Trig. 1	Trig. 2	Trig. 3	Total
	Day	Night	Day	Night	Day	Night	Day	Night	>2.0dB	Cumul.	Acute	
NCA01	69	65	63	59	69	65	63	59	-	1	-	1
NCA02	60	56	59	55	61	57	60	56	1	1	-	2
NCA03	59	55	61	57	59	55	61	57	5	3	-	5
NCA04	72	68	63	60	73	69	64	60	-	6	3	6
NCA05	60	56	53	49	60	56	54	50	-	-	-	-

NCA	Predicted noise level (dBA)								Number of NMG triggered buildings			
	At opening (2020)				Future design (2036)							
	No build		Build		No build		Build		Trig. 1	Trig. 2	Trig. 3	Total
	Day	Night	Day	Night	Day	Night	Day	Night	>2.0dB	Cumul.	Acute	
NCA06	66	62	60	56	67	63	60	57	-	1	-	1
NCA07	68	64	69	65	69	65	69	65	4	8	2	11
NCA08	45	41	66	62	46	42	67	63	4	3	1	4
NCA09	66	62	53	50	67	63	54	50	-	-	-	-
NCA10	61	57	54	50	61	57	54	50	-	-	-	-
NCA11	72	68	69	65	72	68	70	66	-	4	4	4
NCA12	70	66	72	68	70	66	72	68	1	5	5	5
NCA13	68	64	68	64	69	65	69	65	-	5	5	5
Total												44

Note 1: Daytime and night-time are LAeq(15hour) and LAeq(9hour) noise levels, respectively.

Other sensitive receivers

Other sensitive receivers that are predicted to have exceedances of the trigger levels are shown in Table 6-50. Three other sensitive receiver buildings are predicted to have exceedances of the operational road traffic noise criteria.

Table 6-50 Other sensitive receiver triggers

NCA	Receiver	Floor	Type	NCA Triggers		
				Trigger 1	Trigger 2	Trigger 3
				>2.0 dB	Cumulative	Acute
NCA07	St Bernard's Presbytery	1	Place of worship	-	Y	-
	Saint John's Anglican Church	1	Place of worship	-	Y	-
NCA11	Bowenfels Presbyterian Church	1	Place of worship	-	Y	Y

Maximum road traffic noise levels

As the proposal would widen and realign certain roads there is potential for changes to maximum noise level events in the study area due to vehicles being closer to adjacent receivers. A summary of the predicted changes is provided in

Table 6-51.

While receivers are not triggered for consideration of 'additional noise mitigation' by maximum noise levels alone, the selection of feasible and reasonable mitigation measures should consider the potential change in maximum noise levels and the effect the potential mitigation would have on those levels.

Table 6-51 Predicted change in maximum noise levels

NCA	Worst-case change (dB)	Discussion
NCA1	0	Negligible change in maximum noise levels predicted in this NCA, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA2	7	Maximum noise levels are predicted to increase by up to 7 dB at receivers in the eastern area of this NCA due to the new road alignment being nearer than the existing highway. Maximum noise levels at receivers in the west of this NCA which are closer to the existing highway are predicted to increase by up to 1 dB.
NCA3	9	Maximum noise levels are predicted to increase by up to 9 dB at the nearest receivers to the new carriageway near Coxs River Road, due to previously unexposed facades being affected. Maximum noise levels at other receivers where the new Great Western Highway is closer than the existing highway are predicted to increase by up to 3 dB.
NCA4	10	Maximum noise levels are predicted to increase by up to 10 dB at receivers between the existing highway and the new Great Western Highway, due to previously unexposed facades being affected. Negligible change in maximum noise levels predicted at the other receivers, however, the number of events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA5	0	Negligible change in maximum noise levels predicted at receivers in this NCA, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away. The proposed truck rest areas may introduce additional impacts and maximum noise levels from events such as truck airbrake releases. Noise levels and maximum events are, however, expected to generally be louder from the realigned Great Western Highway.
NCA6	3	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels predicted at receivers where the existing highway is closer than the new Great Western Highway, however, the number of high-level events would reduce due to traffic transferring to the new carriageway which is further away. The proposed truck rest areas may introduce additional impacts and maximum noise levels from events such as truck airbrake releases. Noise levels and maximum events are, however, expected to generally be louder from the realigned Great Western Highway.
NCA7	4	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA due to alignment and elevation changes of the new Great Western Highway relative to the existing highway.

NCA	Worst-case change (dB)	Discussion
NCA8	6 (28)	Maximum noise levels are predicted to increase by up to 6 dB at receivers in this NCA due to alignment and elevation changes of the new Great Western Highway. A small number of receivers to the west of Jenolan Caves Road have previously unexposed facades that are predicted to have large increases of greater than 20 dB due to the new road alignment.
NCA9	3	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels is predicted at receivers where the existing highway is closer than the new Great Western Highway, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA10	6	Maximum noise levels are predicted to increase by up to 6 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels is predicted at receivers where the existing highway is closer than the new Great Western Highway (including those in-between the new carriageway and existing highway), however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA11	2	Maximum noise levels are predicted to increase by up to 2 dB at receivers in this NCA which are close to areas where the existing highway is widened. Negligible change in maximum noise levels is predicted at receivers further from the alignment and those where widening occurs on the opposite side of the highway.
NCA12	4	Maximum noise levels are predicted to increase by up to 4 dB at receivers in this NCA which are close to areas where the existing highway is widened. Negligible change in maximum noise levels is predicted at receivers further from the alignment and those where widening occurs on the opposite side of the highway.
NCA13	0	Negligible change in maximum noise levels predicted in this NCA.

Receivers eligible for consideration of additional noise mitigation

The receivers which have been identified as eligible for consideration of ‘additional noise mitigation’ (ie triggered receivers) in Table 6-49 and Table 6-50 above are shown in Figure 6-13 to Figure 6-16.

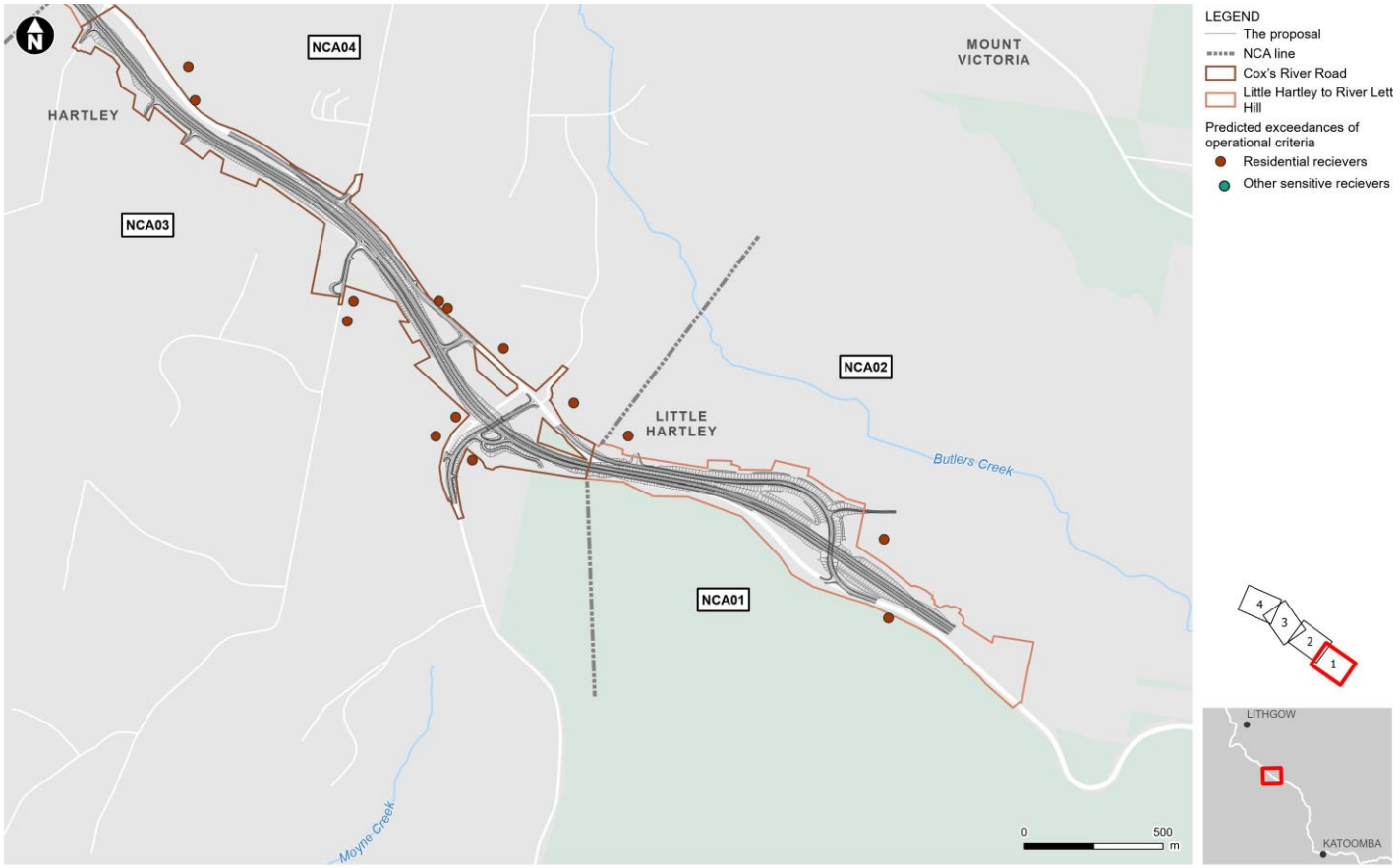


Figure 6-13 Receivers eligible for consideration of additional mitigation – Little Hartley to River Lett and Coxs River Road

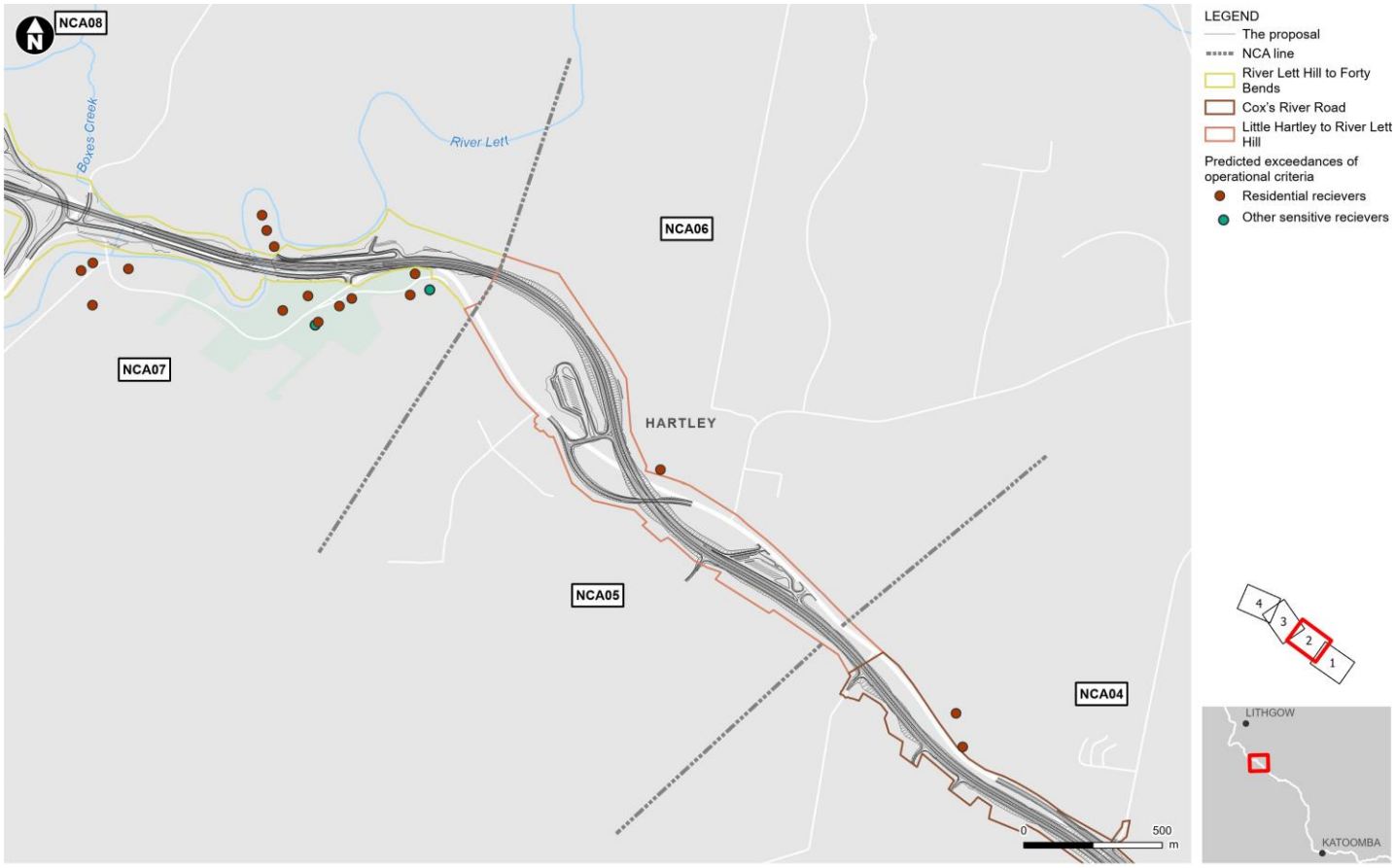


Figure 6-14 Receivers eligible for consideration of additional mitigation - Little Hartley to River Lett to River Lett to Forty Bends

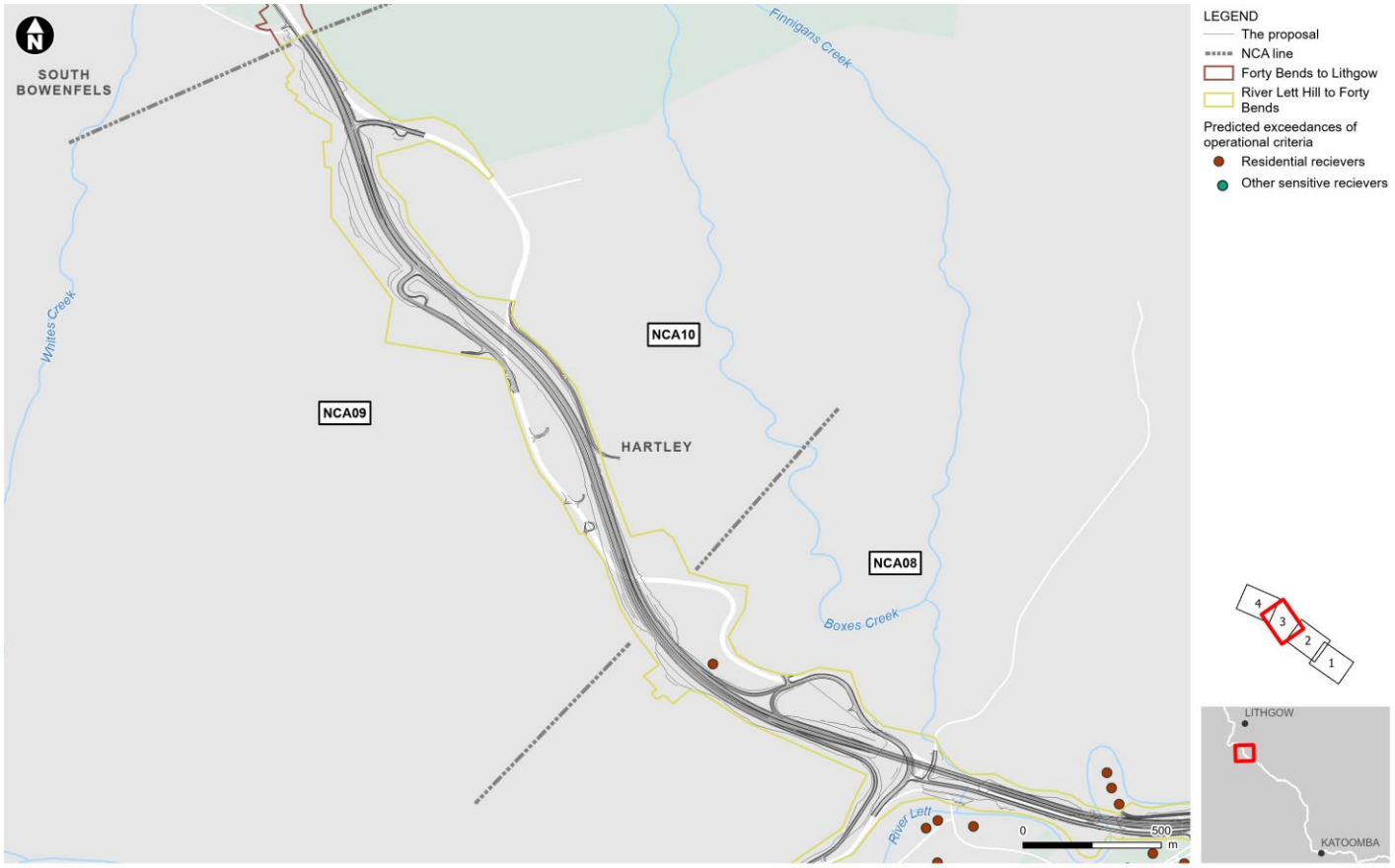


Figure 6-15 Receivers eligible for consideration of additional mitigation – River Lett to Forty Bends

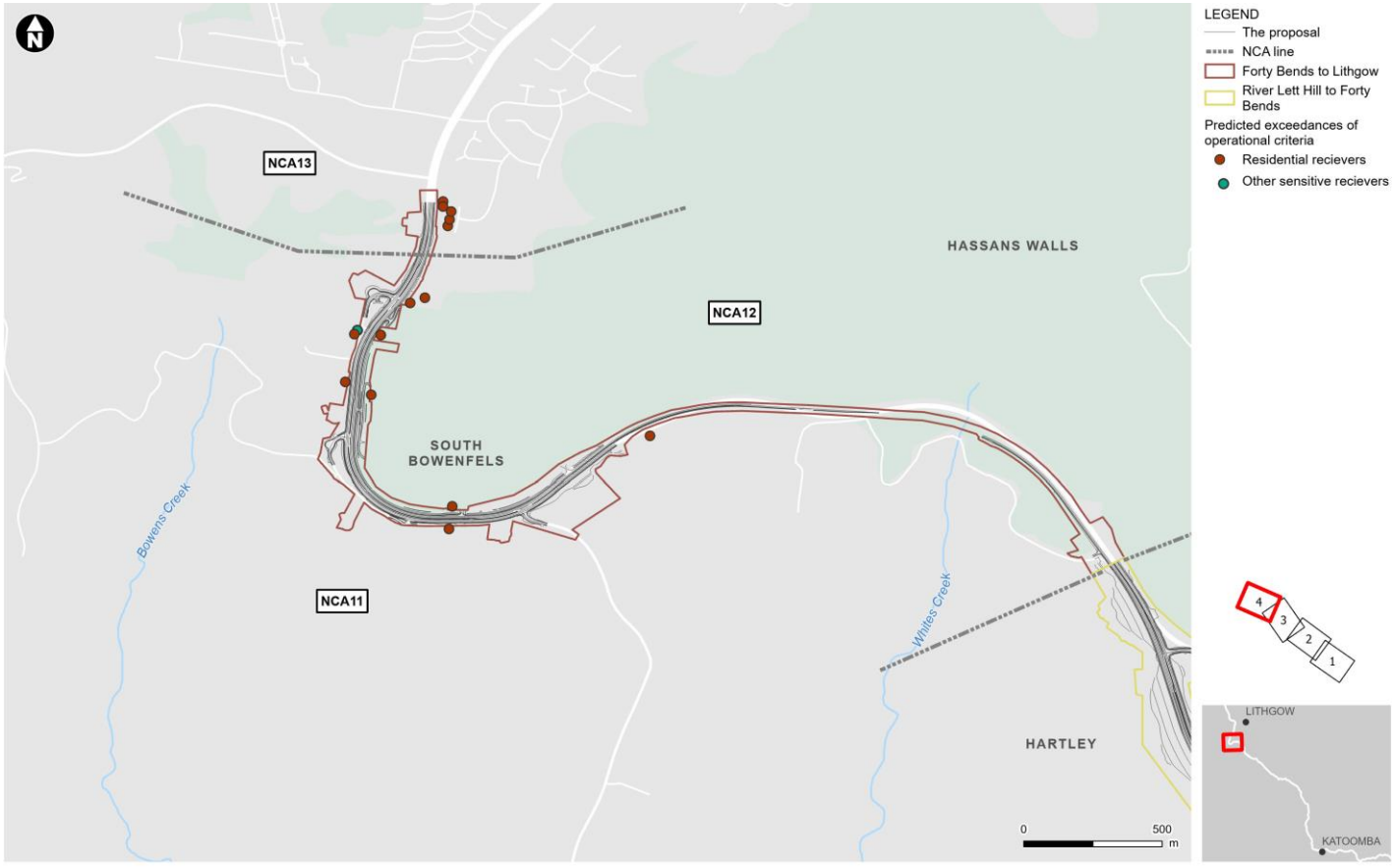


Figure 6-16 Receivers eligible for consideration of additional mitigation – Forty Bends to Lithgow

6.3.4 Safeguards and management measures

The Transport Construction Noise and Vibration Guideline (CNVG) contains a number of 'standard mitigation measures' for mitigating and managing construction impacts. The measures would be applied to construction of the proposal, where feasible and reasonable.

Where noise impacts remain after the use of 'standard mitigation measures', the CNVG requires the use of 'additional mitigation measures' where feasible and reasonable. The 'additional mitigation measures' are determined on the basis of the exceedance of the appropriate management levels and range from notifications, phone calls, individual briefings, respite periods, to in some cases alternative accommodation.

Proposal specific noise and vibration mitigation measures are provided in Table 6-52.

Table 6-52 Safeguards and management measures – traffic and transport

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
NV01	Construction noise and vibration management plan	A Construction Noise and Vibration Management Plan should be prepared before any work begins which would include: • Identification of nearby sensitive receivers • Description of works, construction equipment and hours work would be completed in • Criteria for the proposal and relevant licence and approval conditions • Requirements for noise and vibration monitoring • Details of how community consultation would be completed • Procedures for handling complaints • Details on how respite would be applied where ongoing high impacts are seen at certain receivers.	Contractor	Prior to construction	Appendix F	All
NV02	Construction noise and vibration assessments	Location and activity specific noise and vibration impact assessments should be	Contractor	Prior to construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		carried out prior to (as a minimum) activities: • With the potential to result in noise levels above 75 dBA at any receiver • Required outside Standard Construction Hours likely to result in noise levels in greater than the relevant Noise Management Levels • With the potential to exceed relevant criteria for vibration. The assessments should confirm the predicted impacts at the relevant receivers in the vicinity of the activities to aid the selection of appropriate management measures, consistent with the requirements of the CNVG.				
NV03	Construction noise exceedances	The assessment has identified that 'highly intrusive' impacts are likely at the nearest receivers when noise intensive equipment such as concrete saws or rockbreakers are in use, especially during evening and night-time periods. Where noise intensive equipment is to be used near sensitive receivers, the work should be scheduled for Standard Construction Hours, where possible. If it is not possible to restrict the work to the daytime then they should be completed as early as possible in each work shift. Appropriate respite should also be provided	Contractor	Construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		to affected receivers in accordance with the CNVG and/or the proposal's conditions of approval.				
NV04	Compounds noise	Hoarding, or other shielding structures, should be used where receivers are impacted near compounds or fixed work areas with long durations. To provide effective noise mitigation, the barriers should break line-of-sight from the nearest receivers to the work and be of solid construction with minimal gaps.	Contractor	Construction	Appendix F	All
NV05	Vibration – monitoring	Monitoring should be carried out at the start of noise and/or vibration intensive activities to confirm that actual levels are consistent with the predictions and that appropriate mitigation measures from the CNVG have been implemented.	Contractor	Construction	Appendix F	All
NV06	Construction traffic	The potential impacts from construction traffic should be reviewed at a later stage when more information is available.	Contractor	Prior to construction	Appendix F	All
NV07	Vibration work within minimum working distance	Where work is within the minimum working distances and considered likely to exceed the cosmetic damage criteria: • Different construction methods with lower source vibration levels should be investigated and implemented, where feasible	Contractor	Construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Attended vibration measurements should be undertaken at the start of the work to determine actual vibration levels at the item. Work should be ceased if the monitoring indicates vibration levels are likely to, or do, exceed the relevant criteria.				
NV08	Vibration work within minimum working distance	Certain receivers in the study area are within the human comfort minimum working distance and occupants of affected buildings may be able to perceive vibration impacts when vibration intensive equipment is in use. The potential human comfort impacts and requirement for vibration intensive work should be reviewed as the proposal progresses.	Contractor	Prior to construction	Appendix F	All
NV09	Vibration impacts on structures	Building condition surveys should be completed before and after the work where buildings or structures are within the minimum working distances and considered likely to exceed the cosmetic damage criteria during the use of vibration intensive equipment and/or blasting activities.	Contractor	Prior to construction	Appendix F	All
NV10	Blasting	The following is recommended to be considered to manage impacts during blasting: • A blast management plan should be prepared prior to the start of blasting	Contractor	Prior to construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Trial blasts should be undertaken when blasting is proposed to occur within the minimum working distances • Monitoring of overpressure and vibration levels should be undertaken at the potentially most affected receivers for each blast • Notification of all potential affected receivers should occur at least 24 hours prior to blasting.				
NV11	Blasting	A Flyrock Management Plan would be developed to manage the potential impacts of flyrock during blasting. This would be developed in consultation with technical specialists. Management measures to be considered would include: • Implementing a minimum clearance distance of 500 metres to non-construction personnel • Temporary evacuation of residents within a 150 metre radius of each planned blast • Timing of blasting to minimise disruption to local residents • Use of blast mats and soil cover.’	Contractor	Prior to construction	Appendix F	All
NV12	Operational road traffic noise mitigation measures	As proposals progress through the early design stages, road design features will be evaluated to minimise	Contractor	Detailed design	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		road traffic noise where necessary. This would include: • Adjustments to vertical and horizontal alignments • Road gradient modifications • Traffic management • Cost effective use of won proposal spoil to provide landscape mounds where there is suitable site footprint.				
NV13	Operational road traffic noise mitigation measures	Where it is determined that receivers would still have residual exceedances of the Noise Criteria Guideline criteria, site specific 'additional noise mitigation measures would be required. For receivers that qualify for consideration of 'additional noise mitigation', potential noise mitigation measures are to be considered in the following order of preference: • At-source mitigation such as quieter road pavement surfaces • In-corridor mitigation such as noise mounds and noise barriers • At-receiver mitigation including at-property treatments.	Contractor	Prior to construction	Appendix F	All

Other safeguards and management measures that would address noise and vibration impacts are identified in Section 6.5 Non-Aboriginal heritage.

6.4 Aboriginal heritage

This section provides a summary of the assessment of potential impacts to Aboriginal heritage during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of Aboriginal heritage impacts is presented in the Aboriginal cultural heritage assessment report (ACHAR) (Appendix G). This assessment covers the entirety of the Great Western Highway Upgrade Program (Katoomba to Lithgow) and not just the proposal (Little Hartley to Lithgow).

6.4.1 Methodology

The Aboriginal heritage assessment involved the following:

- Desktop assessment of the environmental context, local and regional character of Aboriginal land-use, and the development of a predictive model for Aboriginal site distribution
- Desktop assessment of AHIMS registered sites, other heritage databases and an examination of previous Aboriginal cultural heritage investigations
- Consultation with registered Aboriginal parties in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010) undertaken from November 2019 until July 2021
- Archaeological survey of the construction site conducted between November 2019 and March 2020 with representatives from Aboriginal stakeholder groups to locate previously identified Aboriginal heritage sites and any unidentified Aboriginal heritage sites
- Archaeological assessment including field inspection and test excavation carried out in accordance with the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW. The purpose of the test excavations was to confirm whether Aboriginal objects were present in the subsurface soils in a site or PAD, and if so to provide information about the type, extent of site boundary and density of Aboriginal cultural materials.
- Assessment of cultural heritage significance values of Aboriginal sites in and near the study areas
- An assessment of impacts to the Aboriginal heritage significance values of any Aboriginal sites
- Identification of mitigation measures to minimise adverse impacts to the heritage significance of Aboriginal sites, including archaeological investigation

6.4.2 Existing environment

Aboriginal context

The Forty Bends construction footprint is located close to the traditional boundaries of the Wiradjuri, Gundungurra and Darug people and within the boundaries of the Bathurst Local Aboriginal Land Council (LALC). The exact boundaries are not known and it is suggested that instead of a fixed boundary there was actually a ‘zone of interaction’ between the Wiradjuri, the Darug and the Gundungurra people (Jacobs, 2020). The Wiradjuri, Gundungurra and Darug all had their own language although the three nations could communicate with each other. They each had their own distinct spiritual beliefs and creation stories. Each nation moved within their defined territories according to the seasons, along well established pathways.

A variety of resources were utilised by Aboriginal groups within the upper Blue Mountains. Basalt is available as water-rolled pebbles in the Grose River, and other major streams. Chert is another raw material known to be used for tool use. Chert is a glossy, fine-grained siliceous stone which was often used to create knives, scrapers, and points due to the sharp edge it can create.

Aboriginal cultural heritage register searches

A search of the State Heritage Register (SHR) for Aboriginal sites located within the Upper Blue Mountains region was carried out in July 2021. No sites were identified within the study corridor.

A search of Aboriginal sites and places listed in Schedule 5 of the Blue Mountains 2015 LEP and Lithgow 2014 LEP within a one-kilometre radius of the operational footprint was carried out in July 2021. No Aboriginal sites or places identified within a one-kilometre search radius.

A search of the National Native Title Register was conducted in November 2019. The search identified that there are two native title claimants or native title holders within the construction footprint. These include:

- Native Title claim NC2018/002 Warrabinga-Wiradjuri #7
- Land use Agreement NI2014/001 - Gundungurra Area Agreement.

A search of Aboriginal objects, sites, and places registered on the Aboriginal Heritage Information Management System (AHIMS) within 100 meters of the Great Western Highway Upgrade Program was completed in July 2021. The search identified 36 previously registered Aboriginal sites or areas of Potential Archaeological Deposits (PAD) within 50 metres of the Great Western Highway Upgrade Program, consisting of:

- 20 isolated artefacts
- One modified trees (carved or scarred)
- Seven open camp sites
- One isolated artefact and modified tree (carved or scarred)
- Six habitation structures (rockshelters), and PAD
- One habitation structure (rockshelter), PAD, and modified tree (scarred tree).

Further interrogation of the site card data and mapping show that only 11 discrete site records may be reliably reported to occur within the study area. This is due to unreliable archaeological site assessment and recording, destruction of sites during earlier construction projects, replicated site recordings or inaccurate map coordinates on site cards.

Archaeological field survey

Archaeological field survey was carried out between November 2019 and March 2020. The objective of the archaeological survey was to adequately assess the study area and identify any archaeological objects, or areas with the potential to contain PADs.

Following the survey, 28 AHIMS sites located in the study area were reappraised as not being Aboriginal sites and were removed from further consideration. For the most part this was due to natural stone fragments being mis-identified as Aboriginal flaked stone artefacts.

The archaeological survey resulted in the identification of four new Aboriginal sites:

- GWHRS01
- GWHAS01
- GWHST01
- Forty Bends Contact Site

With the incorporation of these sites into the previously recorded sites, a total of 16 Aboriginal sites are located within the construction footprint (Table 6-53), and 8 are located within the study area (but outside of the construction footprint) (Table 6-54).

Table 6-53 Aboriginal sites within the construction footprint

AHIMS ID	Site name	Site features
45-4-0969	SP1	Original location of modified tree (carved or scarred) which has been moved and is now located outside of the study area and recorded as AHIMS 45-4-0980 (refer to Table 6-54)
45-4-0993	River Lett Jenolan Caves Road	Open artefact scatter with 40 artefacts
45-4-1045	GWH 01	Habitation structure, PAD, modified tree (carved or scarred)
45-4-1071	GWH 08	Open artefact scatter
45-4-1072	GWH 09	Open artefact scatter
45-4-1074	GWH 11	Open artefact scatter
45-4-1075	GWH 12	Open artefact scatter
45-4-1081	GWH 18	Open artefact scatter
45-4-1082	GWH 19	Open artefact scatter
45-4-1084	GWH 06	Open artefact scatter
45-4-1097	GWH 07	Open artefact scatter and bone site
45-4-1102	GWH 29	Open artefact scatter
45-4-1103	GWH 31	Open artefact scatter
45-4-1105	GWH 33	Scarred tree
45-4-1106	GWH 34	Isolated find
45-4-1111	GWH 42	Habitation structure and PAD

Table 6-54 Aboriginal sites within the study area (but outside the construction footprint)

AHIMS ID	Site name	Site features
45-4-1081	Blackheath cemetery	Artefact – open camp site
45-4-0935	Hartley Historic Village	Artefact – Isolated find
45-4-0980	SP1	Modified tree (carved or scarred) which was moved from it's original location as AHIMS site 45-4-0969.
45-4-0993	River Lett Jenolan Cave Road	Artefact
TBD[1]	GWHRS01	Habitation structure, PAD
45-4-1111	GWH42	Habitation structure, PAD
TBD	GWHST01	Scarred tree
TBD[1]	Forty Bends contact site	Contact site

Note 1: Sites are protected as per the Code of Practice and no test excavation is proposed. The dominant site types present were open artefact scatters and isolated finds

Potential archaeological deposits

A total of nine PADs were confirmed to occur within 50 metres of the proposal (not including 'Rockshelters with PAD' listed in Table 6-53 above). These PADs are described in Table 6-55.

Table 6-55 Potential archaeological deposits

PAD ID	Landform	Size of PAD (m)	Description
GWH20-1	Upper slope and crest	480 x 50	High ground within 200 metres and overlooking River Lett west/north bank at Little Hartley (area within construction corridor)
GHW20-2	Lower slope	190 x 70	Lower slope within 200 metres and adjacent to second order tributary of River Lett at Little Hartley (area within construction corridor)
GHW20-3	Lower slope	370 x 90	Gentle lower slop within 200 metres of second order tributary to Butlers Creek at Hartley – bisected by existing Great Western Highway (area within construction corridor)
Magpie Hollow Road	Lower slope	245 x 45	Gentle lower slope within 200 metres of ephemeral second order tributary to Bowens Creek. PAD is adjacent to the GWH and abutted by Magpie Hollow Road (area within construction corridor
South Bowenfels Rural Fire Brigade	Lower slope	62 x 100	Gentle lower slope within 200 metres of ephemera second order tributary to Bowens Creek. PAD is adjacent to the GWH and abutted by Mudgee Street (area within construction corridor
[redacted] PAD 1	Mid slope	260 x 120	Large PAD area comprising a lower alluvial terrace, spanning both sides of a small third order stream leading to Whites Creek.
[redacted] PAD 2	Mid sope	160 x 120	Elevated hilltop area on a mid slope below Hassan Walls Range. Within 200 m of a small third order stream leading to Whites Creek. PAD is associated with [redacted] Contact Site and has shallow soils.
River Lett Hill	Hill top	100 x 180	PAD area on an elevated hilltop area on granitic shallow soils overlooking the River Lett Valley to the SE.
Area to the west of 45-4-1097 (GWH 07)	Mid slope	60 x 100	A sloping lower slope within 200 m of River Lett. Bisected by Jenolan Caves Road cutting to the east and disturbance from irrigation and the GWH.

Test excavation

Test excavations were conducted in each of the PADs in Table 6-55, as well as at the portion of registered sites with associated PAD sites within the study area (where permission was granted by landowners). The purpose of the test excavations was to confirm whether Aboriginal objects were present in the subsurface soils in a site or PAD, and if so to provide information about the type, extent of site boundary and density of Aboriginal cultural materials.

The proposal test excavation program identified archaeological evidence of Aboriginal occupation widely distributed across rolling hills, flats and plains, waterway terraces and creek valleys crossed by the construction footprint. Artefact density varied considerably across the study area, with higher density subsurface artefact sites in the River Lett, [redacted] and Hartley site complexes and much lower artefact density in the areas toward Cox River Road to the east.

Test excavation found evidence of repeated Aboriginal stone artefact use in the areas on River Lett Hill, Hartley [redacted], camping activity along River Lett at Jenolan Caves Road, and artefact scatters along tributaries associated with Whites Creek, Butlers Creek, and Boxes Creek. Evidence of activities along minor watercourses and occupation at the western margin of the construction footprint on an alluvial terrace in South Bowenfels was also confirmed.

Following the completion of the test excavation, areas previously designated as PADs were reclassified as Aboriginal objects where artefacts were recovered or have been discarded where none were found. Table 6-56 outlines the final sites confirmed by the test excavation within the construction footprint, summarises the results or the test excavations, and also outlines the changes to nomenclature throughout the assessment process. Table 6-57 provides the same information but for sites located within the study area but outside of the construction footprint.

Table 6-56 Description of sites and PADs within construction footprint following test excavations

AHIMS sites pre-test excavation	PAD as defined by desktop assessment	PAD as refined during excavations	Final site name	Comments
-	GWHAS01	GWHAS01	GWHAS01	Low density site confirmed through test excavation
-	GHW20-3	GHW20-3	GHW20-3	PAD confirmed through test excavation
45-4-1074 (GWH 11)	-	-	45-4-1074 (GWH 11)	Not assessed due to landowner access constraint
45-4-1075 (GWH 12)	-	-	45-4-1075 (GWH 12)	Not assessed due to landowver access constraints
45-4-1081 (GWH 18)	-	-	45-4-1081 (GWH 18)	No artefacts were discovered in sub-surface test excavations. Surface artefacts from original site card not relocated
45-4-1082 (GWH 19)	-	-	45-4-1082 (GWH 19)	No artefacts were discovered in sub-surface test excavations. Surface artefacts from original site card not relocated.
45-4-1084 (GWH 6)	-	-	45-4-1084 (GWH 6)	Low density site confirmed through test excavation
-	GWH20-2	GWH20-2	GWH20-2	Low density site confirmed through test excavation
45-4-1102 (GWH 29)	-	-	45-4-1102 (GWH 29)	No artefacts were discovered in sub-surface test excavations. Surface artefacts from original site card not relocated.

AHIMS sites pre-test excavation	PAD as defined by desktop assessment	PAD as refined during excavations	Final site name	Comments
45-4-1102 (GWH 31)	-	-	GWH 31	Site confirmed through test excavation
-	GWH20-1	N/A	N/A	No artefacts were discovered in test excavations in the PAD. As a result the PAD is not considered a site.
45-4-1095 (GWH35)	-	-	45-4-1095 (GWH35)	Low density site confirmed through test excavation
45-4-1097 (GWH 7)	-	-	45-4-1097 (GWH 7)	Incorporates hearth, PAD and artefact scatter
45-5-1099 (GWH 24)	-	-	45-5-1099 (GWH 24)	Scarred tree
45-4-1072 (GWH 9)	-	-	45-4-1072 (GWH 9)	Large sites and PAD areas with high cultural significance
45-4-1071 (GWH 8)	-	-	45-4-1071 (GWH 8)	Large sites and PAD areas with high cultural significance
-	River Lett Hill	N/A	N/A	No artefacts were discovered in test excavation in the PAD. As a result, the PAD is not considered a site
45-4-1106 (GWH 34)	-	-	45-4-1106 (GWH 34)	Not assessed due to landowner access constraints
45-4-1105 (GWH 33)	-	-	45-4-1105 (GWH 33)	Not assessed due to landowner access constraints
-	[redacted] PAD 1	[redacted] site	[redacted] site	PAD confirmed through test excavation. Post contact site identified to the north of PAD extent (TBD (Forty Bends Contact Site))
-	[redacted] PAD 2			
-	South Bowenfels Rural Fire Brigade PAD	South Bowenfels Rural Fire Brigade PAD	South Bowenfels Rural Fire Brigade Site	PAD confirmed through test excavation
-	Magpie Hollow Road PAD	Magpie Hollow Road PAD	Magpie Hollow Road Site	PAD confirmed through test excavation
Total				
14 registered sites	9 PADs	6 PADs	20 final sites (within construction footprint)	

Table 6-57 Description of sites and PADs within the study area (but outside the construction footprint) following test excavations

AHIMS sites pre-test excavation	PAD as defined by desktop assessment	PAD as refined during excavations	Final site name	Comments
45-4-0181 (Blackheath Cemetery)	-	-	45-4-0181 (Blackheath Cemetery)	
45-4-0935 (Hartley Historic Village)	-	-	45-4-0935 (Hatley Historic Site)	
45-4-0980 (SP 1)	-	-	45-4-0980 (SP 1)	
45-4-0993 (Lett River Jenolan Cave Road)	-	-	45-4-0993 (Lett River Jenolan Cave Road)	
45-4-1111 (GWH 42)	-	-	45-4-1111 (GWH 42)	Rockshelter located on the Bergofen Pass hiking trail
-	-	-	Forty Bends Contact Site	Post contact site was identified to the north of [redacted] Site.
-	-	-	Hartley Grange 2	Not assessed due to landowner access constraints
-	GWHRS01	-	GWHRS01	Rock shelter with associated PAD
-	GWHST01	-	GWHST01	Scarred tree close to GWHRS01 with associated PAD
Total				
5 Registered sites	2 Sites		8 final sites, and 1 PAD within study area (but outside construction footprint)	

Significance assessment

All Aboriginal objects in NSW are protected under the National Parks and Wildlife Act 1974. It is recognised that harm to Aboriginal sites may be necessary to allow other activities or developments to occur. In order for the consent authority to make informed decisions on such matters, an important element of cultural resource management is determining the significance of cultural heritage places and objects to understand what may be lost, and how best it can be mitigated.

Significance assessments for the Aboriginal sites identified during the archaeological within the construction footprint are presented below in Table 6-58. Significance assessments for Aboriginal sites identified outside of the construction footprint but within the study area are presented in Table 6-59. Significant assessments have not been completed for the five sites for which landowners did not permit access (refer to Table 6-56 and Table 6-57).

The assessment of significance is based upon a review of the similarities of sites within a culturally sensitive area. Where the site location has not been confirmed the significance could not be determined.

Further details of the specific criteria used to assess the significance are provided in Section 8 of Appendix G.

Table 6-58 Significance assessment for sites and PADs within the construction footprint

AHIMS ID	Site name	Social	Historic	Scientific	Aesthetic	Overall significance
-	GWH AS01	High	Low - moderate	Moderate	High	Moderate
-	GWH 20-3	High	Moderate	Moderate	High	Moderate-high
45-4-1081	GWH 18	High	Low	Low	Low	Low
45-4-1082	GWH 19	High	Low	Low	Low	Low
45-4-1099	GWH 24	High	High	Low	Low	Low
45-4-1081	GWH 06	High	Low	Low	Low	Low
-	GWH 20-2	High	High	Low	Low	Moderate
45-4-1074	GWH 11	No significance assessment undertaken due to access constraints				
45-4-1075	GWH 12	No significance assessment undertaken due to access constraints				
45-4-1102	GWH 29	High	Low	Low	Low	Low
45-4-1095	GWH 31	High	High	Moderate	Moderate	Moderate – high
45-4-1095	GWH 35	High	High	Low	Moderate	Low
45-4-1097	GWH 07	High	High	High	Moderate	High
45-4-1072	GWH 09	High	High	High	High	High
45-4-1071	GWH 08	High	High	High	High	High
45-4-1105	GWH 33	No significance assessment undertaken due to access constraints				
45-4-1106	GWH 34	No significance assessment undertaken due to access constraints				
-	[redacted] site	High	High	High	High	High
-	South Bowenfels Rural Fire Brigade Site	High	Low	Moderate	Low	Moderate
-	Magpie Hollow Road site	High	Low	Moderate	Low	Moderate

Table 6-59 Significance assessment sites and PADs within the study area (but outside the construction footprint)

AHIMS ID	Site name	Social	Historic	Scientific	Aesthetic	Overall significance
45-4-0181	Blackheath Cemetery	High	High	High	Low	Moderate
45-4-0935	Hartley Historic Village	High	High	Low	Low	Low

AHIMS ID	Site name	Social	Historic	Scientific	Aesthetic	Overall significance
45-4-0980	SP 1	High	Low	Moderate	Low	Moderate
-	GWHST01	High	Low	Low	Low	Moderate
45-4-0993	Lett River Jenolan Cave Road	High	Low	Low	Low	Low
-	Hartley Grange 2	No significance assessment undertaken due to access contraints				
45-4-1111	GWH 42	High	High	High	High	High
-	GWHRS01	High	High	High	High	High
-	Forty Bends Contact Site	High	High	High	High	High

6.4.3 Potential impacts

Impacts to Aboriginal heritage sites

The potential impact of the proposal on Aboriginal heritage sites within the construction foorptint are shown in Table 6-60. Potential impacts of the proposal on Aborigina heritage sites outside of the construction footprint but within the study area are shown in Table 6-61. Most of the Aboriginal sites listed in Table 6-60 below consist of distributions of Aboriginal stone artefacts associated with PADS. These sites are expected to extend well into comparable landscapes outside of the construction footprint. For this reason, the degree of harm to sites whose boundaries likely extend beyond the construction footprint is listed as partial.

There are 20 Aboriginal sites within the construction footprint (one site is located in the central section of the Great Western Highway Program) that would be directly impacted. A further nine Aboriginal sites are located within the study area (but outside of the construction footprint), including two sites that may be subject to minor indirect impacts associated with vibration and settlement and one site that may be subject to moderate indirect impacts, also associated with vibration and settlement.

Further details of the specific criteria used to assess the potential impacts are provided in Section 9 of Appendix G.

Table 6-60 Impact assessment for PADs and Aboriginal sites within the proposed route corridor

Heritage item name (AHIMS ID)	Item type	Overall significance	Type of potential impact	Degree of harm	Significance of potential impact
GWHAS01	Stone artefact site	Low	Direct	Total	Minor
45-4-1105 (GWH 33)	Scarred tree	Low	Direct	Total	Negligible
45-4-1106 (GWH 34)	Artefact site	Moderate	Direct	Total	Minor
GWH 20-2	Site and PAD	Moderate	Direct	Partial	Moderate
45-4-1074 (GWH 11)	Site and PAD	Moderate	Direct	Partial	Moderate
45-4-1075 (GWH 12)	Site and PAD	Moderate	Direct	Partial	Moderate

Heritage item name (AHIMS ID)	Item type	Overall significance	Type of potential impact	Degree of harm	Significance of potential impact
45-4-1071 (GWH 08)	Artefact site	High	Direct	Partial	Moderate
45-4-1072 (GWH 09)	Artefact site	High	Direct	Partial	Major
45-4-1097 (GWH 07)	Stone artefact site, hearth	High	Direct	Total	Major
45-4-1095 (GWH 35)	Site and PAD	Moderate	Direct	Partial	Minor
45-4-1103 (GWH 31)	Stone artefact site	Moderate – high	Direct	Total	Moderate
45-4-1099 (GWH 24)	Scarred tree	Low	Direct	Total	Negligible
45-4-1081 (GWH 18)	Artefact site	Low	Direct	Total	Negligible
45-4-1082 (GWH 19)	Artefact site	Low	Direct	Total	Negligible
45-4-1084 (GWH 06)	Artefact site	Low	Direct	Partial	Negligible
GWH 20-3	Site and PAD	Moderate	Direct	Partial	Moderate
N/A	Site and PAD	High	Direct	Partial	Major
N/A	Site and PAD	Moderate	Direct	Partial	Moderate
N/A	Site and PAD	Moderate	Direct	Partial	Moderate

Table 6-61 Impact assessment for PADs and Aboriginal sites within the study area (but outside the construction footprint)

Heritage item name (AHIMS ID)	Item type	Overall significance	Type of potential impact	Degree of harm	Significance of potential impact
45-4-0181 (Blackheath Cemetery)	Site	Moderate	Indirect	None	Negligible
45-4-0935 (Hartley Historic Village)	Site	Low	Indirect	Partial	Negligible
45-4-0980 (SP 1)	Site	Moderate	Indirect	Partial	Negligible
GWHST01	Site	Moderate	Direct	Partial	Moderate
45-4-0993 (Lett River Jenolan Cave Road)	Site	Low	Indirect	Partial	Moderate
Hartley Grange 2	PAD	N/A	Direct	Partial	Moderate
45-4-1111 (GWH 42)	Rockshelter	High	Indirect	Partial	Minor
GWHRS01	Rockshelter	High	Indirect	Partial	Moderate
Forty Bends Contact Site	Post contact site	High	Indirect	Partial	Minor

Impacts to Aboriginal cultural values

The cultural values assessment carried out for the proposal identified five areas of high cultural values based on cultural information collected during consultation, field surveys and consultation during the test excavation program. Aboriginal community members have stated the entire area within the proposal is significant to Aboriginal people, however knowledge holders have described key sites within the area that are of high importance with the potential to be impacted by the proposal:

- Cox River and River Lett Junction cultural place: Both rivers hold significant value to the Aboriginal community. The main concerns of knowledge holders were centered around the environmental impacts of the proposal.
- River Lett Hill (GWH 08 and GWH 09): Fieldwork conducted at GWH 08 and GWH 09 has unearthed what is reported to be a possum skin processing ground for the Wirajrudi People. Knowledge holders have expressed concerns with the disruption of this area, the site is of high social significance due to the belief that the site is the only known area that this practice would of have taken place. A knowledge holder also noted that that Country spanning the location of the possum skin processing site toward Coxs River may have also been a massacre site.
- Mount Victoria: It was noted that there is a large goanna rock art engraving (location not disclosed) that is highly significant due to the styles incorporated into the art. Further engagement with knowledge holders would be carried out to assess this goanna rock art engraving.
- Coxs River Valley: The Coxs River Valley is reported to have been the pathway in which the Gundungarra people would have traversed to attend ceremony and trade meetings.
- Great Western Highway: Knowledge holders reported the significance of the Great Western Highway as a songline and walking track for all Aboriginal people, and that it was a connector to other pathways such as Mount York and Bells Line of Road.

6.4.4 Safeguards and management measures

Table 6-62 Safeguards and management measures – Aboriginal heritage

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
AH01	Aboriginal heritage management	An Aboriginal Heritage Management Plan (AHMP) will be developed in consultation with the RAPs to document standard procedures for: • Unexpected finds procedure for the discovery of Aboriginal ancestral remains, Aboriginal objects or new Aboriginal sites consistent with RMS (2015) Standard Management Procedures Unexpected Heritage Items	Contractor / Transport	Prior to construction	Appendix G	N/A

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Detailed site salvage strategy • Management and curation of salvaged Aboriginal objects • Detailed locations and installations procedures for fencing and protective coverings • Details of permissible activities and permissible vehicle access inside protected Aboriginal areas • Heritage components of induction package for construction workers and supervisors • Any other heritage matters addressed in the Conditions of Approval for the proposal				
AH02	Minimise impacts to Aboriginal heritage sites	Detailed design will investigate opportunities to minimise impacts to: • Forty Bends contact site • 45-4-1111 (GWH 42) • GWH RS01	Contractor	Detailed design	Appendix G	River Lett to Forty Bends
AH03	Retention of sites located under elevated structures	The feasibility of retaining portions of sites that are located under elevated structures (bridges) over River Lett and on River Lett Hill will be investigated as part of the detailed design process, including the following sites: • 45-4-1097 (GWH 07) • 45-4-1072 (GWH 09) • [redacted] Site • GWH 20-2	Contractor	Detailed design	Appendix G	River Lett to Forty Bends

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
AH04	Aboriginal cultural values interpretation	Across the proposal, the following interpretation elements have been considered for design integration: • Public works of art • Interpretive signage • Bridges • Earthworks • Plantings • Noise walls.	Contractor	Detailed design	Appendix G	All
AH05	Impacts to Aboriginal heritage during construction	Construction works will be closely confined to the minimum possible area required for construction activities. Haulage and other access roads will be designed and located to minimise potential disturbance of soils. Maximising the protection is particularly important in the zone within 100 m of creeks and may require covering the original cultural deposits in temporary protective barriers such as geotextile fabric and a layer of clean fill.	Contractor	Detailed design	Appendix G	All
AH06	Impacts to Aboriginal heritage during construction	Temporary fencing will be placed on the boundary of the following Aboriginal heritage sites: • GWHAS01 • GWH 20-3 • GWH 20-2 • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1072 (GWH 9) • 45-4-1071 (GWH 8) • [redacted] Site) • South Bowenfels Rural Fire Brigade Site	Contractor	Prior to construction	Appendix G	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Magpie Hollow Road site • 45-4-1111 (GWH 42)				
AH07	Community collection	Salvage collection is warranted at those Aboriginal sites in the construction footprint where stone artefacts have been recorded on the surface. Salvage collection is to record MGA coordinates of each artefact by GPS and relevant artefact attributes consistent with the broader archaeological salvage analysis. The results of salvage collection should be collated in an Aboriginal Site Salvage Report (ASSR). Salvage collection will be undertaken by a suitably qualified archaeologist. Sites requiring salvage collection include: • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1075 (GWH 12) • 45-4-1074 (GWH 11) • GWH 20-3.	Contractor	Prior to construction	Appendix G	All
AH08	Salvage excavation	Salvage excavation will be carried out by a suitably qualified archaeologist (refer to Section 1.6 of the Code of Practice) to define the western limit of artefact distribution in accordance with the requirements outlined in Section 10.2 of Appendix G for the following sites: • GWH 20-2 • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1072 (GWH 9)	Contractor	Prior to construction	Appendix G	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• 45-4-1071 (GWH 8) • [redacted] Site • South Bowenfels Rural Fire Brigade Site • Magpie Hollow Road site.				
AH09	Aboriginal heritage sites	An Aboriginal Heritage Impact Permit (AHIP) will be required under Section 90 of the NP&W Act before any known Aboriginal heritage sites are impacted.	Transport	Prior to construction	Section 4.9 of QA G36 Environment Protection	N/A
AH09	Aboriginal heritage sites	Aboriginal site information recording forms (ASIRF) are to be completed for each site and submitted to OEH to be updates on AHIMS.	Transport	Prior to construction	Appendix G	N/A
AH10	Unexpected finds	*The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Prior to construction, construction	Appendix G	All

6.5 Non-Aboriginal heritage

This section provides a summary of the assessment of potential impacts to non-Aboriginal heritage during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of non-Aboriginal heritage impacts is presented in the the technical working paper – non-Aboriginal heritage (Appendix H).

6.5.1 Methodology

The non-Aboriginal heritage assessment involved the following:

- Assessment of the construction footprint plus 50 metre buffer (study area)
- Desktop assessment including a review available heritage registers, lists, relevant heritage report and other source material. Heritage registers included
  - World Heritage List (WHL)
  - National Heritage List (NHL)
  - Commonwealth Heritage List (CHL)
  - State Heritage Register and Inventory (SHR and SHI)
  - Section 170 Heritage and Conservation Registers (S170)
  - Lithgow City Local Environmental Plan 2014 (LEP)
  - Register of the National Estate (RNE)
- Field survey of the study area to inspect listed items and conservation areas and identify any additional potential heritage items or areas of archaeological potential within the study area
- Completion of statements of significance for any additional (unlisted) heritage items or areas of archaeological potential
- Assessment of potential direct and indirect impacts on identified items (listed, unlisted and areas of archaeological potential) within the study area associated with construction and operational of the proposal
- Identification of potential mitigation measures to avoid, manage, minimise and mitigate potential impacts on items likely to be impacted by the construction and operation of the proposal.

6.5.2 Existing environment

Little Hartley to River Lett

Existing context

The hamlet of Little Hartley was created in response to traffic along Thomas Mitchells line of road down Victoria Pass from 1829 to 1930. Following his commercial success of the nearby Golden Fleece Inn at the foot of Mount York (Hartley Vale), the Royal Garter Inn (now Billesdene Grange (LEP I023)) was built in Little Hartley. Unfortunately, Little Hartley did not develop into a village around his inn site as was hoped but formed an elongated hamlet along the Great Western Highway, and there was immediate competition to the Royal Garter Inn from the Harp of Erin (LEP I028) which opened in 1832 as a general store and public house. Other rival hostelries in Little Hartley in the 1830s were short lived with the exception of the Victoria Inn (now Rosedale, (LEP I024)), opened in 1839 and intermittently licensed until 1893, which competed with the Rose Inn (now Ambermere, (LEP I022)) in the 1840s.

Heritage items

Listed heritage items within the Little Hartley to River Lett study area and the items significance are outlined in Table 6-63. The location of these items are shown on Figure 6-17.

Table 6-63 Listed heritage items – Little Hartley to River Lett

Item name	Register	Register number	Significance
Hartley Valley	NHL	106092	National
Rosedale (former Victoria Inn)	LEP, RNE, NT	I024, 834, R3404	Local
Nioka	LEP	I025	Local
Billesdene Grange	LEP, NT	I023, R3389	Local
Hartley Public School	LEP	I018	Local
Mount York Conservation Precinct	RNE	18622	Not specified
Hartley Valley (Coxs River) Landscape Conservation Area	NT	R2977	Not specified

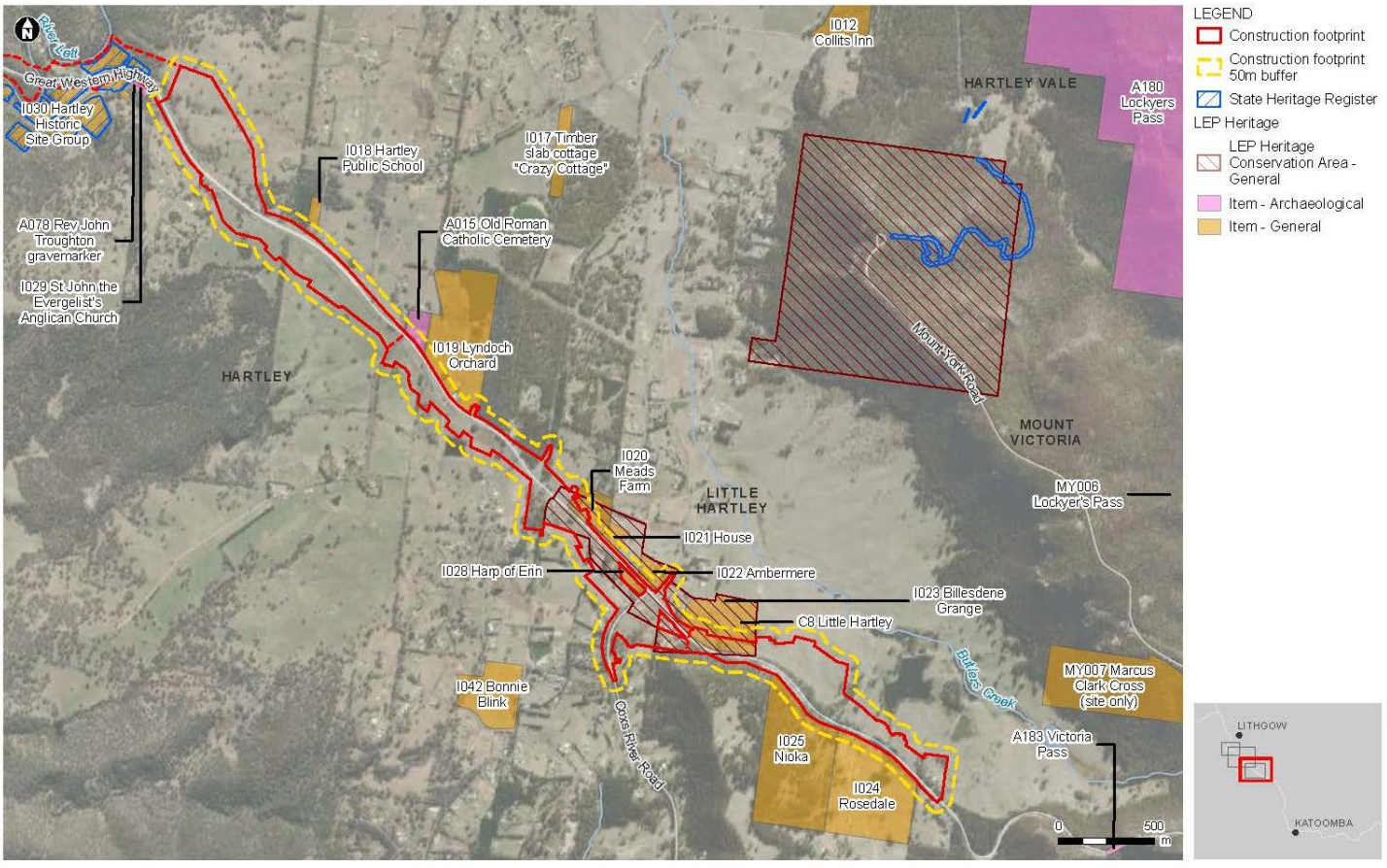


Figure 6-17 Existing heritage items – Little Hartley to River Lett

Unlisted heritage items

Unlisted heritage items within the study area are outlined in Table 6-64.

Table 6-64 Unlisted heritage items – Little Hartley to River Lett

Item name	Location	Description
Section of Coxs River Road	Lot 15/DP880798	Early alignment of Coxs Road which remains in use as a dirt farm track and is approximately 380 metres in length. No visible earthworks or other infrastructure associated with the track, packed earth with some gravel scalds, which runs along the rise of a gentle rolling hill. Only visible due to continued use and vehicle tracks. Terminates at the end of a sealed road (Wheeler Place) in the west, and a revegetation corridor within the property at its eastern end.
Remnant section of an earlier alignment of Michell's Road	West of Noika	Remnant section of an earlier alignment of Michell's Road connecting to Noika. The alignment is currently blocked by tall security fencing.

Archaeological potential

Archaeological potential was identified within the heritage curtilage of Rosedale, around the main house, related to previous outbuildings, wells, or refuse pits.

Coxs River Road

Existing context

Refer to existing context provided above under Little Hartley to River Lett.

Heritage items

Listed heritage items within the Coxs River Road study area and the items significance are outlined in Table 6-65. The location of these items are shown in Figure 6-18.

Table 6-65 Listed heritage items – Coxs River Road

Item name	Register	Register number	Significance
Billesdene Grange	LEP	I023	Local
Little Hartley Conservation Area	LEP	C8	Not specified
Ambermere	LEP, NT	I022, R3403	Local
Harp of Erin (former Williams Store)	LEP, RNE, NT	I028, 826, R3406	Local
House	LEP	I021	Local
Meads Farm	LEP, RNE, NT	I020, 838, R3405	Local
Lyndoch Orchard	LEP	I019	Local
Old Roman Catholic Cemetery	LEP, RNE, NT	A015, 19055, R2978	Local

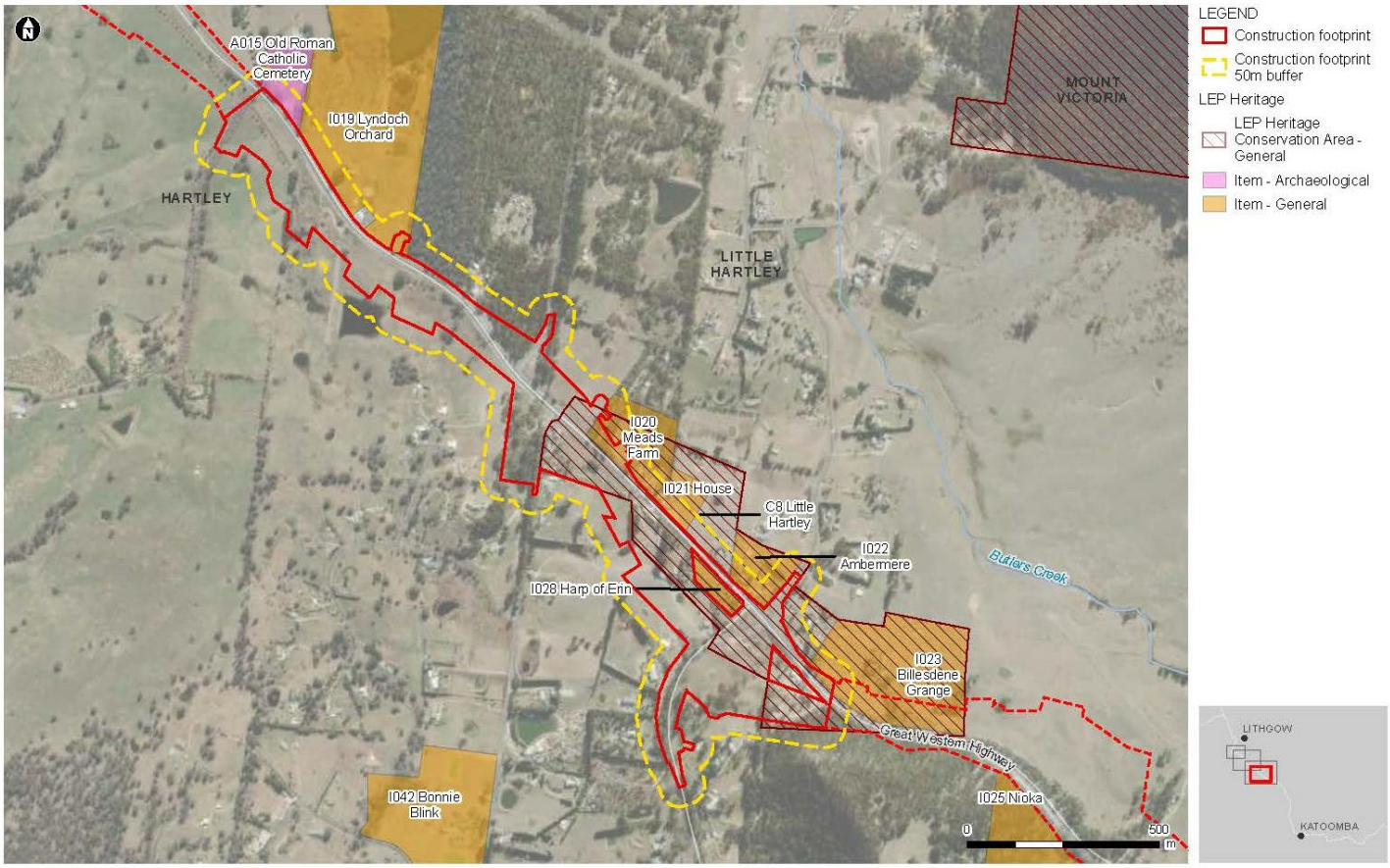


Figure 6-18 Existing heritage items – Coxs River Road

Unlisted heritage items

Unlisted heritage items within the study area are outlined in Table 6-66.

Table 6-66 Unlisted heritage items – Coxs River Road

Item name	Description
The Log Cabin Farmhouse Shop and adjacent land	A composite timber structure set back approximately 15 metres from the Great Western Highway, also known as the Lolly Bug Store. Former petrol bowsers currently screened by decorative landscaping located less than three metres from the highway edge.
Convict-built causeway connecting Billesdene Grange to the Great Western Highway	The convict-built causeway extends from the highway to the entrance gate of the property where it narrows to a single lane. When viewed from the Great Western Highway, the causeway bridges a deep gully running alongside the alignment of Mitchells road and leads to Billesdene Grange.

Archaeological potential

Archaeological potential was identified at the rear of the Harp of Erin (particularly within the ‘house paddock’), related to previous outbuildings related to the inn.

River Lett to Forty Bends

Existing context

Hartley Village is located four kilometres northwest of Little Hartley along the Great Western Highway, around the point where Mitchells Road crossed the River Lett. Land was set aside in 1830 for the creation of a village, and with law and order a military responsibility until 1834, the government in Sydney decided to create a police district with a courthouse on the site, replacing the stockade at Coxs River. The courthouse was the focus of the village, which occupied both sides of the River Lett along Mitchells Road, with sixteen streets laid on a grid pattern.

Hartley village depended on increased use of the highway, which was driven by coach services through to Bathurst during the 1830s. Once the courthouse opened in the 1840s, Hartley replaced Little Hartley as the primary transport hub west of the mountains and associated accommodation and public buildings (hotels and inns) were opened to take advantage of this shift. Western gold rushes drove further development in the town during the 1850s, however when the railway bypassed Hartley Valley and a major oil-extraction industry developed in Hartley Vale (both in the 1860s), growth of the town was quickly stifled. Following the development of the motor car, tourist traffic increased travelling through to Jenolan Caves and Corney's garage was opened in the 1940s. However, the town continued to stagnate and was further diminished through the rerouting of the Great Western Highway to the east of the village (its current alignment).

The village was eventually recognised for its heritage values and passed into the ownership and management of the National Parks and Wildlife Service (NPWS), who own eleven 19th century buildings (including the courthouse and a woolshed) and four later buildings. Only the house known as Bungaribee Bungarribee and the Anglican Church remain in private ownership.

Heritage items

Listed heritage items within the River Lett to Forty Bends study area and the items significance are outlined in Table 6-67. The location of these items are shown on Figure 6-19.

Table 6-67 Listed heritage items – River Lett to Forty Bends

Item name	Register	Register number	Significance
Hartley Historic Village	SHR, LEP, RNE	00992, I020, 837	State
Fernhill	SHR, LEP, NT	00225, I043, R4569	State
Hartley Courthouse (former)	RNE, NT	841, R2985	Not specified
St John the Evangelist Church	RNE, NT	825, R2986	Not specified
Royal Hotel (former)	RNE	822	Not specified
Rev John Troughton gravemarker	LEP	A078	Local
Sunnyside	LEP	I044	Local
Hassans Walls Stockade and Barracks	LEP	A021	Local

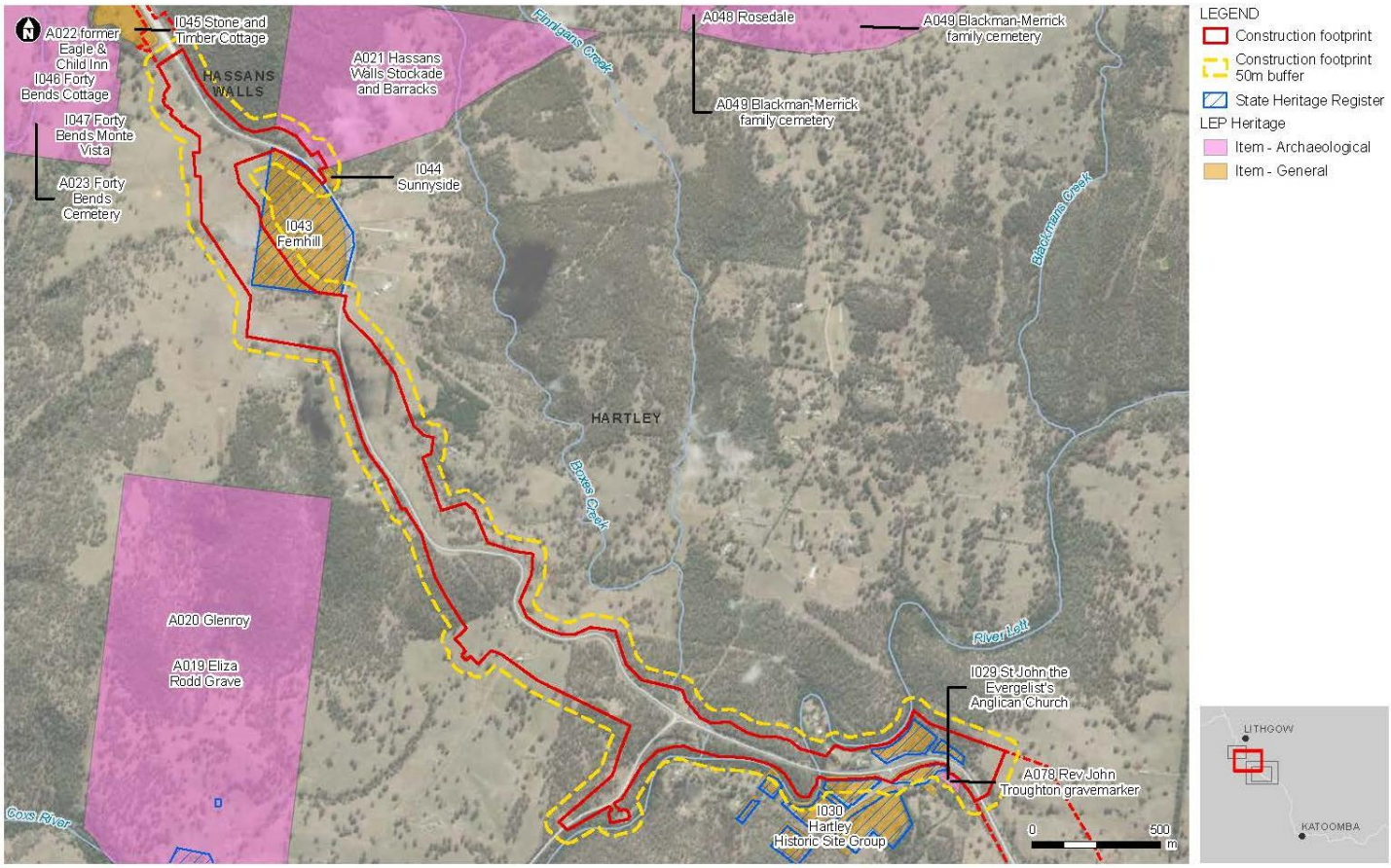


Figure 6-19 Existing heritage items – River Lett to Forty Bends

Unlisted heritage items

Unlisted heritage items within the study area are outlined in Table 6-68.

Table 6-68 Unlisted heritage items – River Lett to Forty Bends

Item name	Description
Bridge over the River Lett (located on the Old Great Western Highway, over the River Lett)	The bridge is significantly dilapidated, and it is no longer possible to cross it on foot, with sections of the timber deck having rotted through and collapsed. The piers appear sound with no visible subsidence or cracking. One of the timber supports (the centremost one) has collapsed and the timbers have been removed or washed downstream, with the footing beam the only piece still in situ. Sandstone steps have been informally constructed on the northern side to allow easy public access down to the riverbed.

Archaeological potential

Archaeological potential has been identified at the following locations:

- The rear of the Royal Hotel at Hartley and within the vacant land to its east
- Land behind the Royal Hotel at Hartley to the north of the current highway
- Land to the rear (north) and east of the courthouse at Hartley
- On unidentified Lot, possibly associated with the historical bullock track

Forty Bends to Lithgow

Existing context

The earliest land grants in the area of Bowenfels were made in 1831 and some of the early subdivisions of the original grants remain largely unchanged today. Following the relaxation of restrictions on settlement by Governor Bourke, there was a rapid development of a number of roadside inns in the Hartley-Bowenfels area during the 1830s-40s and the establishment of a National School in 1851 (Lavelle 1995:5). Following the completion of the Lithgow Zig-Zag and the opening of the railway to the new Bowenfels station (further north) in 1869, the 'old' Bowenfels township gradually declined.

The present Great Western Highway from Mckanes Falls Road to the village of Old Bowenfels essentially follows original alignment of the 1830s Western Road, though some sections have been upgraded, widened or slightly realigned. The proposal travels through the area of Old Bowenfels (also referred to as South Bowenfels). Along Mitchells Road in this area, service buildings began to flourish from the 1830s onwards including inns, stores and the first National School west of the mountains (which opened in 1851).

Heritage items

Listed heritage items within the Forty Bends to Lithgow study area and the items significance are outlined in Table 6-69. The location of these items are shown on Figure 6-20.

Table 6-69 Listed heritage items – Forty Bends to Lithgow

Item name	Register	Register number	Significance
Stone and Timber Cottage	LEP	I045	Local
Former Eagle & Child Inn / Forty Bends Cottage / Forty Bends Monte Vista / Forty Bends Cemetery	LEP	A022, I046, I047, A023	Local
Emoh (Emu Store/Corderoy's Store)	LEP	I051	Local
Road culvert and retaining wall at Emoh	LEP	A027	Local
Umera (Bowenfels Inn, Tricks House)	LEP	I052	Local
Ben Avon (former Royal Hotel)	LEP	I053	Local
Bowenfels National School Site;	SHR, LEP	00761, I054	State
Former Bowenfels Lockup	NT	12858	Not specified
Old Catholic Cemetery	LEP	A029	Local
Somerset House	LEP	I057	Local
Parsonage Farm	LEP	I058	Local
Presbyterian Church & Sessions Hall South Bowenfels	LEP	I059	Local
Bowenfels Presbyterian Cemetery	LEP	A030	Local
Caldwells house	LEP	I061	Local

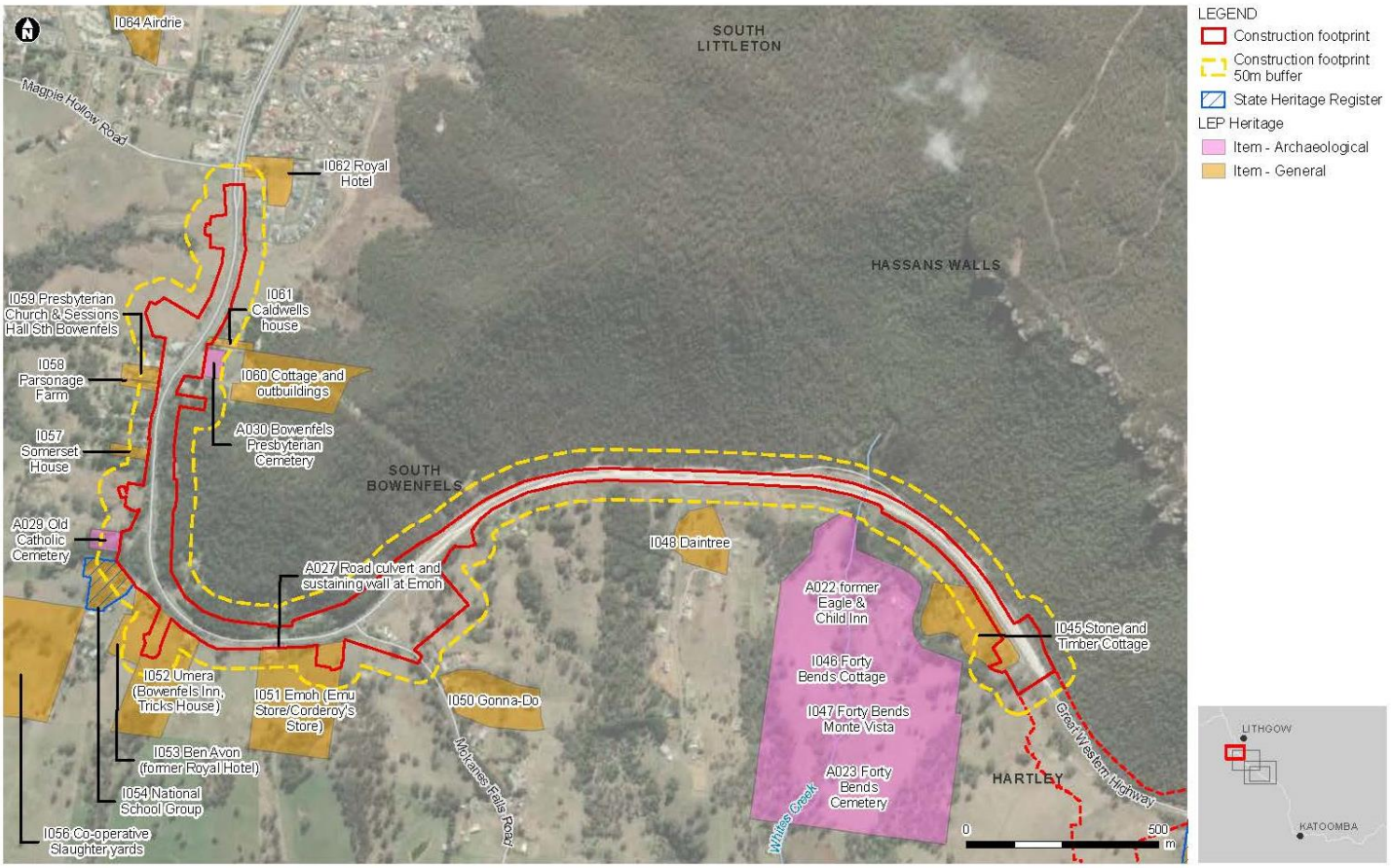


Figure 6-20 Existing heritage items (listed and unlisted) – Forty Bends to Lithgow

Unlisted heritage items

Unlisted heritage items within the study area are outlined in Table 6-70.

Table 6-70 Unlisted heritage items – Forty Bends to Lithgow

Item name	Location	Description
Culverts 1 and 5	Forty Bends	Unlisted culverts
Location of bridge party encampment	Forty Bends	Unlisted area of archaeological potential
Bridge party reserve	Forty Bends	Unlisted area of archaeological potential
Old line of road	Forty Bends	Unlisted item

Archaeological potential

Previous assessments have identified a potential convict-era archaeological site which provided accommodation for a work party during 1832-33. Previous testing indicates that no archaeological remains are likely to survive within the existing road reserve north of the highway due to substantial modifications during the late 20th century. An area of most intact and substantial potential remains was identified, however the plan of the amended location of the potential site was removed from the publicly available copy of the report for confidentiality purposes.

The Bowenfels Presbyterian Cemetery contains archaeological potential within its heritage curtilage (assuming that the curtilage matches the original gazetted boundary) associated with unmarked burials and archaeological materials.

6.5.3 Potential impacts

Little Hartley to River Lett

A summary of potential impacts on heritage items within the Little Hartley to River Lett construction footprint is provided in Table 6-71. Heritage items that have been assessed as experiencing a level of impact of negligible or less have not been included. A detailed summary of potential impacts on these heritage items is provided in Section 6 of Appendix H.

Table 6-71 Potential impacts on heritage items – Little Hartley to River Lett

Item name	Significance	Description of impact	Level of impact to item's heritage significance
Rosedale	Local	**Indirect (visual)** • The proposal would remove of some of the mature vegetation along the eastern side of the highway • The proposal would increase the visual bulk of the highway, creating a major visual element in the setting of the heritage item **Indirect (vibration)** • Construction work would be within the minimum working distances for vibration-intensive construction equipment. • Given the nature of the building's construction (stone walls with soft mortar bedding and variable stone arrangements) there may be existing deterioration which could be exacerbated by vibration	Minor
Billesdene Grange	Local	**Direct (physical)** • The proposal would impact a large portion of the southern side of the heritage curtilage, including the convict-built causeway, which provides access between the building complex and the highway • The proposed works would also require the demolition of the gallery/roadside stall building **Indirect (visual)** • The proposal would remove an extensive stand of poplars planted in the 1930s, plantings along the driveway and a screen between the highway and the property • The proposal would introduce an increased visual bulk in closer proximity to the heritage item building complex than currently exists **Archaeological** • There is potential for the proposed works to have a major archaeological impact on the Billesdene Grange causeway.	Moderate

Item name	Significance	Description of impact	Level of impact to item's heritage significance
Section of Coxs River Road	Not specified	**Direct (physical)** • The proposal would directly truncate the eastern end of the historical road alignment in this area due to the excavation of a deep cutting.	Minor

Coxs River Road

A summary of potential impacts on heritage items within the Coxs River Road construction footprint is provided in Table 6-72. Heritage items that have been assessed as experiencing a level of impact of negligible or less have not been included. A detailed summary of potential impacts on these heritage items is provided in Section 6 of Appendix H.

Table 6-72 Potential impacts on heritage items – Coxs River Road

Item name	Significance	Description of impact	Level of impact to item's heritage significance
Little Hartley Conservation Area	Not specified	**Direct (physical)** • The proposed works will remove the existing Great Western Highway to a more southerly location. Due to the nature of the hamlet's development, this will remove the key historical relationship with the heritage items that Little Hartley had with the through-route of the highway • The proposal would require the removal of existing street trees (noted as being a significant element of the conservation area). **Indirect (visual)** • The proposal would introduce a significant visual obstruction at both the eastern and western end of the conservation area impacting the rural setting of Little Hartley.	Minor
The Log Cabin Farmhouse Shop and adjacent land	Not specified	**Direct (physical)** • The proposed works would truncate the proposed heritage curtilage of the heritage item however the building itself would be retained and is the primary element of significance for the heritage item • The relocation of the alignment would substantially alter the relationship between the heritage item and the highway which is an integral part of the building's history. **Indirect (visual)**	Minor

Item name	Significance	Description of impact	Level of impact to item's heritage significance
		• The proposal would require the remove a large section of the heritage item's existing rural setting of cleared, open, grass paddocks.	
House	Local	**Direct (physical)** • The proposed resurfacing works will take place immediately adjacent to the heritage item's southern boundary, however they are confined to the existing road corridor. The other works are located 20-80 metres from the item's curtilage, physically distanced from any heritage fabric.	Minor
Meads Farm	Local	**Direct (physical)** • The realignment of the highway will directly truncate the heritage curtilage of Meads Farm in its southwest corner and would require ground disturbance through the construction of large batter slopes for the new alignment. • The proposal would also require the removal of mature Eucalypts along the northern side of the Great Western Highway and the front section of a revegetated corridor on the heritage item's western side. **Indirect (visual)** • The proposed works would introduce two new road levels in proximity to the heritage item representing a visual barrier to the heritage item and its views southward • The embankment of the new highway alignment is expected to be at least four metres higher than the current ground surface (potentially as high as five metres in some areas) and would create an obtrusive visual element in a primarily rural setting. **Indirect (vibration)** • Construction work would be within the minimum working distances for vibration-intensive construction equipment. • Meads Farm has the potential to be sensitive to road construction techniques and vibration, which is supported by previous internal inspections at the property	Minor
Lyndoch Orchard	Local	**Direct (physical)** • The proposal would truncate a small stand of remnant orchard trees on the south side of the highway. If these trees are the sole surviving remnant	Major

Item name	Significance	Description of impact	Level of impact to item's heritage significance
		of the extensive orchard (previously 120 acres in total) they can be considered a rare surviving element of one of the earliest orchards in the Hartley area **Indirect (visual)** • The proposal would require the removal of the remnant orchard trees south of the highway – currently the only visual marker of the area and item's orcharding history.	

River Lett to Forty Bends

A summary of potential impacts on heritage items within the River Lett to Forty Bends construction footprint is provided in Table 6-73. Heritage items that have been assessed as experiencing a level of impact of negligible or less have not been included. A detailed summary of potential impacts on these heritage items is provided in Section 6 of Appendix H.

Table 6-73 Potential impacts on heritage items – River Lett to Forty Bends

Item name	Significance	Description of impact	Level of impact to item's heritage significance
St Johns the Evangelist's Anglican Church/Rev John Troughton gravemarker	Local	**Indirect (visual)** • The proposed works represent the duplication of an existing visual element in the landscape context of historical Hartley. The new road surface would be roughly at-grade with the existing highway through the section in proximity to the church, with a large fill embankment on its northern side. However, there would be minimal direct lines of site between the heritage item and the proposed works due to the topography, deep cutting of the existing highway and vegetation screening.	Minor
Hartley Historic Village	State	**Direct (physical)** • The realignment of the highway and new northern access road will directly truncate parts of the heritage curtilage of the item, primarily those portions to the north of the existing Great Western Highway, with minor truncation of the LEP heritage curtilage behind the Royal Hotel • Although the core village to the south of the highway would be largely unaltered, the proposed works would directly impact and bury a portion of its heritage curtilage **Indirect (visual)**	Moderate

Item name	Significance	Description of impact	Level of impact to item's heritage significance
		• The new highway alignment will be constructed to a higher level than the existing highway, increasing the visual bulk of the roadway and partially obstructing views from the heritage item down to the incised path of the River Lett • The scale of the new roadway would introduce a major visual element in an area which is currently a rural residential landscape, and the new bridge structure over the Jenolan Caves Road intersection would be visible from multiple points within the heritage item and be visually intrusive against the existing backdrop of natural bushland which covers the surrounding hills **Indirect (vibration)** • The Hartley Historic Village consists of a number of 19th century buildings of varying construction materials and techniques. Dependant on the specific heritage fabric and construction methodology for the proposed works in proximity to the item, the item may be sensitive to vibration impacts during construction. **Archaeological** • A previous assessment and the Hartley Conservation Management Plan identified several areas of archaeological potential within and around Hartley. • There is some limited potential for deep features such as wells and cesspits to have survived in the land immediately surrounding the Royal Hotel • The land behind the Royal Hotel on the north side of the current highway has moderate archaeological potential for a rubbish dump associated with the operation of the Royal Hotel and residential uses of the building during the 19th and early 20th century • The proposal would have the potential to impact subsurface remains.	
Bridge over the River Lett (located on the Old Great Western Highway, over the River Lett)	Not specified	**Direct (physical)** • The required embankment for the Hartley/Jenolan Caves Road/Blackmans Creek Road access road would bury a section of the Old Great Western Highway on the north side of the River Lett, including its road surface, cutting, associated infrastructure, and potentially the north abutment of the Bridge over the River Lett. This would permanently disconnect the bridge from its previous road context and past as operational road infrastructure, and partially obscure its fabric. **Indirect (visual)**	Major

Item name	Significance	Description of impact	Level of impact to item's heritage significance
		• The construction of the access road necessitate a vast, visually prominent embankment in the heritage item's immediate vicinity, which would potentially obscure some of the item's heritage fabric • The height of the proposed concrete overbridge is such that it would be visible above the top of the embankment, looming over the landscape as a visually dominant element **Indirect (vibration)** • Due to the current condition of the bridge it is considered to be sensitive to vibration impacts during construction	
Archaeological potential on unidentified Lot	Not specified	**Direct (physical)** • Realignment of the highway west of the current alignment and the construction of the access road would directly impact the areas of archaeological potential as a possible grave site and possible rubbish dump/camp site. **Archaeological** • There is moderate potential for archaeology related to a possible gravesite and 19th and 20th century rubbish dumps recorded in oral history. There may also be material related to campsites and work areas related to bullock drays and the use of the historical bullock track and creek crossing	Major
Fernhill	State	**Direct (physical)** • The proposed works would require substantial cut and fill earthworks in order to construct the new alignment, directly truncating the southwest corner of the heritage item and removing a portion of its heritage curtilage, encroaching on the state-heritage listed building complex. **Indirect (visual)** • The construction of the new alignment would require an embankment and batter slope of over 10 metres in height, which would introduce a major visual element into the rural setting of the heritage item and has the potential to be visually intrusive **Indirect (vibration)** • As a heritage building complex of substantial age (circa 1859) Fernhill has the potential to be sensitive to road construction techniques and vibration.	Moderate

Item name	Significance	Description of impact	Level of impact to item's heritage significance
Historic bullock track and creek crossing	Not specified	**Direct (physical)** • The construction of the new alignment would require substantial cut and fill earthworks to maintain a level grade for the roadway, which would directly impact the track alignment and the creek crossing, burying it beneath 10-30 metres of overburden. **Indirect (visual)** • The construction would introduce a significant visual intrusion to an otherwise undeveloped rural valley setting, obstructing natural topography and drainage gullies and drastically changing the visual context of the heritage item.	Major

Forty Bends to Lithgow

A summary of potential impacts on heritage items within the Forty Bends to Lithgow construction footprint are provided in Table 6-74. Heritage items that have been assessed as experiencing a level of impact of negligible or less have not been included. A detailed summary of potential impacts on these heritage items is provided in Section 6 of Appendix H.

Table 6-74 Potential impacts on heritage items – Forty Bends to Lithgow

Item name	Significance	Description of impact	Level of impact to item's heritage significance
Road culvert and retaining wall at Emoh	Local	**Direct (physical)** • The proposed works would include the decommissioning of the culvert.This would remove its purpose as a functional item of heritage infrastructure and represents a major direct (physical) impact to the heritage item. **Indirect (visual)** • The burial of the culvert and retaining wall would obstruct all views of its external 'rock-faced' masonry wall and arched stone culvert, totally removing all views to and from the heritage item. **Indirect (vibration)** • The culvert has been noted as being sensitive to vibration impacts due to the operation of the existing highway **Archaeological** • Proposed works related to drainage and this culvert has the potential to impact the subsurface fabric of	Minor

Item name	Significance	Description of impact	Level of impact to item's heritage significance
		the culvert, particularly the channel linking the north and south facades	
Bowenfels Presbyterian Cemetery	Local	**Direct (physical)** • The proposed works would be primarily located outside of the cemetery heritage curtilage, with the exception of one small section of the access road which intersects with the item's northwest corner. **Indirect (visual)** • The encroachment of the highway alignment, access road and associated embankments to the cemetery would negatively impact its setting and views both to and from the heritage item, which were previously reduced by the widening of the highway in 1998. **Indirect (vibration)** • The cut and fill activities required for the proposed works will be very close, and potentially within, the boundary of the heritage curtilage, and as the standing headstones and monuments vary in integrity and condition, they are considered sensitive to vibration during construction. **Archaeological** • Assuming that the heritage curtilage of the cemetery marks the original gazetted boundary of the grounds, the portion of the new access road currently proposed within the heritage curtilage has the potential to impact archaeological material or burials. An excavation permit under Section 140 (s140 permit) of the Heritage Act, or a s139 exception would be required prior to construction.	Minor

6.5.4 Safeguards and management measures

Table 6-75 Safeguards and management measures – non-Aboriginal heritage

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
NH01	Discovery of historical heritage materials features or deposits	If at any time during the construction of the proposal, historical heritage materials, features and/or deposits are located, the Transport Standard Management Procedure: Unexpected Heritage Items (unexpected finds protocol) (Transport for NSW 2019) will be implemented The works will not re-commence until the requirements of the procedure have been satisfied	Contractor	Construction	Appendix H	All
NH02	Discovery of human remains	In the event that construction activities reveal possible human skeletal material (human remains), the Transport Standard Management Procedure: Unexpected Heritage Items (unexpected finds protocol) (Transport for NSW, 2019) will be implemented. These guidelines have been developed in consultation with Heritage NSW and are consistent with the requirements of the Skeletal Remains: Guidelines for Management of Human Skeletal Remains under the Heritage Act (NSW Heritage Office 1998)	Contractor	Construction	Appendix H	All
NH03	Inadvertent impacts by contractors during construction	Historical heritage awareness training will be provided for contractors prior to the commencement of construction works to ensure understanding of known and potential heritage items that may be	Contractor	Construction	Appendix H	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		impacted or otherwise encountered during the proposed works This training will include specific mention of the procedure required in the event unexpected heritage finds or human remains are encountered				
NH04	Direct impacts to heritage fabric/within an item's heritage curtilage	Design consideration should be given to the heritage item and proposed works with critical assessment of the necessity of the proposed impacts: • Road culvert and retaining wall at Emoh (LEP A027) • Bowenfels Presbyterian Cemetery (LEP A030) If the impacts cannot be mitigated through design, additional justification will be required to inform the item's Statement of Heritage Impact	Contractor	Detailed design	Appendix H	Forty Bends to Lithgow
NH05	Direct impacts to heritage fabric	An archival recording of the heritage item would be carried out, in accordance with the guidelines Photographic Recording of Heritage Items Using Film or Digital Capture (Heritage Council of NSW 2006) at the following sites: • Billesdene Grange (LEP I023) • Section of Coxs River Road (unlisted) • Lyndoch Orchard (LEP I019) • Bridge over the River Lett (unlisted) • Historical bullock track and creek crossing (unlisted)	Contractor	Prior to construction	Appendix H	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Road culvert and retaining wall at Emoh (LEP A027) Dependant on the nature and complexity of the heritage item and the potential impact of the proposed works, the archival recording may also include additional primary or archival research, and additional digital data capture methods such as 3D scanning				
NH06	Proposed works within the curtilage of an SHR listed heritage item	Options to reduce the construction footprint within the SHR curtilage should be considered at the following items: • Hartley Historic Village (SHR 00992/LEP I043) • Fernhill (SHR 00225/LEP I043) An archival recording of the heritage item would be carried out, in accordance with the guidelines Photographic Recording of Heritage Items Using Film or Digital Capture (Heritage Council of NSW, 2006). The appropriate heritage permits must be obtained prior to construction This will be an approval under either Section 60 or subsection 57(2) of the Heritage Act Either application will require the approval of the NSW Heritage Council or its delegate	Contractor	Detailed design	Appendix H	River Lett to Forty Bends
NH07	Changes to, or exacerbation of existing, water	An assessment of existing drainage and water runoff on the item should be completed for the following items: • House (LEP I021)	Contractor	Detailed design	Appendix H	Coxs River Road

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
	runoff and drainage in proximity to a heritage item	• Meads Farm (LEP I020) Options to mitigate drainage or runoff issues through the installation of drainage infrastructure or other modifications should be explored prior to or during detailed design				
NH08	Direct impact to heritage fabric with unknown impacts	Structural assessment by a heritage structural engineer in order to determine the structural capability of the causeway, the probable impacts from the road construction and required compaction, and any additional management or mitigation measures at Billesdene Grange (LEP I023). Archaeological investigation of the area of impact should be completed in order to fully understand the structure and enable a comprehensive archival recording to be produced	Contractor	Prior to construction	Appendix H	Coxs River Road
NH09	Removal of old, rare, or otherwise significant trees or vegetation	The remnant orchard trees at Lyndoch Orchard (LEP I019) should be examined by a qualified arborist and assessed for significance and horticultural value Any rare, old, or otherwise significant examples or varieties should have potential for propagation or preservation considered	Transport	Prior to construction	Appendix H	Little Hartley to River Lett
NH10	Construction (cut or fill) of large road cuttings, embankments or batter slopes	Attempts should be made, where possible, to blend new batter slopes and embankments with existing topography near: • Rosedale (LEP I024) • Meads Farm (LEP I020) • Old Roman Catholic Cemetery (LEP A015)	Contractor	Prior to construction and construction	Appendix H	Little Hartley to River Lett, Coxs River Road, River Lett to Forty Bends

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Hartley Historic Village (SHR 00992/LEP I043) • Fernhill (SHR 00225/LEP I043) Where the construction requires vegetation removal, embankment design should aim to be of an obtuse angle such that revegetation or new landscape planting is possible				
NH11	Removal of visually significant vegetation or areas of existing mature trees	Wherever possible, areas where vegetation removal is required should attempt to revegetate or landscape the area, with plantings to match the existing landscape (trees replacing trees, grasses replacing grasses) at the following items: • Rosedale (LEP I024) • Billesdene Grange (LEP I023) • Harp of Erin (LEP I028) • Meads Farm (LEP I020) • Old Roman Catholic Cemetery (LEP A015) • Fernhill (SHR 00225/LEP I043) • Old Catholic Cemetery (LEP A029) Landscaping of new works elements should not introduce plantings of tall height species if they did not previously exist in that location. This should aid in maintaining an open landscape where suitable and screening vegetation where it currently exists	Contractor	Construction	Appendix H	All
NH12	Structures not expected to be sensitive	A dilapidation survey should be confirmed for the following items, with consideration to the proposed works and	Contractor	Prior to construction	Appendix H	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
	to vibration impacts, but need this to be confirmed prior to constructio n	expected construction plant to be used in their proximity, in order to confirm whether they would be sensitive to vibration impacts during construction: • Billesdene Grange (LEP I023) • Log Cabin Farmhouse Village Shop (unlisted) • House (LEP I021) • Lyndoch Orchard (LEP I019) • Old Roman Catholic Cemetery (LEP A015) • St John the Evangelist's Anglican Church (LEP I029) • Stone and Timber Cottage (LEP I045) • Bowenfels National School Site (SHR 00761/LEPI054)				
NH1 3	Structures considered to be sensitive to vibration impacts during constructio n	A dilapidation report should be prepared for each of the following sensitive heritage item to assess, on a case-by-case basis, whether the fabric would be sensitive to vibration impacts during construction or operation: • Rosedale (LEP I024) • Nioka (LEP I025) • Harp of Erin (LEP I028) • House (LEP I021) • Meads Farm (LEP I020) • Hartley Historic Village (SHR 00992/LEP I043) • Bridge over the River Lett (unlisted) • Fernhill (SHR 00225/LEP I043)	Contractor	Prior to construction	Appendix H	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Emoh (Emu Store/Corderoy's Store) (LEP I051) • Road culvert and retaining wall at Emoh (LEP A027) • Umera (Bowenfels Inn, Tricks House) (LEP I052) • Ben Avon (former Royal Hotel) (LEP I053) • Old Catholic Cemetery (LEP A029) • Somerset House (LEP I057) • Parsonage Farm (LEP I058) • Presbyterian Church and Sessions Hall (LEP I059) • Bowenfels Presbyterian Cemetery (LEP A030) • Caldwells House (LEP I061) Vibration monitoring would be carried out on sensitive heritage items for at least the period of construction Monitoring should continue at least 12 months after the completion of works to determine if ongoing impacts are occurring i.e. identify any operational damage attributable to the proposal Surfacing and construction methods in proximity to sensitive heritage items should be in accordance with the Transport criteria for construction adjacent to sensitive heritage buildings The dilapidation report for each cemetery should involve archival recording/photographs showing the present state of monuments, followed by an assessment of any tilting of headstones or				

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		cracking of slabs that may be attributable to roadworks				
NH14	Vibration impacts during construction	Where a heritage item is deemed sensitive to vibration impacts, the more stringent German Standard guideline values (DIN 4150) should be followed when assessing minimum safe distances and determining allowable plant and its maximum vibration level This may require a greater safety buffer to be maintained between the heritage item a particular vibration-intensive construction equipment	Contractor	Construction	Appendix H	All
NH15	Ground disturbance in an area of low archaeological potential	Application for a s139 exception and test excavation or monitoring of ground disturbance works by an appropriately qualified archaeologist are required at the following locations: • Harp of Erin (LEP I028) • Hartley Historic Village (SHR 00992/LEP I043) • Archaeological potential on unidentified Lot (unlisted) Test excavation prior to, or monitoring during ground disturbance works in this area under a s139 exception.	Contractor	Prior to construction	Appendix H	Little Hartley to River Lett and Coxs River Road
NH16	Ground disturbance in an area of moderate archaeological potential	Test excavation under a s140 permit - an Excavation Permit under Section 139(4) of the Heritage Act is required at the following sites: • Hartley Historic Site (SHR 00992/LEP I043) • Ben Avon (LEP I053)	Contractor	Prior to construction	Appendix H	River Lett to Forty Bends and Forty Bends to Lithgow

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Former Bowenfels Lockup (unlisted) • Bowenfels Presbyterian Cemetery (LEP A030) For works within the SHR curtilage, the excavations would require approval under s60 of the Heritage Act instead Where test excavations are proposed, an archaeological research design and methodology must be prepared in accordance with Archaeological Assessments: Archaeological Assessment Guidelines (NSW Heritage Office 1996a)				
NH17	Disturbance of an area of high archaeological potential	As the causeway at Billesdene Grange (LEP I023) is considered to be an archaeological 'work' it does not trigger the requirement for a s140 permit Archaeological investigation should be completed under appropriately qualified supervision to expose, investigate and record the causeway fabric A detailed archival recording of the causeway and Billesdene Grange frontage to the Great Western Highway should be completed prior to works	Contractor	Prior to construction	Appendix H	Little Hartley to River Lett
NH18	Disturbance of an area with the potential for human remains	An archaeological assessment should be completed of the site Archaeological potential on unidentified Lot, including a detailed survey of the lot and area of potential in order to assess the landform and identify any	Contractor	Prior to construction	Appendix H	River Lett to Forty Bends

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		surface features, and remote sensing of an appropriate method Based on the results of the survey and remote sensing, an archaeological research design should be prepared for management of the site and. It should include further research to try and ascertain the potential identity of the deceased and may subsequently include genealogical research to locate any of their descendants If the archaeological assessment identifies potential features, complete a test excavation. If the results are inconclusive then the area to be impacted should be monitored during the removal of topsoil by an appropriately qualified archaeologist. This work would require a s139 exception and should be completed with the support of a physical anthropologist in case potential human remains are identified.				
NH19	Properties unable to be accessed	Further assessment in the detailed design phase will be completed at the following locations in order to physically inspect these items and amend the desktop assessment of the items presented in this report: • Billesdene Grange (LEP I023) • House (LEP I021) • Meads Farm (LEP I020) • Lyndoch Orchard (LEP I019)	Contractor	Detailed design	Appendix H	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Archaeological potential at unidentified Lot (unlisted) • Fernhill (SHR 00225/LEP I043) • Emoh (I051) • Umera (LEP I052)				

Other safeguards and management measures that would address non-Aboriginal heritage impacts are identified in Section 6.3 Noise and vibration.

6.6 Soils and surface water

This section provides a summary of the assessment of potential soils and surface water impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of soil and surface water quality impacts is provided in the technical working paper – soils and surface water assessment (Appendix I).

6.6.1 Methodology

Soils

A soils assessment for the proposal was conducted including:

- Assessment of soils based on the proposal geotechnical investigation report and publicly available data
- Identification of soil condition, erosion and sedimentation of soils (erodibility), soil risks and constraints, applicable erosion and sedimentation controls, management and mitigation strategies
- Assessment of Acid Sulfate Soils/Potential Acid Sulfate Soils and rock, saline and dispersive soils and areas prone to potential instability and/or settlement.

Surface water

The surface water assessment incorporated a desktop review and analysis of existing water quality information to understand existing water quality and identify potential water specific risks within the proposal and surrounding area. A qualitative and quantitative assessment of anticipated pollutants that may be produced through construction and operation of the proposal was conducted and the likely impacts to surface water quality in regard to relevant environmental values and guidelines outlined.

The assessment provided recommendations for appropriate treatment measures to mitigate the construction and operational impacts on surface water quality, including water quality controls and a suggested water quality monitoring program for pre-construction, construction and operation of the proposal.

The existing condition of surface water quality was assessed through a review of literature, water quality data, background information on land use and information on the design and operation of the proposal.

6.6.2 Existing environment

Catchment overview

The proposal is located within the mid Coxs River sub-catchment in Hawkesbury-Nepean Catchment region and covers an area of about 2630 square kilometres. The Coxs River catchment is part of the Sydney Drinking Water Catchment as it flows into the Warragamba Dam. The major waterway located within this catchment is the River Lett, which flows into Coxs River about two and a half kilometres downstream of the Great Western Highway. A variety of creeks and tributaries flow into River Lett near the proposal including Boxes Creek, Blackmans Creek, Butlers Creek, Finnigans Creek and other minor tributaries. Bowens Creek, located within the north western extent of the proposal, is in proximity to the proposal however does not cross the Great Western Highway. Bowens Creek flows into Coxs River about four kilometres downstream of the proposal.

Land use

The proposal is located within a low-lying valley west of the Blue Mountains escarpment. The land adjacent to the Great Western Highway is predominantly privately owned land cleared for agricultural purposes. Some of the creeks and tributaries entering River Lett, particularly Butlers Creek, have been modified for agricultural use including creation of farm dams and registered groundwater boreholes used for domestic stock purposes. Some locations along the major waterways, including River Lett and Blackmans Creek, have retained vegetation that provide recreational areas for public use, such as Hyde Park Reserve.

Climate

Rainfall data provided by the Bureau of Meteorology shows a trend of the wet season extending between November to March and the dry season between May to October. Average total annual rainfall for the area is 984.7 millimetres. The proposal is located within a temperate climatic region characterised by mild to warm summer and cold winters.

Soil landscapes and characteristics

Geology

Two resources were used to determine the surface geology within the construction footprint including the Sydney 1:250,000 Geology Sheet (third edition developed in 1966; NSW Resources and Geoscience, 2021) and the seamless geology data (Department of Regional NSW, 2020).

The Sydney 1:250,000 Geology Sheet shows the geology in the area is comprised of lower Carboniferous-age adamellite, granite and granodiorite, and the Permian-age Berry Formation of the Shoalhaven Group.

The seamless geology data shows the geology in the area is comprised of granites of the Carboniferous-age Bathurst Batholith Group and the Berry Siltstone of the Permian-age Shoalhaven Group.

The Bathurst Batholith Group consists of granites. The Berry Siltstone is described as a mid- to dark-grey siltstone that grades up-sequence to very fine-grained sandstone, is highly fossiliferous and includes sporadic-dropped pebbles. The Bathurst Bathlith Group underlies the Shoalhaven Group across the region whilst the Berry Siltstone is present across the majority of the construction footprint but is absent within River Lett Hill to Forty Bends section.

The geology of each of the four sections is as follows:

- Little Hartley to River Lett – mapped as Shoalhaven Group
- Coxs River Road – mapped as Shoalhaven Group
- River Lett to Forty Bends – northern half mapped as Shoalhaven Group and southern half mapped as Bathurst Batholith Group
- Forty Bends to Lithgow – mapped as Shoalhaven Group.

Soil landscapes

The Katoomba 1:100,000 Soil Landscape Sheet indicates that soils within the construction footprint are comprised of Lithgow, Hassans Walls, Cullen Bullen, Marrangaroo and Round Mount soil landscape types, with some minor areas of Disturbed Terrain. Soil landscape types present within the construction footprint are summarised in Table 6-76.

Table 6-76 Soil landscape types present within the construction footprint

Soil Landscape Name	Landscape	Soil characteristics	Qualities and Limitations
Lithgow	Flat to undulating rises and broad valley floors on Illawarra Coal Measures and the Berry Formation. Slopes <10%, localised rock outcrops, extensively cleared open forest/woodland	Moderately deep, moderately well-drained residual soils on upper slopes and well-drained areas. Moderately deep to deep imperfectly drained soils on lower slopes and in areas of poor drainage	Hardsetting topsoils, high run-on, localised mine subsidence district, localised rock fall hazard, localised high potential aluminium toxicity
Hassans Walls	Cliffs derived from Narrabeen Group sandstones and steep colluvial talus sideslopes developed over the Illawarra Coal Measures and the Shoalhaven Group. Slopes mostly >40%. Open-forest and open-woodland	Shallow, discontinuous, rapidly-drained colluvial sands on small rocky ledges on cliffs; moderately deep, stony, rapidly drained colluvial lithosols/sands on upper slopes and recently deposited talus; moderately deep, imperfectly to moderately well-drained soils on lower slopes; shallow, well-drained sands/lithosols along narrow steep, deeply incised drainage lines; and moderately deep, well-drained sands/lithosols along narrow drainage flats	Severe rock fall hazard, mine subsidence, steep slopes, extreme water erosion hazard, mass movement hazard, severe foundation hazard, rock outcrop and localised shallow soils, high run-on, non-cohesive soils (localised)
Cullen Bullen	Rolling low hills and rises on Illawarra Coal Measures and the Berry Formation. Slopes 10% to 25%. Localised rock outcrop occurs as small isolated low scarps (<5 m). Extensively cleared open-woodland and open-forest	Shallow to moderately deep, moderately well-drained erosional soils on crests, upper slopes, midslopes, and lower slopes near drainage lines. Shallow, well-drained soils associated with low scarps	Hardsetting topsoils, high water erosion hazard, localised mine subsidence district, high run-on, rock outcrop, localised rock fall hazard and localised high foundation hazard
Marrangaroo	Rolling hills and narrow flat to rounded convex crests on Carboniferous granites. Slopes <30%. Granite tors are common (<5 m) on upper slopes, and small swampy drainage depressions on lower slopes and drainage lines. Extensively cleared open-woodland	Shallow, rapidly drained erosional sands and deep, rapidly drained red earths on crests and moderately inclined sideslopes; moderately deep, imperfectly drained soils on lower slopes near drainage lines; imperfectly drained alluvial soils and minimal prairie soils along very narrow swampy drainage lines	Localised steep slopes, localised rock outcrop, acid soils of low fertility, seasonally high watertables in valley flats
Round Mount	Steep to very steep hills and mountains on Carboniferous granite in the Hartley Valley and Kanangra Gorge. Slopes	Shallow, rapidly drained colluvial sands associated with rock outcrop; shallow to moderately deep, rapidly drained sands on slopes with	Steep slopes, extreme water erosion hazard, mass movement hazard (localised), acid, sandy

Soil Landscape Name	Landscape	Soil characteristics	Qualities and Limitations
	generally >35%. Granite rock outcrop (tors) is commonplace. Occasional cliffs. Open-woodland	negligible rock outcrop; occasional moderately well-drained soils on lower slopes and along drainage depressions	soils of very low fertility, rock outcrop
Disturbed Terrain	Level plain to hummocky terrain, extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Local relief	Turfed fill areas commonly capped with up to 40 cm of sandy loam or up to 60 cm of compacted clay over fill or waste materials	Dependent on nature of fill material. Mass movement hazard, unconsolidated low wet strength materials, impermeable soil, poor drainage, localised very low fertility and toxic materials

The soil landscape type of each of the four sections is as follows:

- Little Hartley to River Lett – Lithgow, and a small area that is Hassans Wall across the eastern portion; Lithgow, Cullen Bullen and a small area that is Marrangaroo across the western portion.
- Coxs River Road – Lithgow and a small area of Cullen Bullen.
- River Lett to Forty Bends – from east to west, a small area at the eastern end that is Cullen Bullen, Marrangaroo, Disturbed Terrain at two localised areas, Round Mount, Lithgow, Cullen Bullen and Hassans Wall.
- Forty Bends to Lithgow - Lithgow, Cullen Bullen and Hassans Wall.

Soil landscape types are shown in Figure 6-21.

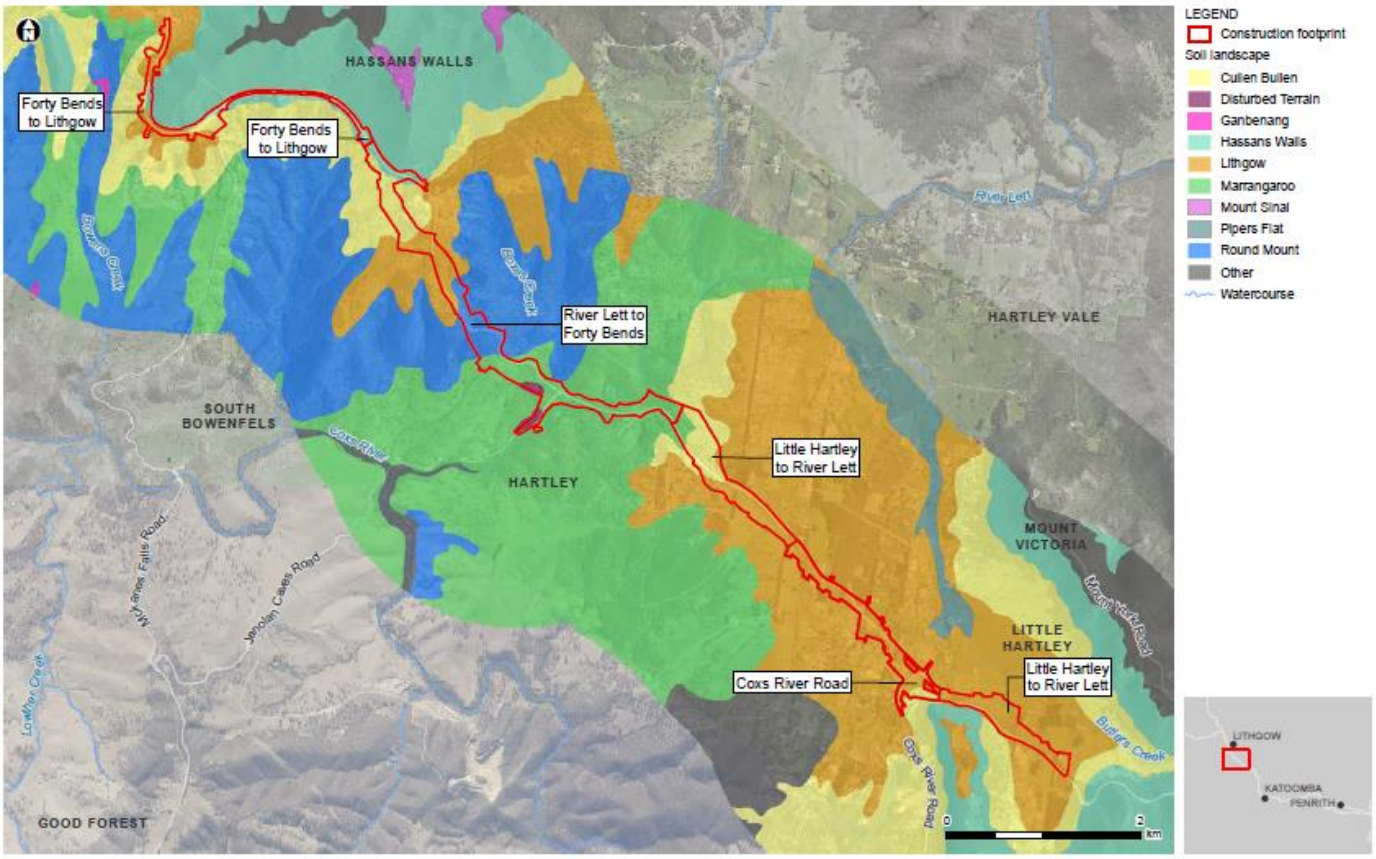


Figure 6-21 Soil landscape types present within the area surrounding the proposal

Soil erodibility

Dispersive soils are soils which are prone to erosion through dispersion of fine clay molecules, which may then be transmitted through groundwater flow. Internal erosion can result from the flow of fine materials through groundwater, forming pipes or tunnels within the soil. This internal erosion can pose a risk to earthwork embankments by weakening the internal structure and potentially leading to embankment failure. Dispersive soils are also prone to scour erosion resulting from surface run-off.

Water erosion hazard is categorised as extreme for the Hassans Wall and Round Mount soil landscape types and high for the Cullen Bullen soil landscape type. High risk areas for erosion include areas with erodible soils and steep and rugged terrain. Specific high-risk areas for soil erosion within the construction footprint include a large portion of both the River Lett Hill to Forty Bends and Forty Bends to Lithgow sections as well as the far eastern and western section of the Little Hartley to River Lett stage and far eastern section of the Coxs River Road section. Table 6-77 outlines the soil erodibility factors for each section as identified in the geotechnical report (Jacobs 2021a to 2021d).

Table 6-77 Soil erodibility for soils within the construction footprint

Section	Soil dispersion	K-Factor	Erodibility rating
Little Hartley to River Lett Hill	10 – 40 per cent	0.02 – 0.05	Moderate to High
Cox River Road	30 – 50 per cent	0.04 – 0.06	High
River Lett Hill to Forty Bends	50 – 70 per cent	0.01 – 0.04	Low to moderate

Section	Soil dispersion	K-Factor	Erodibility rating
Forty Bends to Lithgow	40 -70 per cent	0.025 – 0.04	Moderate

Salinity

The salinity hazard for the proposal is mapped as low indicating that the presence of sodic soils within the region is low.

Acid sulfate soils and rock

Acid sulfate soils mapped by the Commonwealth Scientific and Industrial Research Organisation show that there is a low probability of occurrence of Acid Sulfate Soils within the construction footprint. Acid rock is present in a number of locations within the construction footprint, including the Coxs River Road and River Lett to Forty Bends sections.

The Shoalhaven Group strata along the alignment are typically marine sediments and have the potential to contain sedimentary pyrite. Acid sulfate rock is only likely to be present within the fresher rock cuts in bedrock and areas above the existing groundwater table. Any available pyrite in weathered rock would likely have already oxidised and therefore no longer have the potential to form acid. Due to the weathering observed within the nearby cuttings in the Little Hartley to River Lett Hill section, acid sulfate rock is anticipated to be present within base of the cut batters.

Laboratory testing of rock core samples from the Shoalhaven Group undertaken for the proposal (Jacobs, 2021a to 2021d) suggest that significant quantities of acid may be generated over time by exposure of and seepage through the slightly weathered rock at each section of the proposal except at the River Lett to Forty Bends section where insufficient laboratory testing has been undertaken. Further laboratory testing is being undertaken as part of the proposal geotechnical investigations and will be completed prior to construction.

Waterways

There are numerous waterways and waterbodies including major perennial waterways, minor intermittent creeks, ephemeral drainage channels and waterbodies such as farm dams, present within proximity of the construction footprint. Waterways present within each section are listed in Table 6-78 and shown in Figure 6-22 to Figure 6-25.

Waterways included in the below table include those with a Strahler steam order of greater than 3, as these waterways are likely to have water present a majority of the time, if not permanently, and minor waterways which are specifically crossed by the alignment and/or have a drainage pathway to a key waterway. Key Fish Habitat (KFH) has been provided in accordance with the Biodiversity Assessment (Section 6.1 Biodiversity).

Table 6-78 Key waterways present within each section

Waterway name	Stream type	Crossed by the proposal alignment	KFH Type (DPI, 2013)
Little Hartley to River Lett/Cox River Road			
Tributary to Butlers Creek 1	Ephemeral	Yes (existing)	1
Butlers Creek	Intermittent	No	1
Tributary to Butlers Creek 2	Ephemeral	Yes	3

Waterway name	Stream type	Crossed by the proposal alignment	KFH Type (DPI, 2013)
Tributary to Moyne Creek	Ephemeral	Yes	3
Tributary to Coxs River 1	Ephemeral	Yes	3
Tributary to Coxs River 2	Ephemeral	Yes	3
River Lett to Forty Bends			
Tributary to River Lett 1	Ephemeral	Yes	1
River Lett	Perennial	Yes (existing)	1
Tributary to River Lett 2	Ephemeral	Yes	3
Tributary to River Lett 3	Ephemeral	No	2 or 3
Coxs River	Perennial	No (downstream of River Lett)	1
Boxes Creek	Perennial	Yes (existing)	1
Tributary to Boxes Creek 1	Ephemeral	Yes (existing)	3
Tributary to River Lett 4	Ephemeral	Yes (existing)	3
Tributary to River Lett 5	Ephemeral	Yes (existing)	3
Tributary to Boxes Creek 2	Ephemeral	Yes	3
Tributary to Whites Creek 1	Ephemeral	Yes	1
Forty Bends to Lithgow			
Tributary to Whites Creek 2	Ephemeral	Yes (existing)	3
Whites Creek	Ephemeral (perennial downstream)	Yes (existing)	1
Tributary to Whites Creek 3	Ephemeral	Yes (existing)	3
Tributary to Bowen Creek 1	Ephemeral	Yes (existing)	3
Bowen Creek	Ephemeral (perennial downstream)	No	1 or 2
Tributary to Bowen Creek 2	Ephemeral	Yes (existing)	3
Tributary to Bowen Creek 3	Ephemeral	Yes (existing)	3
Tributary to Bowen Creek 4	Ephemeral	Yes (existing)	3

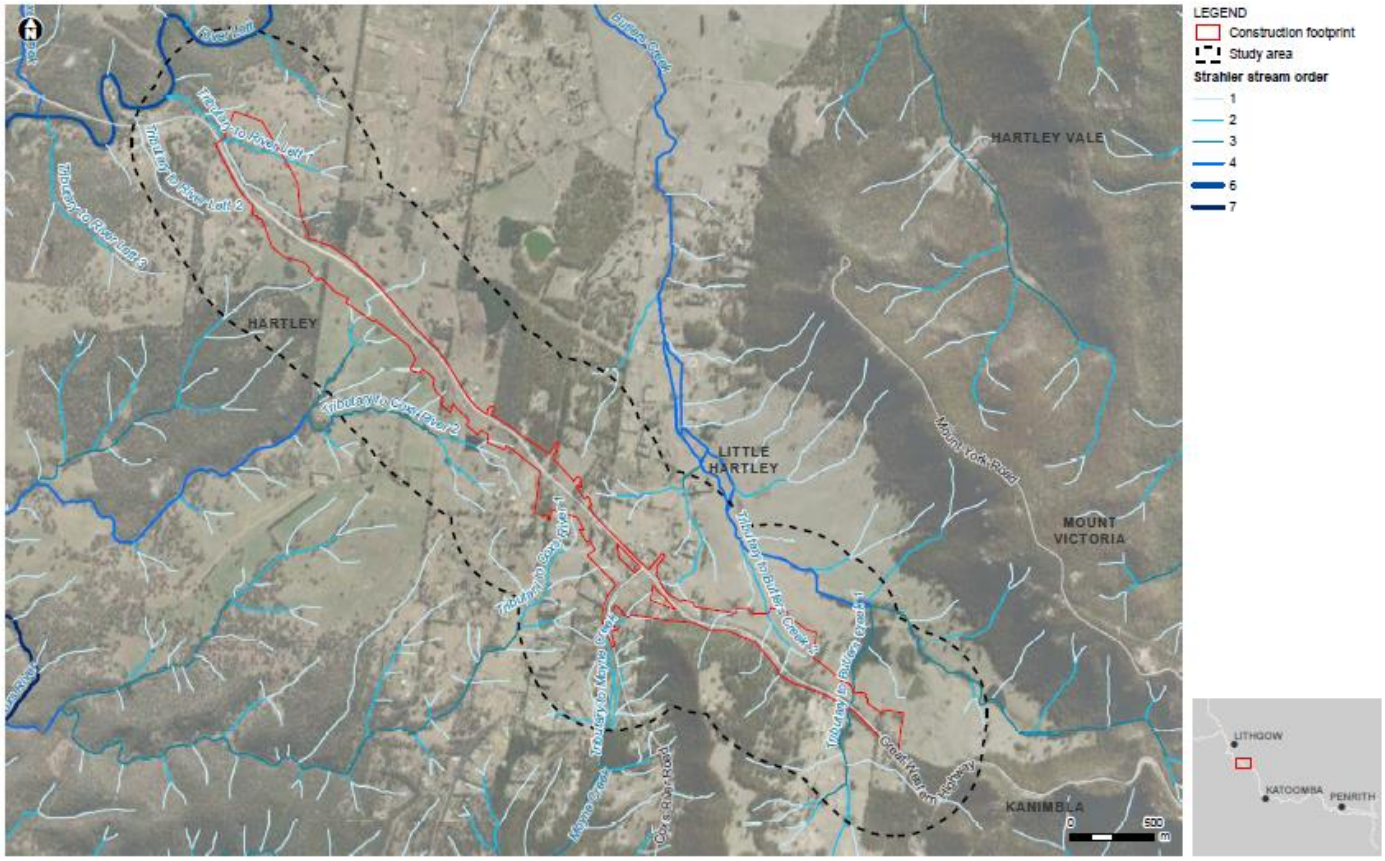


Figure 6-22 Soils and surface water quality study area - Little Hartley to River Lett Hill

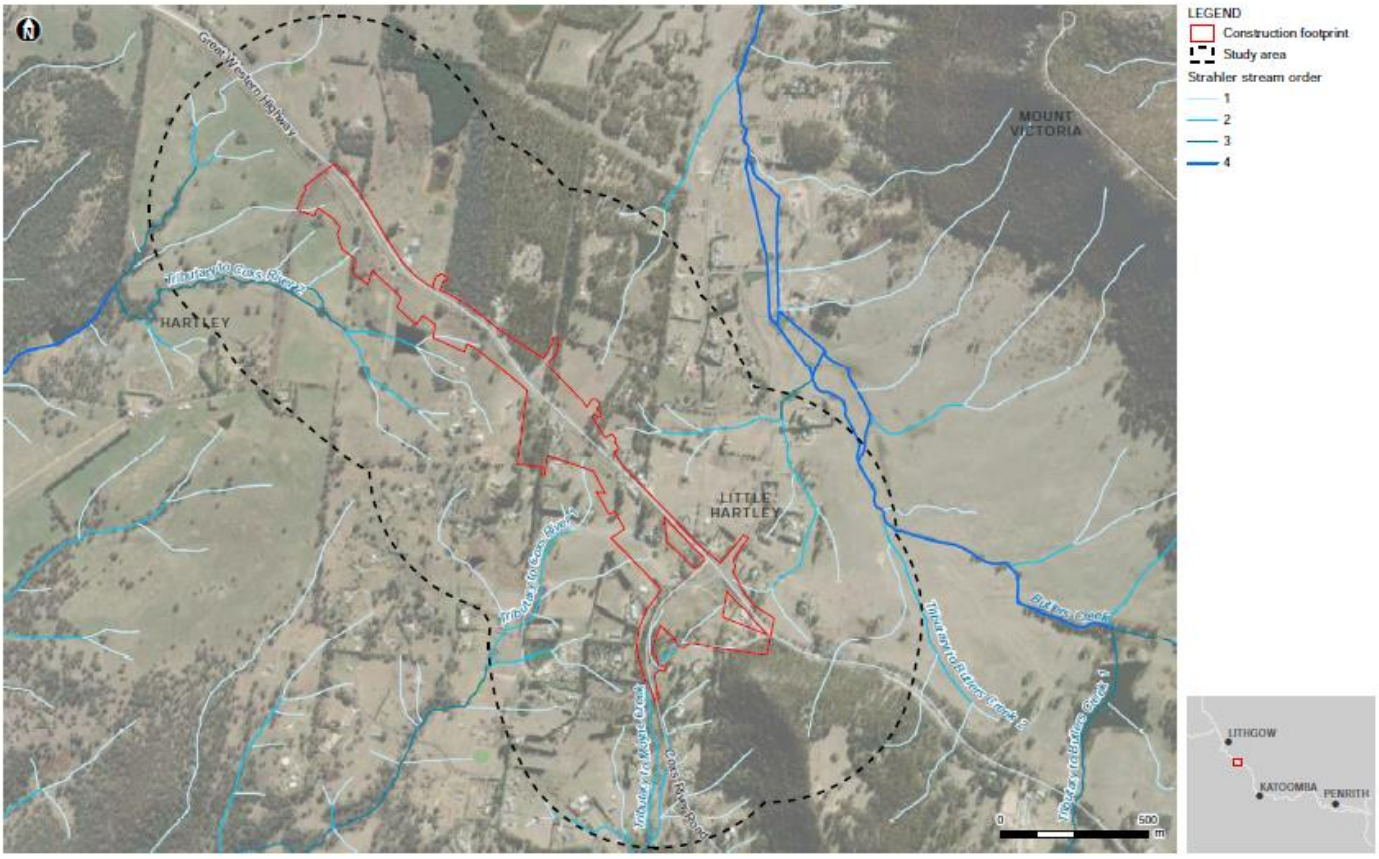


Figure 6-23 Soils and surface water quality study area - Coxs River Road

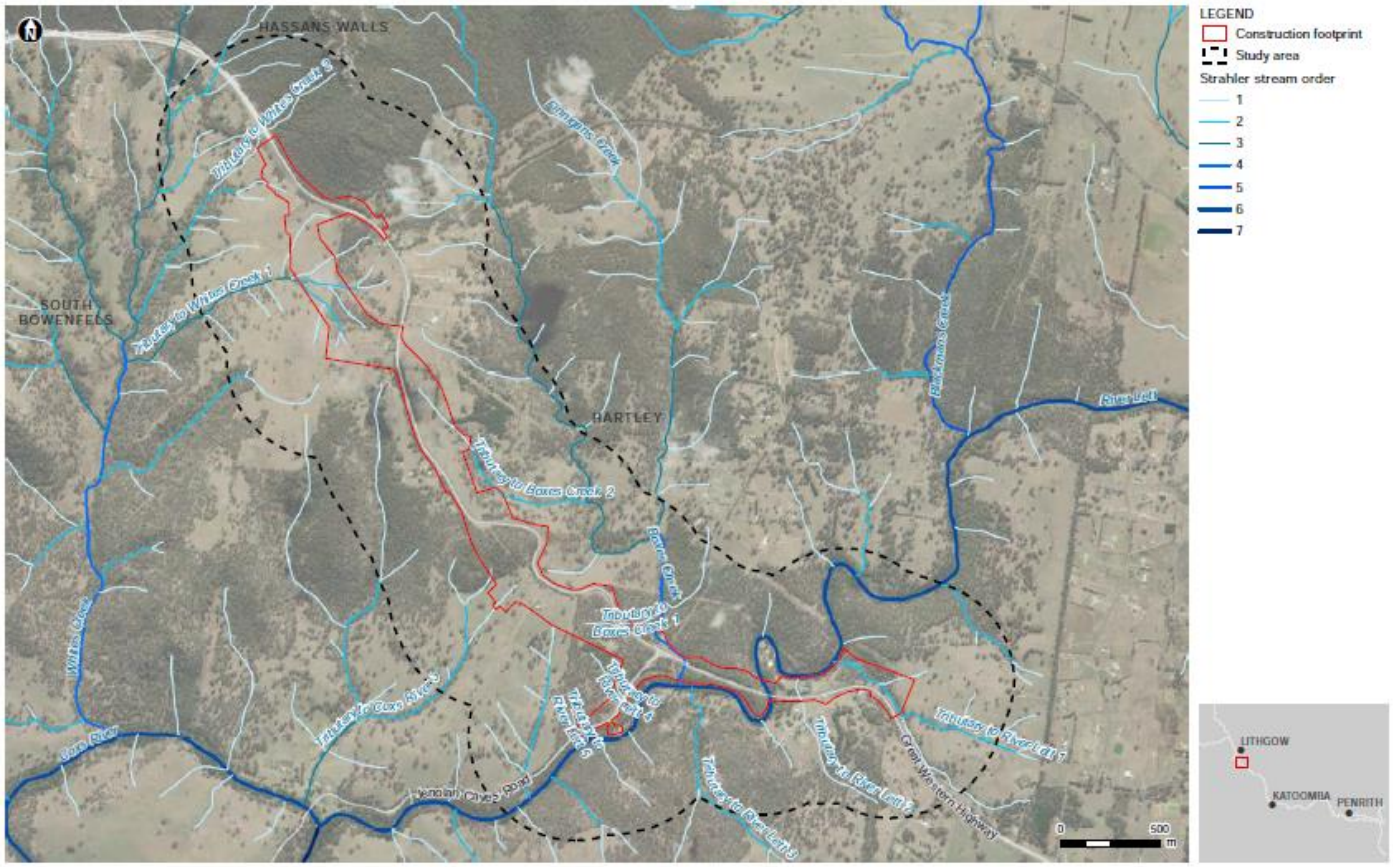


Figure 6-24 Soils and surface water quality study area - River Lett Hill to Forty Bends

Figure 6-25 Soils and surface water quality study area - Forty Bends to Lithgow

Existing surface water quality

Historic water quality data for the River Lett indicates that water quality is generally good and complies with the guidelines for protection of slightly disturbed upland river aquatic ecosystems for a majority of indicators. Water quality monitoring of waterways within the construction footprint will be carried out prior to construction and data will be reviewed to inform detailed design.

Historic water quality data was provided by Water NSW for the Coxs River at Glenroy Bridge for five years between 2016 and 2021. Based off this water quality data of the Coxs River has been variable and fails to comply with guideline values for a number of indicators. Overall, the water quality of the Coxs River does not currently meet the environmental value for protection of aquatic ecosystems due to elevated nutrient, pH and total aluminium.

Sensitive receiving environments

Sensitive receiving environments are areas that have a high conservation value or support ecosystems and/or human uses of water that are sensitive to degradation of water quality. All perennial waterways (Butlers Creek, River Lett, Coxs Creek, Boxes Creek, White Creek), and tributaries which flow to these waterways (tributary of Boxes Creek and tributary of White Creek) have been considered sensitive receiving environments because they are situated with the Sydney Drinking Water Catchment.

Neutral or Beneficial Effect (NorBE) on Water Quality Assessment

The proposal is located within the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 catchment area. Under the Drinking Water Catchment SEPP, there is a requirement to consider whether the proposal would have a neutral or beneficial effect (NorBE) on water quality. This was assessed using the 'Neutral or Beneficial Effect on Water Quality Assessment Tools' (the NorBE tool). The NorBE requires that pollutant loads are equal to or less than existing conditions. The pollutants modelled were Total Suspended Solids, Total Nitrogen and Total Phosphorus.

The results of the assessment are presented in Table 6-79. The assessment showed that without mitigation the proposal would increase the pollutant loads in comparison to the existing conditions. However once the proposed mitigation measures are implemented the pollutants load are reduced to a level that is better than the existing conditions.

The annual average pollutant loads for the upgraded road conditions with the proposed water quality controls are anticipated to provide between eight and 68 per cent improvement on existing conditions. These results demonstrate compliance with the NorBE requirements.

Table 6-79 Annual average pollutant loads and percentage improvements for all sections

Parameter	Existing conditions	Proposed conditions without any water quality controls	Proposed conditions with water quality controls	Percentage improvements from existing conditions	NorBE Compliant? Y/N
Total Suspended Solids	126,700	229,400	40,720	68 per cent	Y
Total Phosphorus	224	1,055	114	49 per cent	Y
Total Nitrogen	1,008	1,591	930	8 per cent	Y

During the construction and operation phases sediment basins are required to capture and treat runoff from all disturbed areas before discharging into the receiving waterways. An assessment has been undertaken as part of this REF work to identify appropriate locations where permanent water quality basins should be considered and sized during the concept and detailed designs.

6.6.3 Potential impacts

Construction

Soils

Construction of the proposal would include earthworks within the construction footprint, access tracks and site compounds. Earthworks would be undertaken for the establishment of the new road alignment, temporary haulage roads, cut and fill and drainage works, as well as stockpiling materials during the construction phase.

Construction activities have the potential to impact soils through erosion and sedimentation, however these would be temporary in nature and confined to the construction phase of the project. These activities include:

- Vegetation clearing and grubbing, including riparian areas
- Pavement removal
- Bulk earthworks, including cut and fill work in sloping terrain and forming slopes and batters
- Movement of heavy machinery and vehicles on unpaved areas
- Creek bridge work including bridge abutments and in-stream work
- Bridge abutments and piers over land or in water
- Sediment basins and other erosion controls
- Service relocation
- Drainage construction and stabilisation
- Ancillary site preparation and operation
- Generation of building and construction waste
- Importing, handling, stockpiling and transporting material resources
- General waste generation from construction compounds.

Details of key soil characteristics within the construction footprint and associated implications for the proposal are provided in Table 6-80.

Table 6-80 Summary of key soil characteristics

Soil characteristic	Details	Implication
Dispersive soils and soil erodibility	There is a high risk of soil erosion for the Hassans Walls, Cullen Bullen and Round Mount soils along the River Lett to Forty Bends and Forty Bends to Lithgow sections, and for the Hassans Walls soils in the Little Hartley to River Lett section	Potential for soil erosion to impact construction works, surrounding land uses and the water quality of surrounding waterways. Highest risk in sections Forty Bends to Lithgow, River Lett to Forty Bends and Little Hartley to River Lett.

Soil characteristic	Details	Implication
Topsoil structure	Hardsetting topsoils are present in the Lithgow and Cullen Bullen soil landscapes	Potential for increased rainfall runoff in these areas. All proposal sections at risk
Rockfall hazard	Severe rock fall hazard associated with the Hassans Wall soil landscape, and localised rockfall hazard associated with the Lithgow and Cullen Bullen soil landscapes	Potential to impact construction works and safety of workers. Areas along all proposal sections at risk.
Salinity	Salinity hazard is low within the construction footprint	Available data do not indicate salinity potential/impact
Acid sulfate rock	Potential acid forming rocks identified in the Cox River Road, Forty Bends to Lithgow and Little Hartley to River Lett sections. Data insufficient in River Lett to Forty Bends section to confirm presence of acid forming rocks	Oxidation of acid sulfate rock during construction has the potential to produce sulfuric acid, resulting in more aggressive conditions and potential impacts to groundwater and/or surface water quality.
Soil fertility	Low fertility associated with the Marrangaroo and Round Mount soil landscapes	Potential difficulty in vegetating slopes for erosion reduction and slope stability. Risk in River Lett to Forty Bends section

The main construction activities with the potential to cause impacts associated with soils and the relevant REF are presented in Table 6-81.

Table 6-81 Potential impacts on soils from construction activities

Construction activity	Details	Potential impact
Site establishment and access tracks	Activities involve movement and use of vehicles across exposed earth, excavation, vegetation clearing and grubbing, and transport of materials to and from site	Soil erosion, particularly in Forty Bends to Lithgow, River Lett to Forty Bends and Little Hartley to River Lett sections
Ancillary facilities/construction compounds	Activities occurring at ancillary facilities include movement and use of vehicles across exposed earth to transport material, stockpiling, vegetation clearing and grubbing	
Earthworks	Activities including cut and fill of existing soils, importing materials to work areas and stockpiling and treatment of soils. Potential cuts through acid sulfate rock, potential rockfalls	Soil erosion, particularly in Forty Bends to Lithgow, River Lett to Forty Bends and Little Hartley to River Lett sections. Acid rock formation resulting in more aggressive conditions and potential impacts to groundwater and/or surface water quality (potentially all proposal sections).

Construction activity	Details	Potential impact
		Rockfalls impact construction works and safety of workers (potentially all proposal sections).
Removal of pavements	Excavation of existing pavements	Soil erosion and waterway contamination.
Bridge work (construction of new bridge and refurbishment of existing bridge)	Involving instream work, vegetation clearing instream and on banks, concrete work, steel work	
Drainage work	Including excavation, vegetation clearing and grubbing, and construction of swales and water quality basins	
Excavation and relocation of utilities	Relocation of utilities using trenching and/or under-boring techniques	
Site restoration and landscaping	Restoration and landscaping of disturbed areas (including ancillary facilities and access roads) where required	

There is also potential to impact soils due to disturbance of existing contaminated soils during earthworks, and leaks or spills of contaminated materials from plant and equipment. Further assessment of potential contamination impacts is provided in Section 6.12 Contamination.

Surface water quality

Construction of the proposal presents a risk to downstream surface water quality through the disturbance of the existing ground surface for road and bridge construction. Potential water quality impacts associated with construction of the proposal include increased turbidity from sedimentation, which can reduce visual amenity, and increased nutrients which can lead to algal blooms. Specific works that have a high risk of impacting surface water quality include:

- Movement and use of heavy vehicle across exposed earth
- Earthworks – cut and fill
- Stockpiling
- Vegetation Clearing
- Relocation of Utilities
- Disturbance of contaminated land
- Concreting

The main construction activities with the potential to cause surface water quality impacts are described in

Table 6-82.

Table 6-82 Potential impacts on surface water

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
Site establishment and access tracks		
• Excavation • Movement and use of vehicles across exposed earth • Vegetation clearing and mulching • Transport of materials to and from site	Potential causes of downstream water quality impacts associated with the establishment and use of access tracks may include: • Transportation of soils, exposed sediments and contaminants associated with earthworks and vegetation clearing to downstream receiving environments via wind and stormwater runoff • Tannin leachate from vegetation clearing and mulching can enter downstream watercourses via stormwater runoff • Transportation of dust, litter and other pollutants (including spills or leaks of oils and/or fuels) associated with vehicle movements and transport of material loads along access tracks. As a result of the above, the following impacts to water quality may occur: • Erosion and sedimentation can result in increased turbidity and poor water clarity, impacting visual amenity and potentially leading to smothering of aquatic ecosystems due to clogging fish gills or decrease trophic interactions due to reduced visibility • Sediments may also contain high concentrations of nutrients which can lead to algal blooms and subsequently result in reduced light penetration that limits the growth of aquatic vegetation. Algal blooms may also result in a reduction of dissolved oxygen content of the water which can lead to the creation of 'dead zones' where aquatic life cannot survive • Mobilised sediments may contain elevated concentrations of metals and other contaminants, which can negatively impact aquatic life • Tannins can cause dark coloured water to be discharged into downstream watercourses from vegetation clearing. This can alter the instream pH and reduce visibility and light penetration. Tannins can also increase biochemical oxygen demand (BOD) which can decrease instream dissolved oxygen concentrations which can impact on aquatic ecosystems and lead to fish kills	**Little Hartley to River Lett and Coxs River Road** Unnamed first and second order ephemeral streams **River Lett Hill to Forty Bends** Boxes Creek River Lett **Forty Bends to Lithgow/South Bowenfels** Unnamed drainage lines (1st order ephemeral streams)

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
	• Mobilisation of pollutants from leaks and spills may lead to the introduction of hydrocarbons and heavy metals into the waterways which may be harmful to aquatic ecosystems.	
Ancillary facilities/construction compounds		
• Movement and use of vehicles across exposed earth to transport material • Stockpiling • Vegetation clearing and mulching, batching plants • Establishment of water quality controls	In addition to the transportation of soils and litter as discussed above; potential causes of downstream water quality impacts associated with the establishment and use of ancillary facilities may include: • Transportation of sediment-laden runoff from areas of excess spoil storage • Transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment and vehicles in the ancillary facilities • Transportation of cement dust, concrete slurries or washout water from concrete works in batching plants and precast facilities. As a result of the above, impacts to water quality that may occur are the same as those for access tracks with the addition of: • Concreting and its by-products can result in increased alkalinity and pH which can be harmful to aquatic flora and fauna species. Water from concrete curing can additionally be high in chromium that can accumulate in the gills of fish affecting the health of aquatic organisms.	**Little Hartley to River Lett and Coxs River Road** Unnamed first and second order ephemeral streams **River Lett Hill to Forty Bends** Boxes Creek River Lett **Forty Bends to Lithgow/South Bowenfels** Unnamed drainage lines (1st order ephemeral streams)
Road Construction works		
• Vegetation clearing and mulching • Cut and fill of existing soils • Importing materials to work areas and stockpiling • Modification to existing roads and construction of new roads including concreting and steel works • Excavation and relocation of utilities • Establishment and use of water quality controls	Potential causes of downstream water quality impacts associated with the construction of new road infrastructure and modification to existing roads also include those mentioned above with the addition of: • Transportation of pollutants associated with rock blasting activities and steelworks • Transportation of dust, litter and other pollutants associated with on-site construction activities and use by construction workers • Transportation of poor-quality runoff from overflow captured water from construction sediment basins • Transportation of acidic runoff if exposure of Acid Sulfate Rock is not adequately mitigated. The impacts to water quality are as per those mentioned previously with the addition of: • Poor quality runoff may contain sediment that results in increased turbidity and poor water clarity impacting visual amenity and potentially leading to smothering of aquatic	**Little Hartley to River Lett** Unnamed tributary of Butlers Creek (3rd order ephemeral) Unnamed drainage lines (1st and 2nd order ephemeral streams) **Coxs River Road** Unnamed drainage lines (1st order ephemeral streams)

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
	organisms. Increased sediment can result in increased construction of nutrients, metals and other contaminants that can be toxic to aquatic life, result in algal blooms and reduce dissolved oxygen concentrations. • Acidic runoff may reduce pH of downstream receivers which may stress aquatic fauna and lead to reduced hatching and survival rates. Low pH can also encourage the solubility of metal pollutants which are more toxic to aquatic organisms in this state.	**River Lett Hill to Forty Bends** Boxes Creek River Lett Unnamed drainage lines (1st and 2nd order ephemeral streams) Farm dams **Forty Bends to Lithgow/South Bowenfels** Unnamed drainage lines (1st order ephemeral streams)
Bridge work (construction of new bridge and refurbishment of existing bridge)		
• Vegetation clearing near banks • Concrete work and steel work • Refurbishment of existing bridge (removal of panels potentially containing asbestos)	Potential causes of water quality impacts from the construction of bridge over creeks may include: • Disturbance of sediments • Transportation of sediment from vegetation clearing • Transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment • Transportation of concrete dust, concrete slurries or washout water associated with concrete works and cast-in-place concreting • Transport of pollutants (ie steel cuttings) associated with steel works • Transportation of dust, litter and other pollutants associated with use of construction sites by construction workers. As a result of the above, the following impacts to water quality may occur: • Erosion and sedimentation can result in increased turbidity and poor water clarity, impacting visual amenity and potentially leading to smothering of aquatic ecosystems due to clogging fish gills or decrease trophic interactions due to reduced visibility • Sediments may also contain high concentrations of nutrients which can lead to algal blooms and subsequently result in reduced light penetration that limits the growth of aquatic and estuarine vegetation. Algal blooms may also result in a	**Lithgow to River Lett** River Lett **River Lett to Forty Bends** Boxes Creek

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
	reduction of dissolved oxygen content of the water which can lead to the creation of 'dead zones' where aquatic life cannot survive • Mobilised sediments may contain elevated concentrations of metals and other contaminants, which can negatively impact aquatic life • Tannins can cause dark coloured water to be discharged into downstream watercourses. This can alter the instream pH and reduce visibility and light penetration. Tannins can also increase BOD which can decrease instream dissolved oxygen concentrations that may impact on aquatic ecosystems and lead to fish kills • Concreting and its by-products can result in increased alkalinity and pH which can be harmful to aquatic flora and fauna species. Water from concrete curing can additionally be high in chromium and can accumulate in the gills of fish affecting the health of aquatic organisms • Mobilisation of litter, leaks and spills may lead to the introduction of gross pollutants, hydrocarbons and heavy metals into the waterways which may be harmful to aquatic ecosystems.	
Drainage work		
• Excavation and vegetation clearing • Instream works such as installation and/or extension of culverts, • Construction of swales and water quality basins	Potential causes of water quality impacts from the construction of drainage infrastructure may include: • Transportation of soils, exposed sediments and contaminants associated with earthworks and vegetation clearing to downstream receiving environments via wind and stormwater runoff. Tannin leachate from vegetation clearing and mulching can enter downstream watercourses via stormwater runoff • Altered flow rate and flow regime which may result in bank erosion that could subsequently lead to transport of sediments and other contaminants into the retained watercourses The impacts to water quality are those previously discussed.	**Little Hartley to River Lett** Unnamed tributary of Butlers Creek (3rd order ephemeral) Unnamed drainage lines (1st and 2nd order ephemeral streams) **Coxs River Road** Unnamed drainage lines (1st order ephemeral streams) **River Lett Hill to Forty Bends** Boxes Creek River Lett

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
		Unnamed drainage lines (1st and 2nd order ephemeral streams) **Forty Bends to Lithgow/South Bowenfels** Unnamed drainage lines (1st order ephemeral streams)
Excavation and relocation of utilities		
Relocation of utilities such as water main, telecommunication facilities underground	Potential causes of water quality impacts associated with relocation of utilities may include: • Soil disturbance from trenching and underboring and construction of new service routes • Erosion of disturbed soils from machinery The impacts to water quality from erosion and sedimentation are as per those already discussed.	**Little Hartley to River Lett** Unnamed tributary of Butlers Creek (3rd order ephemeral) Unnamed drainage lines (1st and 2nd order ephemeral streams) **Coxs River Road** Unnamed drainage lines (1st order ephemeral streams) **River Lett Hill to Forty Bends** Boxes Creek River Lett Unnamed drainage lines (1st and 2nd order ephemeral streams) **Forty Bends to Lithgow/South Bowenfels** Unnamed drainage line (1st

Construction activity	Potential surface water quality impacts	Waterway potentially impacted and relevant design section
		order ephemeral stream)
Site restoration		
Restoration and landscaping of disturbed areas (including ancillary facilities and access roads) where required	Potential causes of water quality impacts during site restoration may include: • Erosion of disturbed soils that have not yet stabilised during landscaping, with potential for sediment to be transported downstream by wind or runoff. The impacts to water quality from erosion and sedimentation are as per those already discussed.	All waterways

Water quality would be managed within the area bounded by the construction footprint.

During construction, temporary sediment basins are required to capture and treat runoff from all disturbed areas of the Proposal before discharging into the receiving waterways. The proposed erosion and sediment control measures and the sizing of temporary sediment basins used during the construction must meet the requirements of *Managing Urban Stormwater, Soils and Construction guidelines, Volume 1* (Landcom, 2004) and *Volume 2* (2008); and *Managing Urban Stormwater, Volume 2D*: Main Road Construction (DECC, 2008).

Where construction does not result in a high potential for erosion, such as resurfacing existing roads, or where sediment basins are not warranted as per the requirements of the Blue Book, local sediment controls, such as sediment fences, filter logs, level spreaders and other source controls would be required.

With the implementation of the safeguards and management measures listed in Section 6.6.4, construction of the proposal would have minimal impact on existing water quality.

Operation

Soils

The potential risk for erosion and sedimentation of soils is considered to be low during operation of the proposal. Soils disturbed during construction would be stabilised through rehabilitation and landscaping (see Section 6.9 Landscape Character and Visual Impact). All roads, bridges, batters, median strips and drainage channels would either be sealed or would have been stabilised with topsoil, hydromulching, landscaping or other scour protection.

There is potential for soil contamination on the road verges from contaminated stormwater runoff due to leaks and spills occurring from vehicles using the road. This is discussed further in Section 6.12 Contamination. Maintenance activities undertaken during operation, such as the management of vegetation, clearing of culverts and table drains, and the use of vehicles on unpaved areas, have the potential to disturb soils. The risk would be relatively low due to the scheduled nature of maintenance activities. The impacts associated with maintenance activities would be managed by adhering to Transport maintenance specifications.

Surface water quality

During the operational phase of the proposal, the site would be completely stabilised, all roads and bridges would be sealed, cleared areas would be landscaped and scour protection would be installed. There would be no exposed topsoils and therefore little or no risk of soil erosion and subsequent transport of sediment into downstream waterways. Water quality risks during operation therefore relate to increased pollutant deposition from increased traffic loading due to improved road conditions which are washed to downstream waterways following rainfall, accidental spills and operational basin discharges.

The proposal lies inside the Sydney drinking water catchment, therefore the design criteria for water quality are required to satisfy the requirements of the State Environmental Planning Policy (SEPP) for the drinking catchment. The key criteria are that the annual average pollutant loads for proposed mitigated conditions must be equal or better than the annual average pollutant loads for current conditions.

Proposed water quality controls consist of vegetated swales, water quality wet basins and dry biofiltration basins. Water quality controls for all roads with high traffic volumes need to be provided where practicable. Water quality treatment for local roads and access ramps with lower traffic volumes is not warranted due to minimal pollutant loads.

Proposed developments in the Sydney drinking water catchment must have a neutral or beneficial effect on water quality, as specified in the Sydney Drinking Water SEPP. This is assessed using the Neutral or Beneficial Effect on Water Quality (NorBE) Assessment Tool. A NorBE assessment was conducted for this phase of the proposal, with a summary provided in Appendix C. This assessment will need to be updated during the detailed design phase.

6.6.4 Safeguards and management measures

Table 6-83 Safeguards and management measures – soils and surface water

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
SW01	Erosion and sedimentation of soils / Surface water quality	A Construction Soil and Water Management Plan (CSWMP) would be developed as a subplan to the CEMP and will outline measures to manage water quality impacts associated with construction work. The CWSMP will provide: • An Erosion and Sediment Control Plan (ESCP) including measures to mitigate erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans for all progressive stages of	Contractor	Prior to construction Construction	Appendix I	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		construction and the implementation of erosion and sediment control measures including the use of sediment basins. • Erosion and sediment control measures which would be implemented and maintained in accordance with *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom, 2004) and *Volume 2D* (DECC, 2008). • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation. • Measures to manage waste including classification and handling of spoil. • Measures to manage tannin leachates. • Measures to manage accidental spills including requirement to maintain materials such as spill kits, an emergency response procedures and regular visual water quality checks when working near waterways. • Controls for sensitive receiving environments which may include but not be limited to designation of 'no go' zone for construction plant and equipment (where application).				

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
SW02	Erosion and sedimentation of soils / Surface water quality	A soil conservation specialist will be engaged for the duration of construction of the proposal to provide advice on the planning an implementation of erosion and sediment control including review of the Construction Soil and Water Management Plan and Erosion and Sediment Control Plan.	Transport / Contractor	Prior to construction Construction	Appendix I	All
SW03	Neutral or Beneficial Effect (NorBE) assessment for water quality	A further NorBE assessment will be undertaken during detailed design.	Contractor	Detailed design	Appendix I	All
SW04	Water reuse	A water reuse strategy will be developed as part of the CEMP for both construction and operation to reduce reliance on potable water. Any water from sediment basins will be checked to ensure compliance with *ANZG (2018) Water Quality Guidelines* for proper reuse.	Contractor	Detailed design Prior to construction Construction	Appendix I	All
SW05	Water balance	A water balance assessment may need to be undertaken at the design stages to determine if there is any impact on the quantity of surface runoff that is currently received at various private farm dams located at the downstream end (within approximately 500 meters) of the proposed road corridor. Any increases or decreases would need to be quantified based on an	Transport	Detailed design	Appendix I	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		average yearly runoff yield assessment at each of the affected farm dams.				
SW06	Surface water quality impacts	A surface water quality monitoring program will be developed in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA, 2003). The program will monitor surface water prior to construction, during construction and during operation.	Transport / Contractor	Prior to construction Construction Operation	Appendix I	All
SW07	Surface water quality impacts	An Acid Sulfate Rock Management Plan (ASRMP) would be prepared to provide information on the mitigation and management of acid sulfate rock disturbed as part of the construction works.	Contractor	Detailed design Prior to construction Construction	Appendix I	All

Other safeguards and management measures that would address soils and surface water impacts are identified in Sections 6.1 Biodiversity, 6.7 Groundwater and 6.12 Contamination.

6.7 Groundwater

This section provides a summary of the assessment of potential groundwater impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of groundwater impacts is provided in the technical working paper – groundwater assessment (Appendix J).

6.7.1 Methodology

The groundwater assessment involved the following:

- Desktop review and analysis to characterise the existing environment and identify potential groundwater risks
- Review and analysis of groundwater levels and groundwater quality data to refine the understanding of potential groundwater issues identified in the desktop assessment and address any knowledge gaps
- Assessment of potential construction and operational impacts on groundwater levels and quality, including:
  - Potential groundwater inflow rates to proposed cuttings and associated groundwater level drawdown was assessed using analytical equations. Details of the approach are provided in Section 3.3 of Appendix J
  - Changes in groundwater levels based on criteria adopted in The NSW Aquifer Interference Policy (DPI, 2012) Minimal Impact Considerations
  - Groundwater quality in accordance with the ANZG (2018) Water Quality Guidelines, the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013) and the Minimal Impact Considerations from the Aquifer Interference Policy (DPI, 2012)
  - Groundwater quality assessed against the neutral or beneficial effect (NorBE) principle due to the proposal residing within the Sydney Drinking Water Catchment.
- Qualitative assessment of potential cumulative groundwater impacts, which may occur due to the proposal interacting with other approved or proposed proposals
- Identification of appropriate treatment measures to mitigate potential impacts to groundwater levels, quantity and quality resulting from construction and operation of the proposal.

6.7.2 Existing environment

Groundwater systems and surface water interactions

The following distinct groundwater systems are conceptualised to be present within the construction footprint (RTA/Parsons Brinckerhoff/Sinclair Knight Merz, 2011):

- Semi confined sedimentary rock groundwater systems within Shoalhaven Group siltstone, lithic sandstone and conglomerate
- Semi confined intrusive rock groundwater systems within fractured granite, and
- Localised and relatively minor unconsolidated unconfined to semi confined alluvial groundwater systems.

The degree and type of interaction between groundwater and surface water is largely dependent on topography, stream geomorphology and the underlying groundwater systems. Interactions are also dependent on seasonal variation, as the water table rises and falls in response to seasonal changes, and the fluctuations would be accentuated in particularly dry and wet years.

It is likely that major watercourses in the study area receive groundwater flow during certain periods.

Existing registered bores

There are 63 existing registered groundwater bores within the study area (Figure 4.3 of Appendix J). Nine are located within the construction footprint:

- State bore I.D.s GW070637 and GW104752, which have a purpose of stock and domestic, respectively. GW104752 is located in the CRR construction footprint and GW070637 is located in the FBL construction footprint
- State bore I.D.s GW111924 and GW111961, located in the FBL construction footprint, which have a purpose of monitoring
- State bore I.D.s GW111531 (R2F construction footprint), GW111532 (R2F construction footprint) and GW111530 (L2R construction footprint) and GW111541 (CRR construction footprint), which have a purpose of monitoring and whose locations correspond to a proposal monitoring bore location.

Groundwater levels

Existing groundwater monitoring bores are shown in Figure 6-26. A detailed summary of groundwater levels for each of the identified groundwater monitoring bores is provided in Table 4-3 of Appendix J. Generally, groundwater levels range from shallow (0.5 metres Below Ground Level (BGL)) to moderate (i.e. about 18 metres BGL). Groundwater levels for each construction footprint are estimated below:

- Little Hartley to River Lett groundwater levels range between 18 and seven metres below ground level
- Cox River Road groundwater levels are around 2.63 metres below ground level
- River Lett to Forty Bends groundwater levels range between 15 and 0.5 metres below ground level
- Forty Bends to Lithgow groundwater levels are around 4.85 metres below ground level

It is noted that relatively shallow groundwater depth measurements of less than two metres below ground level may not represent the water table and may be occurring due to semi confined flow conditions in the fractured granite which the bores monitor.

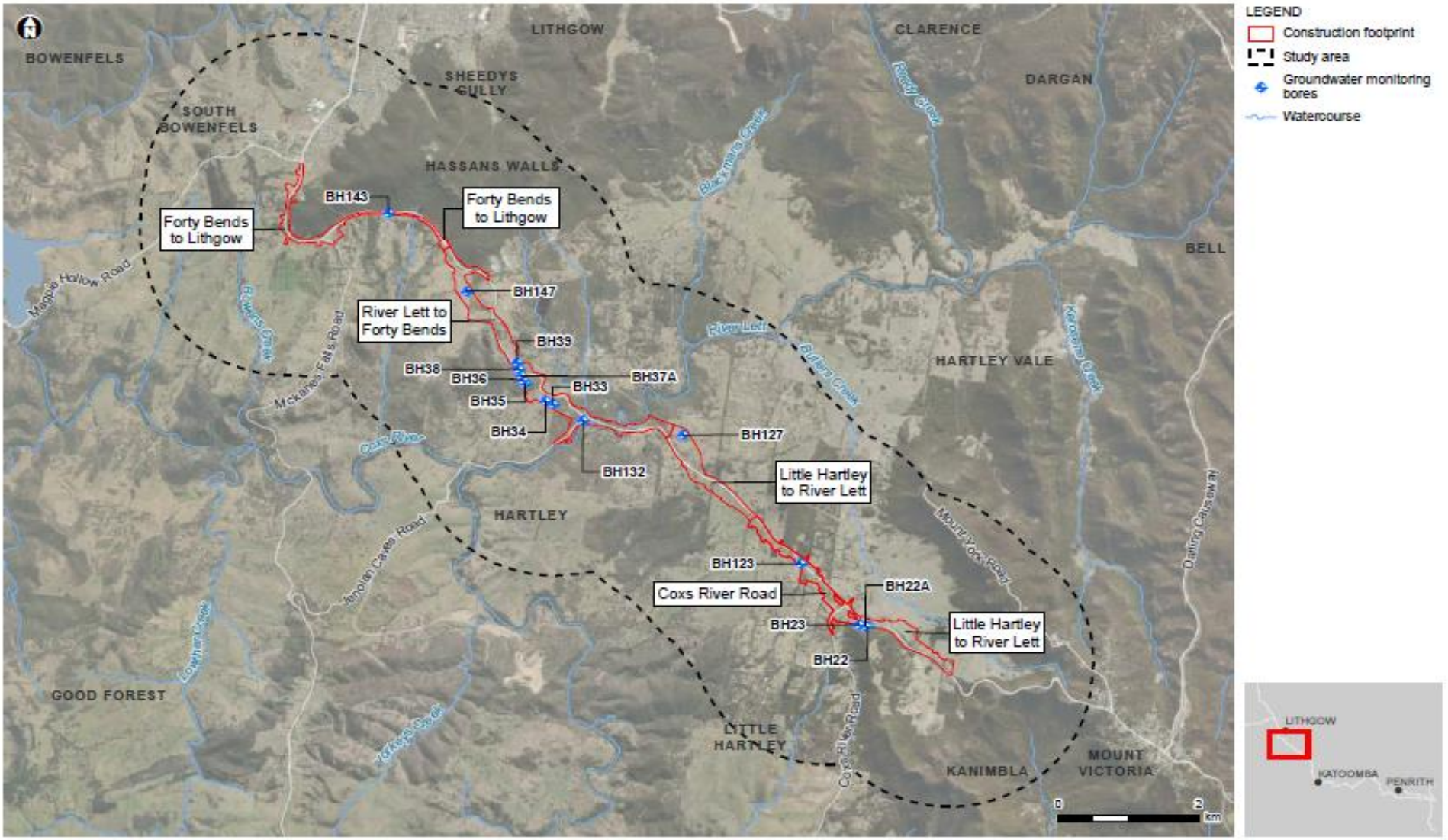


Figure 6-26 Existing proposal groundwater monitoring bores

Groundwater flow directions

Groundwater in the study area is conceptualised to generally flow from areas of relatively high elevation towards areas of relatively low elevation, before discharging to creeks as baseflow, or via evapotranspiration in areas of relatively low elevation where groundwater levels are close to the surface.

Hydraulic conductivity

There is currently no hydraulic conductivity test data or results for the various proposals.

Based on the groundwater system rock types and characteristics, hydraulic conductivity is inferred to be generally relatively low in the groundwater study area for rock groundwater systems. For rock groundwater systems, the bulk hydraulic conductivity is expected to typically be around 0.001 metres to day to 0.01 metres per day but could vary outside this range by multiple orders of magnitude.

There is potential for hydraulic conductivity to be relatively elevated for alluvial groundwater systems.

Groundwater recharge and discharge

Groundwater recharge in the study area is conceptualised to primarily occur through rainfall recharge.

Groundwater discharge is conceptualised to occur as outflow to watercourses, through evapotranspiration in areas of relatively low lying land with shallow water table and at springs, slope breaks, and by groundwater extraction bores.

Groundwater dependent ecosystems

Existing groundwater dependent ecosystems are outlined in Section 6.1 Biodiversity.

Groundwater quality

Groundwater quality data is available for monitoring bores in the study area (refer to Figure 6-26) for field parameters, major ions and dissolved heavy metals, iron and manganese. Groundwater quality results are summarised in Table 6-84 based on whether the monitoring bore is located in granite or Shoalhaven Group (comprising siltstone, lithic sandstone and conglomerate).

Table 6-84 Groundwater quality

Parameters	Geology	Description
pH and conductivity	Shoalhaven Group	• Groundwater is characterised as fresh to brackish • pH ranged from 5.14 to 7.37, with an average value of 6.61. The sample with the minimum pH value of 5.14 (BH123) was outside of the ANZECC 2000 lowland rivers physical and chemical stressors guideline pH range of 6.5 to 8.5.
	Granite	• Groundwater is characterised as fresh • pH ranged from 6.55 to 7.47, with an average value of 7.12. All samples were within the ANZECC 2000 lowland rivers physical and chemical stressors guideline pH range
Cations and anions	Shoalhaven Group	• There is no dominant cation at BH22a. At BH23 and BH123 the dominant cation is sodium. At BH143 the dominant cation is calcium. The anions are dominated by sulfate except at BH143 where they are

Parameters	Geology	Description
		dominated by bicarbonate. The overall water type is mixed (BH22a), sodium chloride (BH23 and BH123) or calcium bicarbonate (BH143).
	Granite	• The dominant cation is calcium, the dominant anion is bicarbonate and the overall water type is calcium – bicarbonate. Exceptions include bores BH132 (no dominant cation) and BH147 (dominant anion was sulfate and overall water type was calcium carbonate).
Dissolved heavy metals	Shoalhaven Group	• Dissolved manganese ranged from 0.183 milligrams per litre to 1.88 milligrams per litre, with an average value of 0.93 milligrams per litre, indicating background concentrations of manganese • Dissolved iron ranged from 0.18 milligrams per litre to 40.6 milligrams per litre, with an average value of 11.21 milligrams per litre, indicating background concentrations of iron.
	Granite	• Dissolved manganese ranged from 0.134 milligrams per litre to 1.11 milligrams per litre, with an average value of 0.50 milligrams per litre, indicating background concentrations of manganese • Dissolved iron ranged from <0.05 milligrams per litre to 42 milligrams per litre, with an average value of 7.63 milligrams per litre (average calculation used 0.05 value for the <0.05 results), indicating background concentrations of iron.

Groundwater contamination

Potential areas of groundwater contamination are considered in Section 6.12 Contamination.

6.7.3 Potential impacts

Little Hartley to River Lett

Potential for groundwater inflows, drawdown, and changes to flow regime

For the purpose of the assessment of impacts to groundwater inflows, drawdown and changes in flow regime, the Little Hartley to River Lett alignment has been divided up into six sections as shown in Figure 6-27. Of these six sections the only section where groundwater interception is predicted is L2R-2. The calculated drawdown extent for this section ranged from about 26 metres to 81 metres.

The calculated groundwater inflow rates are low and the associated drawdown extents are sufficiently small that changes to groundwater flow regimes would be localised to the vicinity of the proposal, with no material changes to regional groundwater flow conditions likely.

Material changes of baseflows to water courses due to groundwater level drawdown would not occur.

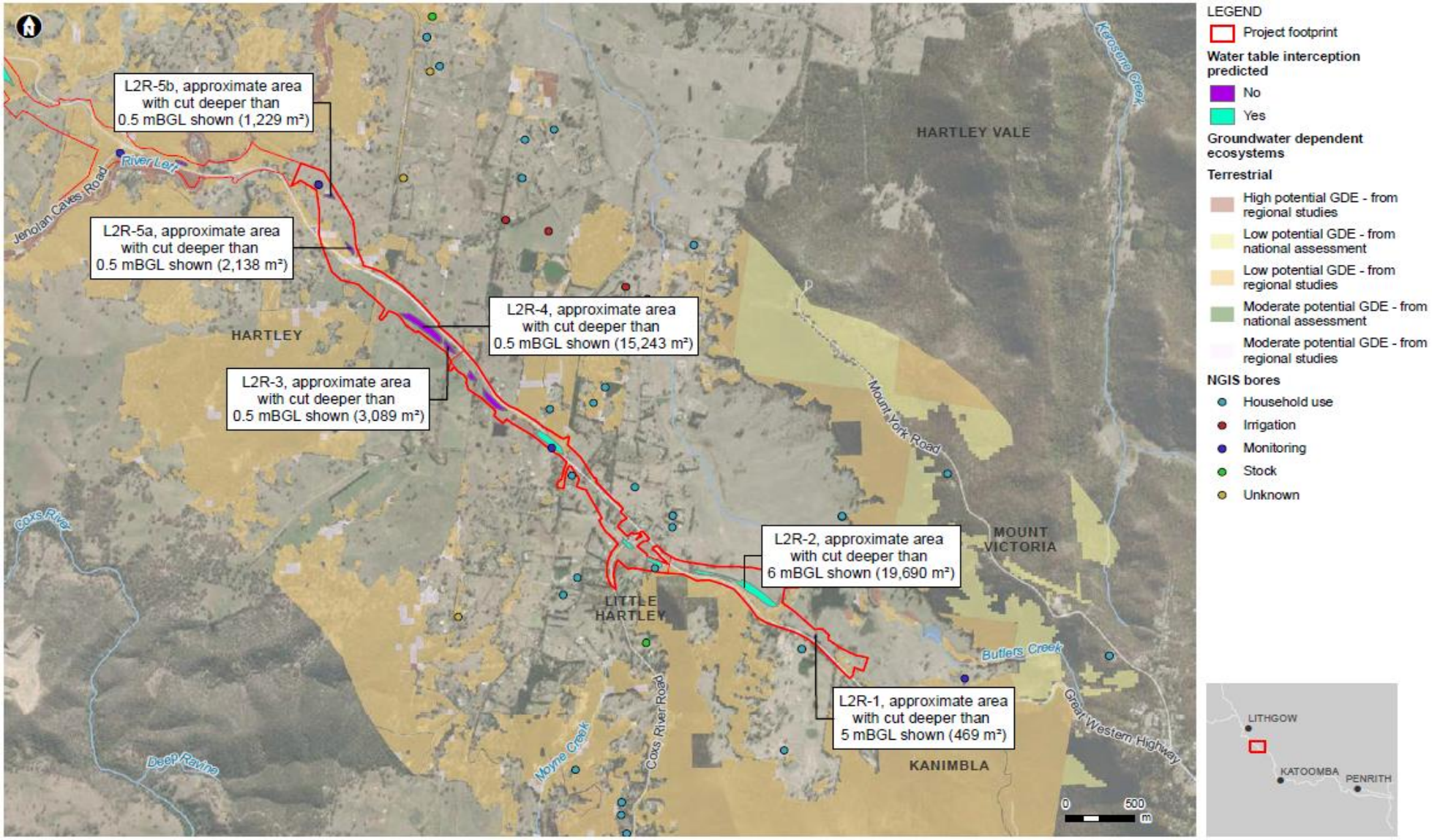


Figure 6-27 Little Hartley to River Lett section for groundwater assessment

Impacts to existing bores

Impacts to existing bores are not anticipated. The zone of influence for groundwater impacts due to water table penetration is predicated to be 81 metres, there are no existing bores within this predicted zone of influence.

Impacts to groundwater dependent ecosystems

Impacts to groundwater dependent ecosystems are considered in Section 6.1 Biodiversity.

Discharge of intercepted groundwater

Discharge of groundwater intercepted by proposed road cuttings could potentially impact receiving environments if the groundwater quality differs significantly from that of the receiving environment water quality and the groundwater discharge rate is sufficiently high that when combined with the groundwater quality, resulting in a significant mass flux of a chemical substance to the receiving environment.

Material impacts associated with discharge of groundwater to receiving environments are considered as unlikely to occur. This is because the calculated groundwater flow of 2.85 kilolitres per day (0.03 litres per second) would be insignificant compared to surface water flows and therefore groundwater would be markedly diluted by surface water flows.

Coxs River Road

Potential for groundwater inflows, drawdown, and changes to flow regime

For the purpose of the assessment of impacts to groundwater inflows, drawdown and changes in flow regime, the Coxs River Road alignment has been divided up into five distinct sections as shown in Figure 6-28. Of these five sections, groundwater interception is predicted is at CRR-1, CRR-2 and CRR3. The calculated drawdown extent for this section ranges from about 13 metres to 53 metres. Estimated groundwater inflow rates for these sections is provided in Table 6-85.

The calculated groundwater inflow rates are low and the associated drawdown extents are sufficiently small that changes to groundwater flow regimes would be localised to the vicinity of the proposal, with no material changes to regional groundwater flow conditions likely.

Material changes to baseflows to water courses due to groundwater level drawdown would not occur.

Table 6-85 Calculated groundwater inflows and drawdown extents for Coxs River Road

Proposed section	Estimated groundwater inflow rate (kL/day)		Estimated groundwater level drawdown extent (metres)	
	Low hydraulic conductivity scenario	High hydraulic conductivity scenario	Low hydraulic conductivity scenario	High hydraulic conductivity scenario
CRR-1	0.04	0.015	13	41
CRR-2	0.06	0.27	16	50
CRR-3	0.13	0.53	17	53

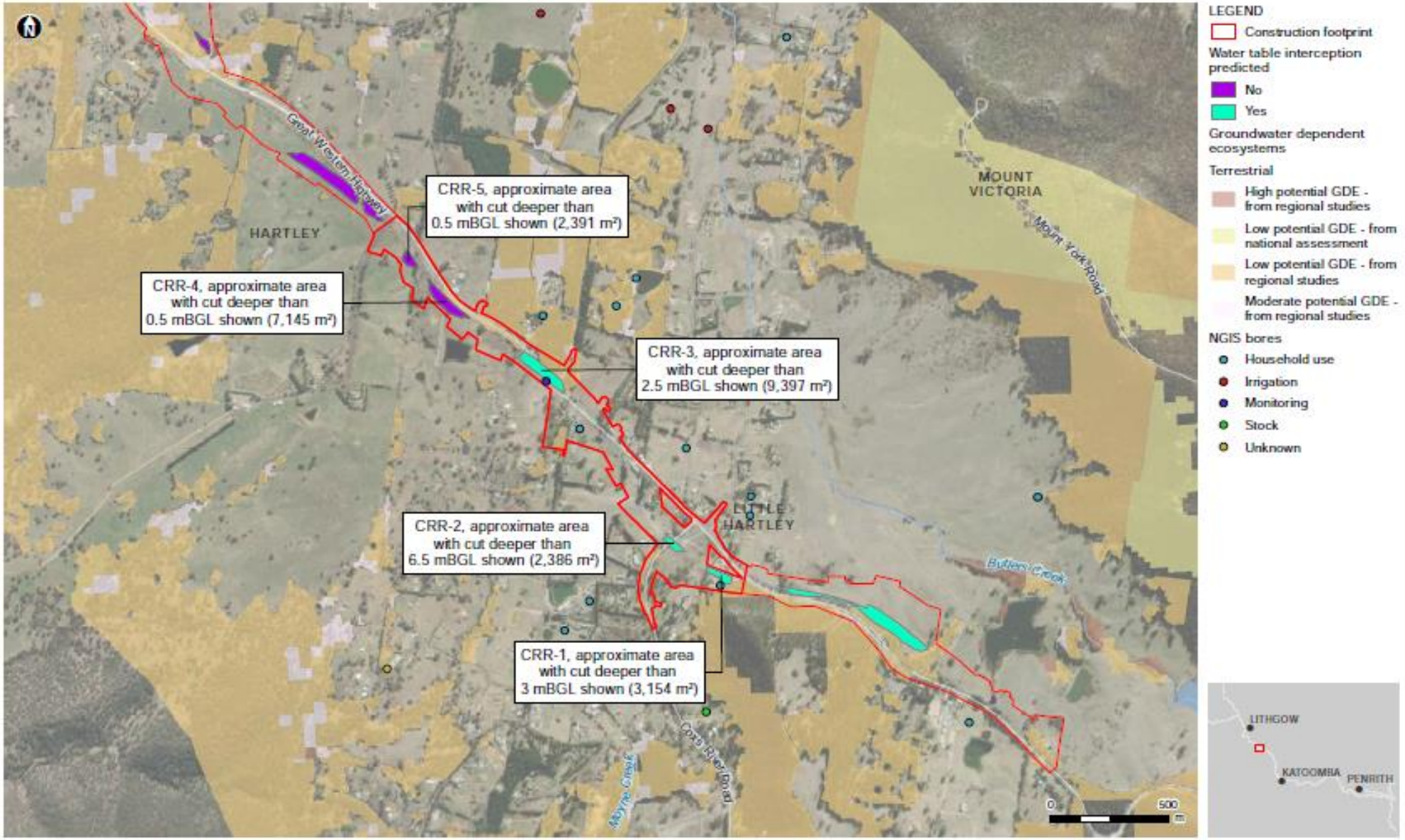


Figure 6-28 Coxs River Road section for groundwater assessment

Impacts to existing bores

Household bore GW104752 is within the construction footprint and will likely require decommissioning; however if retained is not anticipated to be impacted by potential induced groundwater level drawdown resulting from the proposed works. Impacts to other existing bores are not anticipated.

Impacts to groundwater dependent ecosystems

Impacts to groundwater dependent ecosystems are considered in Section 6.1 Biodiversity.

Discharge of intercepted groundwater

Discharge of groundwater intercepted by the Coxs River Road proposal to receiving environments is not anticipated to cause material environment impacts because the calculated groundwater inflow rates are very low and discharged groundwater would be diluted by surface water.

River Lett to Forty Bends

Potential for groundwater inflows, drawdown, and changes to flow regime

For the purpose of the assessment of impacts to groundwater inflows, drawdown and changes in flow regime, the River Lett to Forty Bends alignment has been divided up into three sections as shown in Figure 6-29. Of these three sections, groundwater interception is predicted at R2F-2 and R2F-3. The calculated drawdown extent for this section ranged from about 17 metres to 85 metres. Estimated groundwater inflow rates for these sections is provided in Table 6-86.

The calculated groundwater inflow rates are low and the associated drawdown extents are sufficiently small that changes to groundwater flow regimes would be localised to the vicinity of the proposal, with no material changes to regional groundwater flow conditions likely.

Material changes to baseflows to water courses due to groundwater level drawdown would not occur.

Table 6-86 Calculated groundwater inflows and drawdown extents for River Lett to Forty Bends

Proposed section	Estimated groundwater inflow rate (kL/day)		Estimated groundwater level drawdown extent (metres)	
	Low hydraulic conductivity scenario	High hydraulic conductivity scenario	Low hydraulic conductivity scenario	High hydraulic conductivity scenario
R2F-2	0.70	2.91	27	85
R2F-3	0.17	0.65	17	54

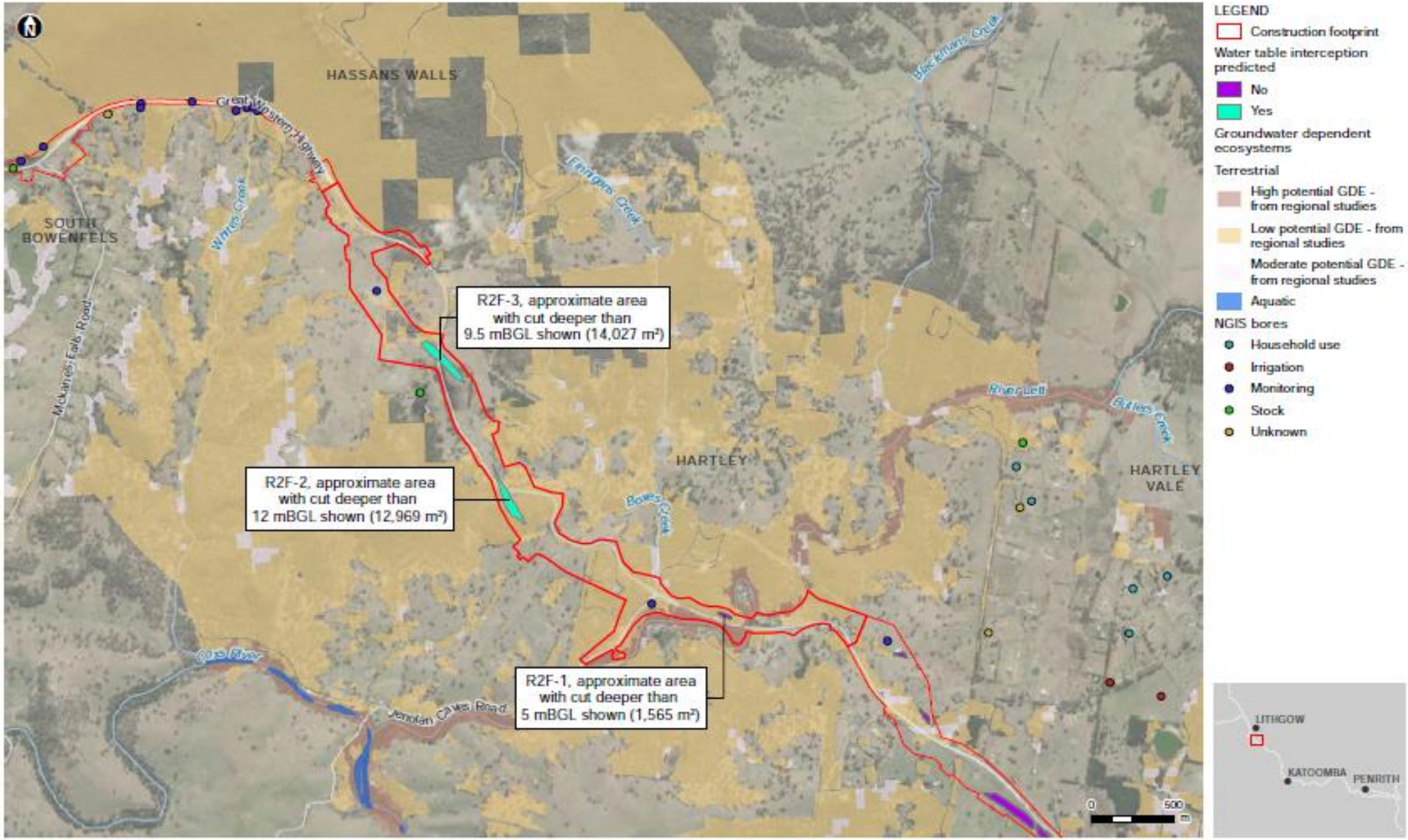


Figure 6-29 River Lett to Forty Bends section for groundwater assessment

Impacts to existing bores

Impacts to existing bores are not anticipated.

Impacts to groundwater dependent ecosystems

Impacts to groundwater dependent ecosystems are considered in Section 6.1 Biodiversity.

Discharge of intercepted groundwater

Discharge of groundwater intercepted by proposed road cuttings to receiving environments is not anticipated to cause material environment impacts because the calculated groundwater inflow rates are very low (calculated maximum rate of 2.91 kilolitres per day, or 0.03 litres per second) and discharged groundwater would be diluted by surface water.

Forty Bends to Lithgow

Potential for groundwater inflows, drawdown, and changes to flow regime

For the purpose of the assessment of impacts to groundwater inflows, drawdown and changes in flow regime, the Forty Bends to Lithgow alignment has been divided up into six sections as shown in Figure 6-30.

Of these sections, groundwater interception is predicted at all six sections. The calculated drawdown extent for this section ranged from about six metres to 50 metres. Estimated groundwater inflow rates for these sections is provided in Table 6-87.

The calculated groundwater inflow rates are low and the associated drawdown extents are sufficiently small that changes to groundwater flow regimes would be localised to the vicinity of the proposal, with no material changes to regional groundwater flow conditions likely.

Material changes to baseflows to water courses due to groundwater level drawdown would not occur.

Table 6-87 Calculated groundwater inflows and drawdown extents for River Lett to Forty Bends

Proposed section	Estimated groundwater inflow rate (kL/day)		Estimated groundwater level drawdown extent (metres)	
	Low hydraulic conductivity scenario	High hydraulic conductivity scenario	Low hydraulic conductivity scenario	High hydraulic conductivity scenario
FBL-1	0.05	0.23	16	50
FBL-2	0.05	0.24	16	50
FBL-3	0.05	0.22	16	50
FBL-4	0.001	0.01	6	20
FBL-5	0.04	0.19	16	50
FBL-6	0.04	0.21	16	50

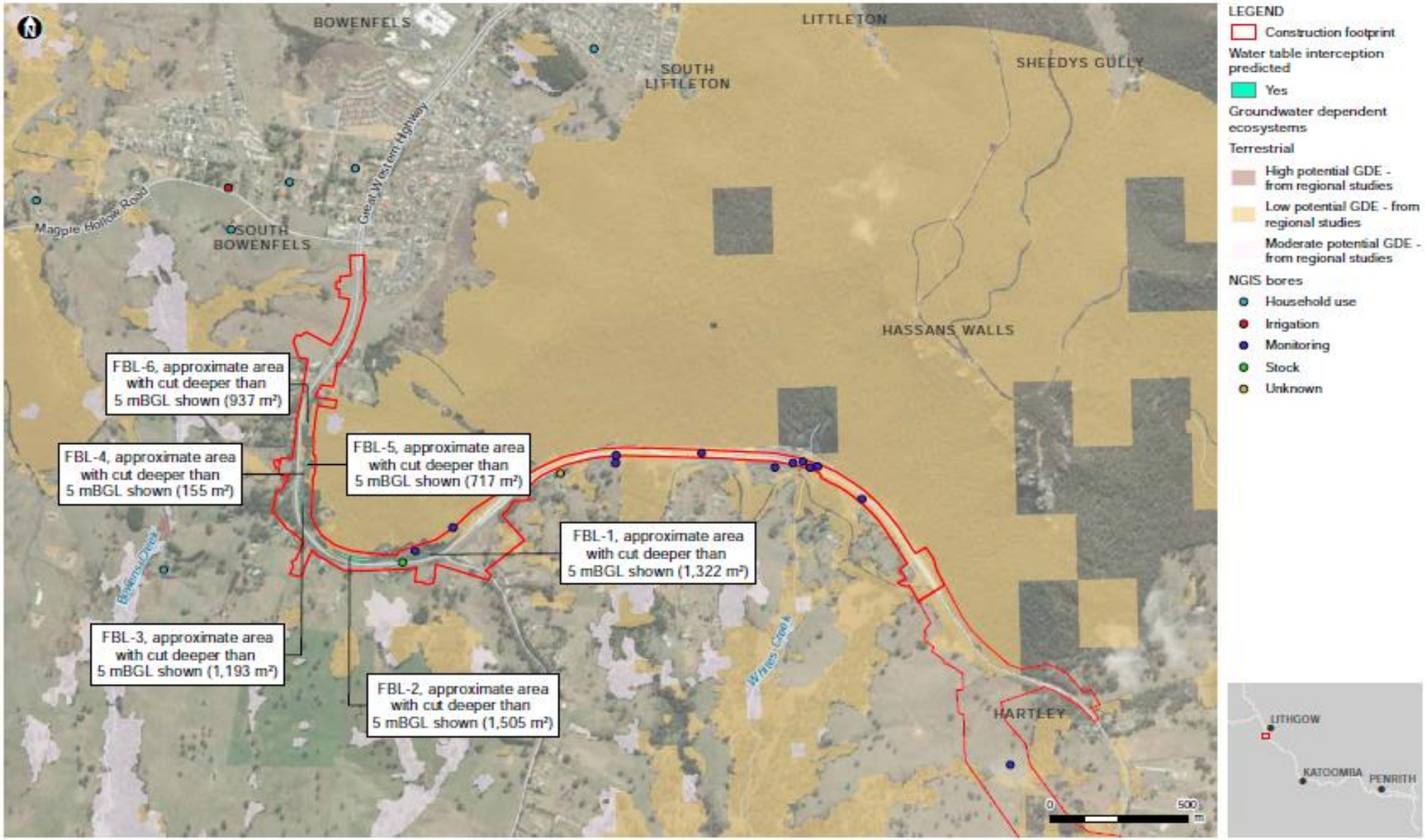


Figure 6-30 Forty Bends to Lithgow section for groundwater assessment

Impacts to existing bores

Stock and domestic bore GW070637 is within the construction footprint and will therefore likely require decommissioning. Monitoring bores GW111924 and GW111961 are also within the construction footprint. Of these monitoring bores, bore GW111961 is on the periphery of the construction footprint and therefore may be able to be retained. However, monitoring bore GW111924 is not on the periphery of the construction footprint and therefore will likely require decommissioning.

Other impacts to existing bores are not anticipated.

Impacts to groundwater dependent ecosystems

Impacts to groundwater dependent ecosystems are considered in Section 6.1 Biodiversity.

Discharge of intercepted groundwater

Discharge of groundwater intercepted by proposed road cuttings to receiving environments is not anticipated to cause material environment impacts because the calculated groundwater inflow rates are very low (calculated maximum rate of 0.24 kilolitres per day or 0.003 litres per second) and discharged groundwater would be diluted by surface water.

Proposal wide impacts

Changes to baseflow

Material changes to baseflow to watercourses due to the proposal are not anticipated. This is because predicted changes to groundwater levels are small and localised to the vicinity of the proposal.

Potential changes to groundwater quality

Impacts to groundwater quality during construction are outlined below:

- Groundwater systems could become contaminated if accidental spills or leaks of hazardous materials (such as fuels, lubricants and hydraulic oils) occur during construction or operation
- If potential acid sulfate soil or rock is excavated and oxidised or if actual acid sulfate soil or rock is excavated and mobilised, some acidification could occur. Acidification could also occur due to oxidisation as a result of lowered groundwater levels. The acidification could also potentially mobilise heavy metals
- The acidification could worsen the quality of groundwater which may flow into proposed road cuttings and subsequently be discharged to receiving environments. If acid sulfate soil or rock material is used as fill, acidified leachate could migrate to the water table and beyond
- Groundwater salinity could be increased if groundwater levels increase, and salts are mobilised that have natural accumulated in the soil.

With the implementation of the mitigation measures outlined in Table 6-88, the risks of these impacts occurring is considered low.

Potential groundwater contamination

Potential groundwater contamination impacts are considered in Section 6.12 Contamination.

NSW API minimal impact consideration assessment summary

Predicted groundwater level reductions are less than the NSW Aquifer Interference Policy minimal impact considerations. The beneficial use category of groundwater sources is not anticipated to be lowered beyond 40 metres of the proposal, which is an AIP water quality criterion. It is not anticipated that an Aquifer Interference License will be required for the proposal.

Sydney Drinking Water Catchment NorBE assessment

In the context of the Sydney Drinking Water Catchment, with adoption of recommended mitigation measures outlined below, the proposal is assessed as likely to have a neutral impact on groundwater quality.

6.7.4 Safeguards and management measures

Table 6-88 Safeguards and management measures – groundwater

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
GW01	Evaluation of hydraulic conductivity test data	Once groundwater monitoring bores associated with the current geotechnical drilling program have been installed and slug tested, the hydraulic conductivity assumptions adopted for the Groundwater report (Appendix J) will be reviewed in light of the test data. If test data shows hydraulic conductivity to deviate significantly from the assumed values in this report, then re-assessment of potential groundwater impacts and groundwater inflow rates will be required. A hydrogeologist will review the hydraulic conductivity test data once available and determine whether re-assessment of potential groundwater impacts/groundwater inflow rates with revised hydraulic conductivity assumptions is required.	Transport	Prior to construction	Appendix J	All
GW02	Groundwater monitoring program	Groundwater monitoring will be undertaken to acquire appropriate baseline data and to provide a basis by which the proposal impact on groundwater can be monitored. This would include:	Transport	Prior to construction	Appendix J	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Reviewing groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores (currently in process of being installed as part of geotechnical investigations) • Prior to commencement of construction, a groundwater quality sampling round should be undertaken at the 26 scheduled proposal groundwater monitoring bores. The analytes should comprise field parameters, major ions (chloride, sulphate, sodium, potassium, magnesium, calcium, carbonate and bicarbonate) and dissolved heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and manganese).				
GW03	Construction groundwater monitoring	During the construction phase, the following groundwater monitoring should occur: • Continuation of groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores. The data should be downloaded and reviewed quarterly. • Quarterly groundwater quality sampling rounds at select (locations and quantity to be confirmed at end of baseline period, prior to	Transport	Construction	Appendix J	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		construction) proposal monitoring bores. The tested analytes should be the same as those outlined in Section 6.3.1 of Appendix J. The data should be reviewed after each sampling round.				
GW04	Operational groundwater monitoring	During the operational phase the following groundwater monitoring should occur: • Continuation of groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores. The data should be downloaded and reviewed quarterly. • Quarterly groundwater quality sampling rounds as per the construction period monitoring regime. The data should be reviewed after each sampling round. After one a year the data should be reviewed, and a decision made as to whether monitoring should continue.	Contractor	Construction	Appendix J	All

Other safeguards and management measures that would address groundwater impacts are identified in sections 6.1 Biodiversity, 6.6 Soils and Surface Water and 6.12 Contamination.

6.8 Hydrology and flooding

This section provides a summary of the assessment of potential hydrology and flooding impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed hydrology and flooding assessment is provided in the technical working paper – hydrology and hydraulic assessment (Appendix K).

6.8.1 Methodology

The flooding and hydrology assessment involved the following:

- Undertaking a desktop review of available literature, databases, aerial photography, topographic mapping and existing land use to aid in interpreting the existing hydrological conditions of waterways and floodplains within the respective study areas
- Analysing of LiDAR terrain data to determine the stormwater sub-catchment areas upstream of the proposed alignment
- Developing a detailed hydrological model using TUFLOW and Australian Rainfall and Runoff 2019 (ARR2019) guideline data and methods for comparison with the previous study's results as well as the new ARR2019 Regional Flood Frequency Estimation method. The hydrological model was run for a range of rainfall events, ranging from relatively frequent (ten per cent Annual Exceedance Probability (AEP)) to extreme (Probable Maximum Flood (PMF)), including a Climate Change estimate as per Transport's guideline Climate Change Adaptation for the Road Network
- Developing two hydraulic computer models to analyse the flood behaviour under pre and post-construction conditions to check flood immunity and impacts of the proposal.

6.8.2 Existing environment

Catchment overview

Most of the proposal lies within the floor of Hartley Valley, a rural landscape of mainly open pastureland. The overall catchment upstream of the proposal is approximately 100 square kilometres in area, with steep bushland and cliffs in the upper reaches draining to flat open pasture. Runoff from the catchment travels past the Great Western Highway into Coxs River, one of the main inflow sources of Warragamba Dam.

Waterways

Key waterways within the study area include:

- River Lett is located near the village of Hartley. Where this waterway crosses the proposal, near the existing Great Western Highway, the river is confined within steep embankments and set deeply within the terrain. The riverbanks are thickly vegetated, and the existing two-span highway bridge (approximately sixty one metres long) is above flood level for all but the largest floods
- Boxes Creek is a tributary of River Lett crosses the highway about four hundred metres west of the River Lett crossing. It has a sizable catchment of almost six square kilometres, part of which extends to the steep terrain of Hassans Walls. A four-cell box culvert (2.74 metres wide by 2.74 metres high) conveys Boxes Creek flows across the highway. Boxes Creek joins River Lett just downstream of the highway, upstream of an old timber bridge which formed the River Lett crossing of the Old Great Western Highway
- Rosedale Creek is a minor waterway that crosses the proposal near its eastern end. Its upstream catchment is about two square kilometres, consisting of bushland in its steep upper regions and rural land-use in its valley floor. This catchment has approximately ten small dams which may influence the

hydrological response depending on their water level when a rainfall peak arrives. There is also a somewhat larger dam downstream of the highway which collects runoff from the catchment prior to discharging to the main tributary of this part of Hartley Valley originating at Mount Victoria (Butlers Creek). A two-cell box culvert (3.6 metres wide by 2.4 metres high) conveys Rosedale Creek flows across the highway.

Catchment areas for the main waterways are listed in Table 6-89.

Table 6-89 Catchment Areas of the Main Waterways

Waterway	Catchment Area (hectares)
River Lett (at the Great Western Highway)	9,240
Boxes Creek (at the Great Western Highway)	590
Rosedale Creek (at the Great Western Highway)	210

Flood conditions

River Lett and Boxes Creek

River Lett and Boxes Creek have a steep longitudinal profile with flow in both River Lett and Boxes Creek confined within steep banks. Modelling shows that floodwater does not overtop the Great Western Highway under existing conditions in the one per cent Annual Exceedance Probability (AEP). The results show that Blackmans Creek Road causeway at Boxes Creek overtops in the smallest flood analysed (ten per cent AEP).

The Probable Maximum Flood (PMF) results for River Lett and Boxes Creek show overtopping of the highway at both waterways. Even though the PMF flooding is large, flows are still confined to the waterways without breakouts across floodplains. This is due in part to the steep nature of the terrain.

Rosedale Creek

Modelling of existing conditions within Rosedale Creek shows flat water within the dams that form part of the upstream catchment, but outside of these dams the watercourses are very steep. Floodwater was shown to build up at the upstream (southern) end of the existing main culvert crossing Great Western Highway. Floodwater does not overtop the highway in the one per cent AEP, however it does overtop the highway in the PMF.

6.8.3 Potential impacts

Construction

Hydrology and drainage

Key activities during construction of the proposal that may impact the nature of surface water hydrology (volume, rate, timing, duration, velocity, etc.) associated with stormwater discharges include:

- Vegetation clearance (of trees, understory and ground cover) and reduced infiltration associated with soil compaction and paving within the road corridor
- Temporary dewatering of groundwater ingress to construction excavations
- Temporary and permanent alteration or impedance of existing drainage paths and waterways which have the potential to result in localised increases in flow velocities around instream features

- Attenuated or delayed discharge of stormwater captured in temporary construction sediment basins and permanent water quality basins
- Reuse of stormwater captured in temporary construction sediment basins and permanent water quality basins
- Construction of bridge abutments on watercourse banks
- Temporary access tracks across watercourses
- Use of haul roads
- Stockpiling and ancillary storage facilities.

Potential surface water quality contaminants during construction include sedimentation from earthworks and chemicals and fuels associated with operating machinery, road surfacing and landscaping. The erosion and sedimentation control strategy and water quality protection from hazardous material spills during construction is described in Section 6.12 Contamination.

The proposal would cross several local drainage lines. During construction there is a potential for drainage lines to be temporarily blocked or diverted. Blocking or diversion of drainage lines may result in localised areas of flooding on the upstream side of the proposal and may prevent flows from reaching downstream receiving waters or dams. Diversion of drainage lines may also create localised areas of flooding and scour. These temporary impacts are expected to be minor and would be managed through the implementation of standard construction techniques.

Operation

Flooding impacts

The proposed road alignment was modelled to determine how key aspects of the design that could affect flood behaviour (such as the road embankments, basin embankments, bridges, and culverts) interact with, and potentially impact on, flood conditions along the proposed alignment.

Potential flooding impacts associated with the proposal would be confined to River Lett (including Boxes Creek) and Rosedale Creek. There are no other upstream catchments along the proposed alignment that are large enough to produce flooding.

The flood analysis results show that the proposal may impact on localised areas, however these are all within land already flooded in present day conditions. This is due to the relatively steep terrain which acts to confine the flood extent in proposed conditions to minor increases.

River Lett and Boxes Creek

Modelling results show that flood behaviour for floods up to the one per cent AEP would be unchanged. There would potentially be two areas of localised flood level increase:

- Upstream of the proposed Great Western Highway River Lett bridge
- Upstream of the Kelly Street service road stub.

Flood velocity changes would be negligible. No dwellings would be impacted by the proposal in the one per cent AEP.

Inundation duration increases would be negligible due to the minor changes in flood levels. Upstream of the proposed River Lett bridge, the results show a 50 millimetre increase in flood level in a six hour duration event. The timespan of this additional 50 millimetre rise and fall is approximately 20 minutes. There are no consequences for 20 minutes for up to 50 millimetres of additional flood level to occur on a creek bank in a one percent AEP flood.

The PMF results show significant flood level increases within River Lett of up to one metre. However, due to the steep riverbanks, the flood extent would not widen by any significant distance, and there would be no

fundamental change in flow behaviour, such as flow breakouts. The Kelly Street service road stub would slow upstream flows with a subsequent velocity increase downstream. Moving this road stub eastwards may improve flooding conditions at this location, and would be considered during detailed design.

At Boxes Creek, the PMF flood levels show an increase of up to 5.5 metres. Floodwater may build up at this location due to the proposed alignment being higher than the existing conditions, however it would not overtop the higher proposed road. All Boxes Creek flows would be conveyed through an existing culvert that would be extended under the proposed road alignment. The flood level increase would dissipate to zero due to the steep gradient of Boxes Creek within a distance of about five hundred metres from the Boxes Creek culvert. No dwellings are within the potentially impacted area, and due to the steep terrain the additional area of flood extent would be a maximum distance of 40 metres, and mostly less than 20 metres compared to existing conditions.

Although the results show that the proposal alters the flooding behaviour at Boxes Creek in the PMF, in the Design Flood Event (and even the Climate Change estimate of 0.2 per cent AEP) there would be no change to flooding conditions. The PMF is an estimate of the most extreme flood possible. Its average recurrence interval is approximately ten million years compared to one hundred years for the Design Flood Event. It is not practical nor advised to use such an extreme flood event for design. The PMF should only be used in the design of critical infrastructure such as dams, or to define the extent of flooding in order to place infrastructure outside the floodplain, such as with tunnel portals susceptible to inflows.

As discussed above, there is an existing culvert proposed to be extended that would be the sole source of conveyance for floodwater at Boxes Creek. This increases the sensitivity of culvert blockage and embankment stress during an extreme flood event. During detailed design, the height of the proposed road embankment at this location would be reviewed or alternative designs considered to eliminate or reduce this potential PMF impact. Additional flood modelling would also be undertaken during detailed design to assess the revised design. If residual risk of embankment stress remains following design review and further modelling, a dam safety check would be undertaken and further mitigation such as a debris catch upstream would be considered.

Rosedale Creek

Modelling results show that flood behaviour for floods up to the one per cent AEP would be unchanged. There is one area of potential localised flood level increase, at the upstream (southern) end of the extended Rosedale Creek culvert beneath Great Western Highway. The results show a potential flood level increase at this location of about 100 millimetres. The flood extent would extend in the order of several metres because the land is relatively steep. Most of the land potentially affected by this flood level increase is flooded under existing conditions. This affectation is mainly on private property pastureland between the existing highway embankment and the base of the adjacent dam embankment, approximately 50 metres in width and about 70 metres in length.

The one per cent AEP results show that the potential inundation duration increase at the upstream end of the Great Western Highway culvert at Rosedale Creek would be about 30 minutes for the 100 millimetres of flood level increase to rise and fall.

The PMF results show a potentially small upstream flood level increase of about 20 millimetres because floodwater overtops the highway in both existing and proposed conditions. Under proposed conditions, any floodwater that may overtop the highway would be diverted westwards along the proposed carriageways across the ridge into the next sub-catchment. This proportion of the PMF flow would reach Butlers Creek via paddocks to the west.

This flow overtopping and diversion would only occur in an extreme flood event. In the one per cent AEP (and even the climate change estimate of 0.2 per cent AEP) there would be no change to flooding behaviour other than the localised flood level increase at the culvert inlet.

Climate change

Flood level results for River Lett show that the nominated climate change event may result in an overall flood level increase of about 700 millimetres in the river (proposed minus existing, both under an increased rainfall intensity scenario). The potential flood level increase due to the proposal under the climate change scenario would be similar in pattern to the one per cent AEP, but amplified along the river to about twice the length. The predicted effects of climate change would not alter the potential flood risks associated with the proposal.

The Rosedale Creek flood level results show that the nominated climate change event may lead to an overall flood level increase of about 400 millimetres at the upstream end of the Great Western Highway culvert at Rosedale Creek. The flood level increase due to the proposal is similar in pattern to the one per cent AEP but would be amplified by about 40 millimetres. The predicted effects of climate change would not alter the flood risks for the proposal.

6.8.4 Safeguards and management measures

Table 6-90 Safeguards and management measures – hydrology and flooding

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
HF01	Operational flooding impacts	All cross-drainage structures including culverts and bridges would be constructed to cater for the 100 year ARI local and regional storm events to minimise upstream afflux.	Contractor	Detailed design	Appendix K	All
HF02	Operational flooding impacts	During detailed design, the height of the proposed road embankment adjacent to Boxes Creek would be reviewed or alternative designs considered to eliminate or reduce potential PMF impact.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends
HF03	Operational flooding impacts	Additional flood modelling would be undertaken during detailed design. If residual risk of embankment stress remains adjacent to Boxes Creek, a dam safety check would be undertaken and further mitigation such as a debris catch upstream would be considered.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends
HF04	Operational flooding impacts	An eastwards shift of the Kelly Street service road will be considered during detailed design to mitigate potential flooding impacts at this location.	Contractor	Detailed design	Appendix K	River Lett to Forty Bends

Other safeguards and management measures that would address hydrology and flooding impacts are identified in section 6.15 Sustainability, greenhouse gas and climate change.

6.9 Landscape character and visual impact

This section provides an assessment of the potential impacts of the proposal on landscape character and visual amenity and identifies safeguards and management measures to avoid or minimise these impacts. A detailed assessment of landscape character and visual impacts is presented in the technical working paper - urban design, landscape character and visual impact assessment (Appendix L).

6.9.1 Methodology

The methodology used to carry out the landscape character and visual impact assessment followed the 'Environment impact assessment practice note: Guideline for landscape character and visual impact assessment' (EIA-N04) (Transport for NSW, 2020), and included:

- Initial site visit and field investigation, review of relevant literature, and analysis of aerial photographs and topographic maps
- Review of the concept design and supporting material to gain an appreciation of the proposal
- Definition of landscape character through a site investigation area analysis
- Identification and description of landscape character zones
- Assessment of the impact of the proposal on these landscape character in terms of the sensitivity of the affected areas and the magnitude of the change created by the proposal, to provide an overall impact rating as indicated by the Impact Assessment Grading Matrix (Table 6-91)
- Identification of the visual catchment of the proposal
- Selection of viewpoints within the visual catchment representing a range of different land uses
- Assessment of the visual impact of the proposal through comparison of the sensitivity of viewpoints and the magnitude of the change created by the proposal, to provide an overall impact rating as indicated by the Impact Assessment Grading Matrix (Table 6-91)
- Identification of urban design and landscape safeguards and management measures to mitigate any adverse visual impacts to assist the ongoing development of the concept design and for consideration in the detail design phase of the proposal.

Table 6-91 Landscape character and visual impact rating matrix (Transport for NSW, 2020a)

		Magnitude			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High	High-moderate	Moderate	Negligible
	Moderate	High-moderate	Moderate	Moderate-low	Negligible
	Low	Moderate	Moderate-low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

6.9.2 Existing environment

The proposal is located about 135 kilometres west of Sydney in the Great Dividing Range. The proposal is predominantly located adjacent to the existing Great Western Highway, with the Newnes Plateau to the north and the Blue Mountains National Park to the east. The majority of the proposal lies within the highly

picturesque Hartley Valley. Bordered by dramatic sandstone escarpments to the north and east, and undulating hills to the west, the valley has a distinctive form and cultural identity that is highly valued by both residents and visitors.

The exposed sandstone escarpments such as Hassan Walls and Mount York are key landscape features when viewed from within the Hartley Valley. The densely vegetated ridges and hill slopes provide a predominantly natural character that contrasts strongly with the more open cultural landscape of the valley, which has been cleared for farming and settlement purposes. Additionally, the adjacent world heritage listed Blue Mountains National Park and numerous public reserves add to the Hartley Valley's natural and cultural value.

The terrain is incised by a series of watercourses that feed into the River Lett, which flows from the north east to the south west transecting through the centre of the construction footprint towards Coxs River. River Lett Hill rises steeply to the west of the river, forming a predominant landform.

The combination of the natural and cultural scenic qualities with the abundant local heritage values establishes a unique identity to the area. These values provide a strong sense of place for the local inhabitants, as well as visitors and through traffic approaching and leaving the Blue Mountains National Park and beyond.

Landscape character zones

Within and surrounding the construction footprint, five Landscape Character Zones (LCZs) have been identified, as shown Figure 6-31 and described below.

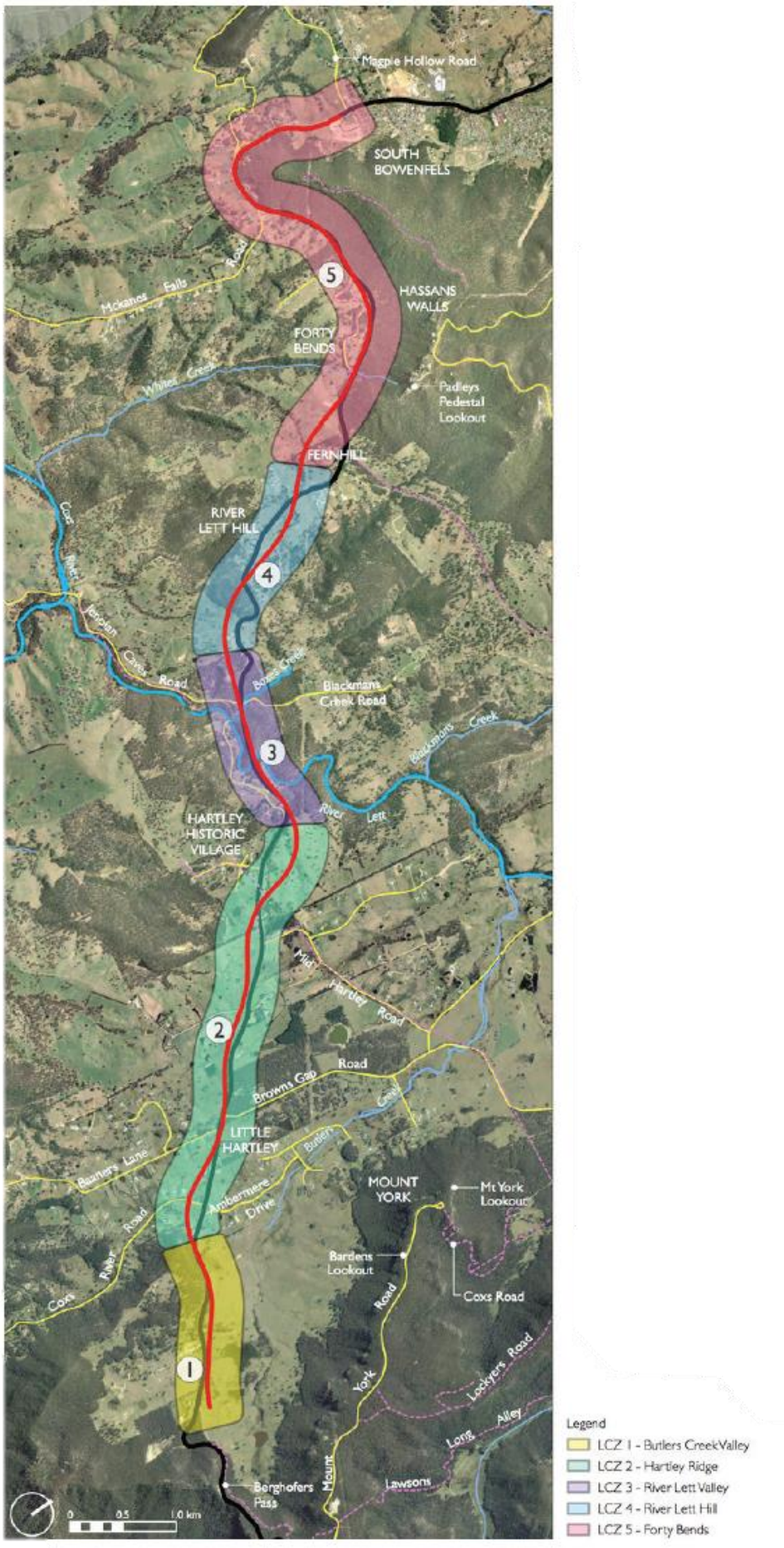


Figure 6-31 Landscape character zones

LCZ 1 – Butlers Creek Valley

Butlers Creek Valley (Figure 6-32) is a small cleared undulating alluvial valley, closely surrounded by the vegetated escarpments of Victoria Pass and Mount York. It is a sparsely populated area of rural pasture land that is highly visible from along the Mount York ridgeline, Great Western Highway, Coxs River Road, Little Hartley and the adjoining rural residential areas.

Butlers Creek is an intermittent stream that flows north west into the River Lett. A series of large farm dams provide water for livestock and contribute to the attractive visual character of the area. Additionally this precinct provides views east towards the Mount York ridgeline, Mitchells Ridge and a distant view north-west to Hassans Walls.

Figure 6-32 View of LCZ 1 facing east towards Victoria Pass

LCZ 2 – Hartley Ridge

Hartley Ridge (Figure 6-33) is an area characterised by flat to gently undulating topography with a varied vegetation pattern of grazing land and scattered remnant stands of woodland vegetation. The land uses are characterised by rural residential properties and small businesses spread along the existing highway.

There are a number of heritage listed properties of state and local significance which contribute significantly to its character. A large escarpment exists on the southern side of the existing highway at Historic Hartley Village. Cultural plantings in association with these historic properties and the remnant road side vegetation are an important feature of the precinct. There is also areas of vegetation that are considered to hold high biodiversity value and is listed as Endangered under the *Biodiversity Conservation Act 2016* and *Environmental Protection and Biodiversity Conservation Act 1999*.

Many of the residences are located very close to the existing highway, in some cases within fifteen metres. In the areas north and south of the highway there have been a substantial number of rural residential subdivisions along local roads such as Ambermere Drive and Coxs River Road.

Figure 6-33 View of LCZ 2 at the Coxs River Road facing west

LCZ 3 – River Lett Valley

The River Lett Valley comprises a steeply undulating landform with a deep river channel. Dense areas of vegetation along the river valley are ecologically important and contribute significantly to the precinct's landscape character.

On the eastern valley slopes of the River Lett the 19th century Hartley Historic Village, a historic site under the administration of the National Parks and Wildlife Service, is set amongst pastures, orchards, native vegetation and the remnants of 19th and 20th century cottage gardens. It comprises seventeen buildings of historical significance (two of which are privately owned).

The existing highway crosses the River Lett and is joined by the local and regional road network including Blackmans Creek Road and Jenolan Caves Road which connect to the existing highway on the western embankment of the river. Jenolan Caves Road provides for local, regional, tourist and freight traffic.

Figure 6-34 View of LCZ 3 at Hartley Historic Village facing east

LCZ 4 – River Lett Hill

This LCZ comprises the majority of the western Hartley Valley whose steeply undulating topography creates significant limitations for traffic on the existing highway. The undulating hills are overshadowed by Hassans Walls to the north which offers panoramic views of the valleys to the south and west. This area is highly visible from Hassans Walls and partially visible from Mount York.

The rolling hills and valleys provide privacy for residents from one another while still living in relative proximity. The majority of dwellings are located on hills sloping down to creeks, and hills adjacent to the highway, but sloping away from the highway.

A sandstone heritage property is located near the top of River Lett Hill close to the existing highway.

Figure 6-35 View over the eastern slopes of LCZ 4

LCZ 5 – Forty Bends

The topography of this LCZ comprises undulating hills that are overshadowed by Hassans Walls to the north and overlooks the valley of Whites Creek to the south. The shadowing effect of Hassans Walls on the highway means that black ice is often a problem during the winter months. The footslopes of Hassans Walls are incised by numerous gullies which are steep and broad as they flow south into Whites Creek.

Similar to LCZ 4, residents are located on hills adjacent to the highway and have privacy from one another due to the rolling hills and valleys.

Several historic heritage properties are located within the vicinity of Forty Bends Road and Old Bowenfels.

This area is highly visible from Hassans Walls and Mount York with extensive views to Hassans Walls, Mount Clarence, Darling Causeway and Mount York, providing rich scenic value.

Figure 6-36 View of LCZ 5 looking north east

6.9.3 Potential impacts

Construction

During construction, there would be temporary landscape character and visual impacts. These impacts would include views of large earthmoving and construction equipment, construction activities, stored materials and stockpiles, activities in and around ancillary facilities, vegetation clearing and excavation.

Construction, particularly out of hours work (as identified in Section 3.3.3 construction hours and duration) would require lighting at ancillary facilities and work areas. These locations could result in light spill impact on adjoining properties. This may result in a temporary visual impact at night, particularly near residences. Safeguards and management measures have been identified for temporary construction works to manage landscape character and visual impacts.

Operation

Landscape character impacts

The proposal would have a high-moderate impact on four of the LCZs due to the vegetation clearing, the introduction of new infrastructure and associated earthworks. The proposal would have a moderate impact on one LCZ where only minor changes to the existing environment are proposed.

An assessment of the magnitude of change as a result of the proposal, the sensitivity of the landscape character zones and the overall landscape character impact the proposal is provided in Table 6-92.

Safeguards and management measures (as identified in Section 6.9.4) would be implemented to minimise potential landscape character impacts.

Table 6-92 Landscape character impacts

Sensitivity of LCZ	Magnitude of change	Landscape character impact
LCZ 1 – Butlers Creek Valley		
Moderate Despite being a modified landscape, the zone has an attractive rural scenic character, and the gently winding highway is predominately lined with exotic trees and woodland species, heightening the country/rural driving experience.	High The scale of the proposal within this rural area would be substantial, with changes including the new dual carriageway, service road, a bridge over the Great Western Highway, new property access roads, permanent water quality basins, moderate vegetation clearing and revegetation works.	High-moderate
LCZ 2 – Hartley Ridge		
Moderate This zone typifies the experience of travelling through the Hartley Valley with its extensive views over rolling pastures dotted with properties and glistening dams, to dramatic escarpments. These views are broken up by roadside planting and stands of native woodland.	High The scale of the proposal within this rural area, and in particular to Little Hartley, would be substantial, with changes including the new dual carriageway, service roads, multiple bridges and intersection upgrades, retaining walls, eastbound and westbound rest areas, permanent water quality basins, moderate vegetation clearing and revegetation works.	High-moderate
LCZ 3 – River Lett Valley		
Moderate The existing road corridor is generally well vegetated with native woodland which has a high sensitivity. Historic Hartley Village is also a highly valued heritage site.	High The scale of the proposal, in particular the twin bridges over Jenolan Caves Road (about 370 metres long), and the extensive vegetation removal would be substantial, with changes including the new dual carriageway, service roads, multiple bridges and intersection upgrades, retaining walls, new property access roads, permanent water quality basins, moderate vegetation clearing and revegetation works.	High-moderate
LCZ 4 – River Lett Hill		
Moderate There are good mid to long distance views to the east over the surrounding landscape from the four lane highway as it winds up River Lett Hill. At the crest, the highway becomes two lanes	High The scale of the new highway alignment and the extensive vegetation removal would be substantial, with changes including the new dual carriageway, service roads, new property access	High-moderate

Sensitivity of LCZ	Magnitude of change	Landscape character impact
and is predominately lined with exotic trees and woodland species, heightening the country/rural driving experience.	roads, permanent water quality basins, vegetation clearing and revegetation works.	
LCZ 5 – Forty Bends		
Moderate The existing road corridor is generally well vegetated with dry sclerophyll forest along the southern slopes of Hassans Walls which has a high sensitivity, though the area outside the immediate road corridor to the south has an open rural character dotted with residences that reduces the sensitivity.	Moderate The proposal generally occurs within the existing Great Western Highway alignment, with upgrades to the existing highway, service roads, intersection upgrades, new property access roads, permanent water quality basins, and revegetation works.	Moderate

Visual impacts

There would be varied visual impacts as a result of the proposal. Twenty seven viewpoints have been selected for the purpose of this assessment that represent a range of directions, distances and sensitive receivers within proximity to the proposal, as shown in Figure 6-37.

A summary of the assessment of the magnitude of the proposal, the sensitivity of the viewpoints and the overall visual impact the proposal is provided in Table 6-93.

Safeguards and management measures (as identified in Section 6.9.4) would be implemented to minimise potential visual impacts. Some of the impacts of the proposal would lessen overtime as vegetation matures.

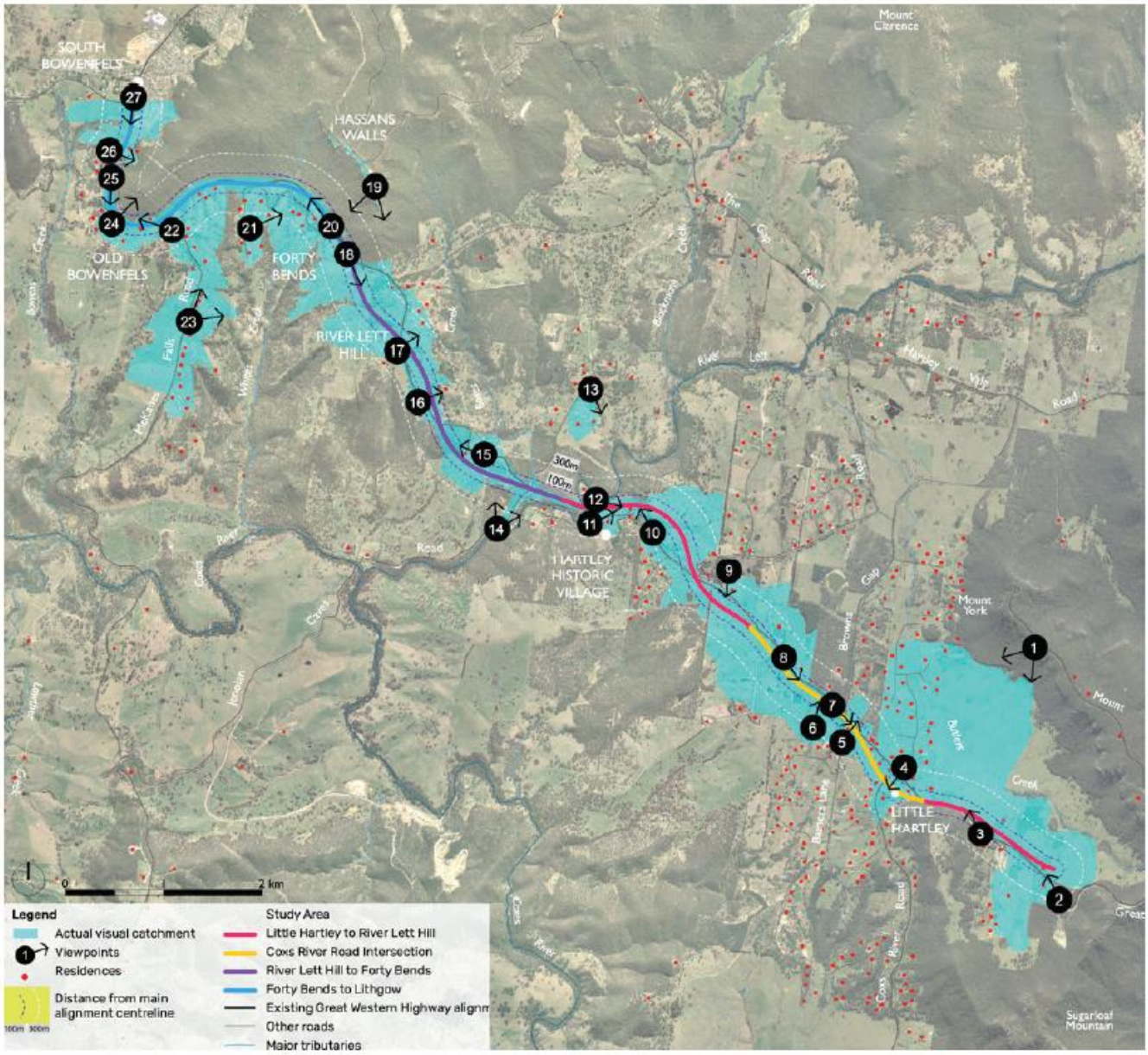


Figure 6-37 Visual catchment and assessment viewpoints

Artist's impressions have been prepared to provide a visualisation of how the proposal may appear during operation, as shown in Figure 6-38 to Figure 6-53.

Figure 6-38 Viewpoint 3 (existing) from Great Western Highway at the entrance of Hartley Valley Holiday Farm, looking north-west.

Figure 6-39 Viewpoint 3 (visualisation of proposal) from Great Western Highway at the entrance of Hartley Valley Holiday Farm, looking north-west.

Figure 6-40 Viewpoint 7 (existing) from Great Western Highway, east of Baaners Lane, looking south-east.

Figure 6-41 Viewpoint 7 (visualisation of proposal) from Great Western Highway, east of Baaners Lane, looking south-east.

Figure 6-42 Viewpoint 11 (existing) from Old Bathurst Road, Hartley Historic Village, adjacent to the Hartley Courthouse Building, looking north-east.

Figure 6-43 Viewpoint 11 (visualisation of proposal) from Old Bathurst Road, Hartley Historic Village, adjacent to the Hartley Courthouse Building, looking north-east.

Figure 6-44 Viewpoint 13 (existing) from Blackmans Creek Road, about 1.1 kilometres from the Great Western Highway, looking south-east.

Figure 6-45 Viewpoint 13 (visualisation of proposal) from Blackmans Creek Road, about 1.1 kilometres from the Great Western Highway, looking south-east.

Figure 6-46 Viewpoint 14 (existing) from Jenolan Caves Road, about 230 metres from the Great Western Highway, looking north-east.

Figure 6-47 Viewpoint 14 (visualisation of proposal) from Jenolan Caves Road, about 230 metres from the Great Western Highway, looking north-east.

Figure 6-48 Viewpoint 16 (existing) from Great Western Highway, near the entrance to 2987 Great Western Highway, looking south-east.

Figure 6-49 Viewpoint 16 (visualisation of proposal) from Great Western Highway, near the entrance to 2987 Great Western Highway, looking south-east.

Figure 6-50 Viewpoint 22 (existing) from McKanes Falls Road at intersection with the Great Western Highway, looking west.

Figure 6-51 Viewpoint 22 (visualisation of proposal) from McKanes Falls Road at intersection with the Great Western Highway, looking west.

Figure 6-52 Viewpoint 25 (existing) from Great Western Highway, near the intersection of Old Bathurst Road, looking south.

Figure 6-53 Viewpoint 25 (visualisation of proposal) from Great Western Highway, near the intersection of Old Bathurst Road, looking south.

A summary of the assessment of the magnitude of the proposal is provided in Table 6-93, along with the sensitivity of the viewpoints and the overall visual impact the proposal. The proposal would result in Moderate-Low impacts for eight viewpoints. Four viewpoints would have High impacts and four viewpoints would have Moderate impacts. Three viewpoints would have a High-Moderate impacts, two viewpoints would have Low impacts and two viewpoints would have negligible impacts.

Table 6-93 Summary of visual impacts from selected viewpoints

Viewpoint		Sensitivity of viewpoint	Magnitude of change	Rationale	Visual impact
1	Bardens Lookout facing south west	Moderate	Moderate	• Public lookout • Wide visibility at a distance • Removal of existing vegetation • Time before landscape mitigation can be effective	Moderate
2	Great Western Highway at the base of Victoria Pass facing north west	Moderate	Low	• Transient viewers • Distance from proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Moderate-low
3	Great Western Highway at the entry of Hartley Valley Holiday Farm facing west	Moderate	Low	• Residential and transient viewers • Minimal vegetation removal • Proposed vegetation would provide screening	Moderate-low
4	Bus stop next to the eastbound lane of the Great Western Highway, west of Ambermere Drive, facing south west	Low	Moderate	• Transient viewers • Distance from proposal • Minor increase in hardstand • Visibility of proposed bridge in the mid-distance • Removal of existing vegetation • Potential for landscape mitigation over time	Moderate-low
5	Baaners Lanes, about 200 metres from the Great Western Highway intersection	High	High	• Residential viewers • Increased hardstand across proposal extents • Removal of existing vegetation • Potential for landscape mitigation over time	High
6	Cul-de-sac of Apple Tree Lane about 260 metres south of	High	High	• Residential viewers • Increased hardstand across proposal extents	High

Viewpoint		Sensitivity of viewpoint	Magnitude of change	Rationale	Visual impact
	the Great Western Highway facing north			• Removal of existing vegetation • Potential for landscape mitigation over time	
7	Great Western Highway at Browns Gap Road intersection facing south east	Moderate	High	• Transient viewers • Proximity of proposal • Increased hardstand across proposal extents • Removal of existing vegetation • Potential for landscape mitigation over time	High-moderate
8	Great Western Highway at Hartley Cemetery entry facing south east	Moderate	Low	• Visitors to cemetery and transient viewers • Distance from proposal • Localised vegetation removal • Potential for landscape mitigation over time	Moderate-low
9	Mid Hartley Road next to the Hartley Community Hall facing south	Moderate	Negligible	• Proposal not visible	Negligible
10	Great Western Highway about 350 metres west of Carroll Drive facing north west	Low	Low	• Transient viewers • Distance from proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Low
11	Old Bathurst Road, Hartley Historic Village, next to the Royal Hotel facing west	High	High	• Visitors to Hartley Historic Village • Proximity of proposal • Increased hardstand across proposal extents • Removal of existing vegetation • Limited opportunity for landscape mitigation	High
12	Walker Street, 50 metres north of the Great Western Highway facing east	High	High	• View covered by proposal	High

Viewpoint		Sensitivity of viewpoint	Magnitude of change	Rationale	Visual impact
13	Blackmans Creek Road about 1.2 kilometres from the Great Western Highway facing south east	Moderate	Moderate	• Residential viewers • Wide visibility at a distance • Increased hardstand across proposal extents • Removal of existing vegetation • Limited opportunity for landscape mitigation as seen from this view	Moderate
14	Jenolan Caves Road about 150 metre from the Great Western Highway intersection facing north	Moderate	High	• Transient viewers including tourists • Proximity of proposal • Minor increase in hardstand • Visibility of proposed twin bridges in the mid-distance • Removal of existing vegetation • Limited opportunity for landscape mitigation	High-moderate
15	Great Western Highway approaching River Lett Hill facing west	Moderate	Negligible	• Residential and transient viewers • Proposal not visible	Negligible
16	Driveway of 2987 Great Western Highway, Hartley, facing west	Moderate	Moderate	• Residential and transient viewers • Minor increase in hardstand visible • Localised vegetation removal • Potential for landscape mitigation over time	Moderate
17	Driveway of 3033 Great Western Highway, Hartley, facing north east	Moderate	High	• Residential and transient viewers • Proximity of proposal • Increased hardstand across proposal extents • Removal of existing vegetation • Potential for landscape mitigation over time	High-moderate
18	Great Western Highway about 200 metres south east of Forty Bends	Low	Moderate	• Transient viewers • Proximity of proposal • Minor increase in hardstand • Localised vegetation removal	Moderate-low

Viewpoint		Sensitivity of viewpoint	Magnitude of change	Rationale	Visual impact
	Road facing south east			• Potential for landscape mitigation over time	
19	Edge of Hassans Walls on Padleys Pedestal lookout facing south east	Moderate	Moderate	• Public lookout • Wide visibility at a distance • Removal of existing vegetation • Time before landscape mitigation can be effective	Moderate
20	Great Western Highway at Forty Bends Road intersection facing north west	Low	Low	• Transient viewers • Proximity of proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Low
21	Southern end of Daintree Close facing east	Moderate	Low	• Residential viewers • Distance from proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Moderate-low
22	Great Western Highway at McKanes Falls Road intersection facing west	Low	Moderate	• Transient viewers • Proximity of proposal • Increased hardstand across proposal extents • Visibility of proposed retaining wall • Removal of existing vegetation • Limited opportunity for landscape mitigation	Moderate-low
23	Driveway of 67 McKanes Falls Road of north east	Moderate	Low	• Residential viewers • Distance from proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Moderate-low
24	Mudgee Street in from of ‘Umera’, 3449 Great	Moderate	Moderate	• Residential viewers • Proximity to heritage buildings • Proximity of proposal • Minor increase in hardstand	Moderate

Viewpoint		Sensitivity of viewpoint	Magnitude of change	Rationale	Visual impact
	Western Highway facing north east			• Visibility of proposed retaining wall • Removal of existing vegetation • Potential for landscape mitigation over time	
25	Great Western Highway near Somerset House facing south	Low	High	• Transient viewers • Proximity of proposal • Increased hardstand across proposal extents • Visibility of proposed retaining wall • Removal of existing vegetation • Limited opportunity for landscape mitigation	Moderate
26	Mudgee Street in front of Bowenfels Presbyterian Church facing east	Moderate	Moderate	• Residential viewers • Proximity to heritage buildings • Proximity of proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Moderate
27	Great Western Highway at Magpie Hollow Road intersection facing south	Low	Low	• Transient viewers • Proximity of proposal • Minor increase in hardstand • Localised vegetation removal • Potential for landscape mitigation over time	Low

An integrated design approach has been adopted for the proposal in order to ensure that the best possible outcomes are achieved. A number of urban design and landscape strategies have been incorporated into the proposal to minimise impacts and improve the project for residents and motorists. These include:

- Roadside drainage channels or median channels would be vegetated or rock-lined to visually integrate with the surroundings as much as possible
- The rounding of cut and fill batters to help integrate into the existing landform and create a more naturalised appearance
- Minimising the removal of existing vegetation and maximising revegetation and planting opportunities with appropriate species
- Refinement of bridge design and the design of peripheral elements to reduce visual impact
- Providing tree planting to mitigate the scale of the proposed infrastructure, reinstating the vegetation character of the area, framing views and providing amenity along the road corridor

- Designing new retaining walls to have a finish that relates to the character of the surrounding landscape.

Landscape concept drawings that take into account these strategies have been developed and are provided in Appendix L.

Safeguards and management measures (as identified in Section 6.9.4) would be implemented to minimise potential visual impacts. Some of the impacts of the proposal would lessen overtime as vegetation matures.

6.9.4 Safeguards and management measures

Table 6-94 Safeguards and management measures – Landscape character and visual impacts

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Section
LV01	Landscape character and visual impact	An Urban Design Plan will be prepared to support the final detailed proposal design and implemented as part of the CEMP. The Urban Design Plan will present an integrated urban design for the proposal, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for: • location and identification of existing vegetation and proposed landscaped areas, including species to be used • built elements including retaining walls and bridges • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. The Urban Design Plan will be prepared in accordance with relevant guidelines, including: • Beyond the Pavement (Transport for NSW, 2020b)	Transport / Contactor	Detailed design Prior to construction	Appendix L	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Section
		• Landscape and design guideline (Roads and Maritime Services, 2018) • Bridge Aesthetics (Transport for NSW, 2019).				
LV02	Landscape character and visual impact	Detailed design of the proposal will consider, where feasible and reasonable: • Opportunities to reduce the construction footprint • Minimising the number of ancillary facilities required • Using visually recessive materials to minimise the visual dominance of the road • Investigating opportunities to reduce the bulk of structures • Minimising vegetation clearing and maximising revegetation and planting opportunities, particularly in high sensitivity areas where screening is required • Ensuring residual land is developed to complement the existing landform • Opportunities to incorporate pedestrian and cycle connections.	Transport/ Contractor	Detailed design	Appendix L	All
LV03	Landscape character and visual impact	Landscape planting and maintenance will be in accordance with the Lithgow City Council Weed List and include indigenous species endemic to the area. Locally collected seeds or bioregionally-sourced indigenous seeds and plants will be used where feasible.	Transport/ Contractor	Detailed design Construction	Appendix L	All
LV04	Lighting	The design of temporary and permanent lighting will be carried out in accordance with AS 1158.1-1986 and will avoid unnecessary light spill on adjacent residents or sensitive receivers.	Transport/ Contractor	Detailed design Construction	Appendix L	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Section
LV05	Landscape character and visual impact	During construction, the following measures will be implemented: • Provide suitable barriers to screen views from adjacent areas during construction • Return temporary works areas, such as ancillary facilities, to at least their pre-construction condition progressively throughout the works, where feasible, or once construction is complete • Identify, protect and retain existing trees located within the ancillary facility areas • Temporary lighting should be screened or diverted to reduce unnecessary light spill.	Transport/ Contractor	Construction	Appendix L	All

Other safeguards and management measures that would address landscape impacts are identified in sections 6.4 Aboriginal heritage and 6.5 non-Aboriginal heritage

6.10 Socio-economic

This section provides a summary of the assessment of potential socio-economic impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of socio-economic impacts is presented in the Technical working paper – Land use, property and socio-economic assessment (Appendix M).

6.10.1 Methodology

The socio-economic assessment involved the following:

- Scoping the likely range of potential socio-economic issues and identifying communities potentially affected by the proposal's construction and operation
- Describing the socio-economic characteristics, conditions and values in the study area to provide a baseline from which potential impacts and benefits of the proposal can be assessed
- Identifying, assessing and evaluating the potential impacts and benefits to socio-economic values from the proposals construction and operation. Impacts were assessed using the evaluation matrix and criteria provided in Section 2.2 of Appendix M
- Identifying measures to avoid, manage or mitigate negative impacts and support potential benefits where practicable.

This assessment principally draws on information from the Australian Bureau of Statistics (ABS) Census of Population and Housing 2016, supplemented with information and data from Government agencies, Lithgow City Council and Blue Mountains City Council resources, and consultation with local businesses, community members and stakeholders.

6.10.2 Existing environment

Regional existing environment

Socio-economic profile

The socio-economic profile of the local community near the proposal based on 2016 Census data and other data from the ABS is outlined in Table 6-95.

Table 6-95 Regional socio-economic profile

Socio-economic profile	Description
Population, age and mobility	• Around 1,975 people are living in the study area (refer to Section 3.1 of Appendix M) of which half live in the suburb of South Bowenfels • Older population (more people 65+ years old) with fewer people of working age when compared with the average for NSW • Low level of mobility with high proportions of people living in the study area for five years prior to the census.
Cultural diversity	• Low levels of cultural diversity compared to NSW with low levels of people born overseas or who speak a language other than English.
Households and families	• Total of 761 households in the study area of which half are in South Bowenfels

Socio-economic profile	Description
	• High number of lone person and couple only households compared to the NSW average.
Housing costs	• Housing is generally more affordable compared to NSW.
Socio-economic disadvantage and need for assistance	• Communities exhibited relatively high levels of advantage and low levels of disadvantage when compared with NSW • Generally, fewer people have need for assistance when compared with NSW with the exception of South Bowenfels which is likely associated with two retirement communities.
Income and employment	• Median incomes were similar or slightly greater when compared to the rest of NSW • Main industries of employment include health care and social assistance, public administration and safety, mining, retail, and construction.
Travel behaviour	• Communities are relatively dependent on private vehicles as their mode of transport to work.

Regional social infrastructure

Social infrastructure refers to community facilities, services and networks that help individuals, families, groups and communities meet their social needs, maximise their potential for development and enhance community well-being.

A range of social infrastructure serving communities in the study area are located within the main regional centres and towns of Lithgow, Mt Victoria, Blackheath and Katoomba. Communities in the study area also access services and facilities in larger centres such as Bathurst and Penrith, both located about an hour drive from the study area.

The urban centre of Lithgow in particular is the main focus of community services and facilities servicing communities in the study area including education, health care, emergency services, sport and recreation, and cultural facilities. Locally, social infrastructure within the study area suburbs are generally limited and include recreational and cultural facilities associated with tourist lookouts and historical sites, community halls, places of worship and emergency services.

Regional business and industry

There were 1,310 businesses in the Lithgow City LGA in 2019 (ABS, 2021 and ABS, 2021a), of which about 18.8 per cent were construction related businesses, and 18.5 per cent were agriculture, forestry or fishing businesses. At the same time, the Blue Mountains LGA had 5,617 businesses, of which construction accounted for 19.4 per cent and professional, scientific and technical services represented 16.4 per cent. Other important industries for businesses in the Lithgow City and Blue Mountains City LGAs included:

- Rental, hiring and real estate services
- Health care and social assistance
- Financial and insurance services
- Retail trade.

Tourism is an important industry within the study area and surrounding Blue Mountains, Central West and Orana region, leveraging the region's natural environment, recreation, cultural, historical and rural values. The region hosts a wide range of tourism related businesses including accommodation, restaurants, cafes, museums and galleries, specialty stores, including several that are located within the study area. Over the

12 months to June 2019, there were about 4.52 million overnight and daytrip visitors to the Blue Mountains Tourism Region (which includes the proposal area).

Regional access and connectivity

The Great Western Highway connects Sydney to Bathurst in Central West NSW, via the Blue Mountains and Lithgow. The highway is an important east-west connection for road freight, tourists and communities and towns along its length. Other important road links include Jenolan Caves Road, Darling Causeway and Hartley Valley Road.

Communities in the study area and surrounding region are also serviced by the Blue Mountains Line (BMT), which provides regular intercity train services between central Sydney and Lithgow and regional train services to Bathurst, Dubbo, Parkes and Broken Hill. Several bus routes operate between South Bowenfels and Lithgow.

Community values

The local character, amenity and identity of the study area is influenced by the area's natural features, nearby World Heritage Area, rural landscapes and lifestyles, and cultural and historic heritage of townships located along the Great Western Highway. These features offer a range of scenic amenity, environmental and recreational values that are important for tourists and visitors, and provide economic and employment benefits for residents and business owners. The region's scenic amenity and landscape values contribute to the study area's sense of place. The protection of important outlooks and view sheds and the study area's rural setting are important to local communities.

A high level of amenity is associated with the study area's natural setting, the valleys and hills of the area, and the rural villages and townships. Many residents have settled to the region in search of a rural lifestyle. Communities appreciate the quietness of the area, and access to open space, natural bushland and wildlife. The area has remained relatively untouched, and residents value the uniqueness and isolation of the area, with its fresh air, extensive orchards and climatic conditions.

Little Hartley to River Lett

The existing socio-economic environment, including local businesses, social infrastructure, local community access and connectivity, and community values, for the Little Hartley to River Lett proposal is summarised in Table 6-96.

Table 6-96 Existing socio-economic environment – Little Hartley to River Lett

Socio-economic criteria	Description
Local business	• Visitor accommodation.
Social infrastructure	• Hartley Cemetery • Hartley Hall • Hartley District Progress Association tennis courts • Hartley Fire Brigade shed.
Local access and connectivity	• Great Western Highway • Local roads including Mid Hartley Road and Carroll Drive • No bus or rail services.
Community values	• Local character and amenity which is influenced by rural character and lifestyle with large rural property holdings

Socio-economic criteria	Description
	• Little Hartley village which supports businesses and is a focus for the community • Quietness of the area, access to open space, natural bushland and wildlife • Heritage places of local and state significance.

Coxs River Road

The existing socio-economic environment, including local businesses, social infrastructure, local community access and connectivity, and community values, for the Little Hartley to River Lett proposal is summarised in Table 6-97.

Table 6-97 Existing socio-economic environment – Coxs River Road

Socio-economic criteria	Description
Local business	• Visitor accommodation • Cafes and restaurants • Retail • Service-related businesses (e.g. real estate businesses).
Social infrastructure	• Hartley Cemetery
Local access and connectivity	• Great Western Highway • Local roads including Coxs River Road, Ambermere Drive, Baaners Lane, Browns Gap Road • No rail service.
Community values	• Rural character and lifestyle • Heritage places of local and state significance.

River Lett to Forty Bends

The existing socio-economic environment, including local businesses, social infrastructure, local community access and connectivity, and community values, for the Little Hartley to River Lett proposal is summarised in Table 6-98.

Table 6-98 Existing socio-economic environment –River Lett to Forty Bends

Socio-economic criteria	Description
Local business	• Visitor accommodation in historic properties • Retail uses • Hartley Historic Village Visitor Centre.
Social infrastructure	• St John the Evangelist Anglican Church • Hartley Historic Village Visitor Centre.

Socio-economic criteria	Description
Local access and connectivity	• Great Western Highway • Local roads including Old Great Western Highway, Kelly Street, Walker Street, Blackmans Creek Road and several unnamed private roads • No rail service or bus services. Various school bus routes use Great Western Highway and local roads.
Community values	• Large areas of natural bushland and scenic landscapes that are interspersed with rural land uses including larger rural property holdings and areas of rural residential uses at Hartley • Hartley Historic Village is highly valued by local and regional communities as one of the first rural settlements west of Blue Mountains. Key heritage buildings include the courthouse, Royal Hotel, St Bernard's Catholic Church and Presbytery, St John the Evangelist Anglican Church, the former Shamrock and Farmers inns, the Finn residence of Bungarribee, Carney's cottage and garage and Ivy cottage • Tourism to Hartley Historic Village and surrounding heritage places of local and state importance such as Fernhill, Sunnyside Cottage and Hassans Walls Stockade and Barracks.

Forty Bends to Lithgow

The existing socio-economic environment, including local businesses, social infrastructure, local community access and connectivity, and community values, for the Little Hartley to River Lett proposal is summarised in Table 6-99.

Table 6-99 Existing socio-economic environment – Forty Bends to Lithgow

Socio-economic criteria	Description
Local business	• Retail uses • Visitor accommodation • Services related businesses that service residents and workers of surrounding suburbs and motorists along Great Western Highway.
Social infrastructure	• Hassan's Walls Lookout • Bownfels Catholic Cemetery • Blunder Street Reserve • Bowenfels Presbyterian Church and Cemetery • Colin McGarry Memorial Play Centre • South Bowenfels Rural Fire Brigade Sheds • Playground • Kirkley Gardens Village • Treeview Estates Retirement Village • Lithgow Bible Church • Unnamed landscaped area • Three Tree Lodge Aged Care

Socio-economic criteria	Description
	• Lithgow Community Private • Lithgow Hospital and Emergency Department.
Local access and connectivity	• Great Western Highway • Local roads including Forty Bends Road, Daintree Close, McKanes Falls Road, Mudgee Street / Old Bathurst Road, Mudgee Street / Quarry Place, Magpie Hollow Road • No rail service. Several bus services including Route 100 loop service connecting Lithgow to Littleton and Route 200 loop service connecting Lithgow to South Bowenfels.
Community values	• Areas of natural bushland and scenic landscapes at Hassans Walls north of the Great Western Highway • Rural landscapes at South Bowenfels, including larger farming properties and rural residential uses at McKanes Falls Road • Urban development and residential subdivisions northern of the proposal • Regional and local level community uses at South Bowenfels, including major health care and medical facilities concentrated at the Lithgow Hospital campus, retirement living and aged care facilities, and local facilities at South Brisbane dating from the mid-1800s • Heritage buildings and sites of local significance.

6.10.3 Potential impacts

Little Hartley to River Lett

Construction impacts

Construction impacts within Little Hartley to River Lett section are summarised in Table 6-100.

Table 6-100 Construction socio-economic impacts – Little Hartley to River Lett

Socio-economic criteria	Description
Business and industry	The only business within the Little Hartley to River Lett section is the Hartley Valley Holiday Farm. During construction, potential impacts on the Hartley Valley Holiday Farm would mainly be associated with: • Noise and dust from construction activities adversely affecting the amenity of the farm and impacting on its use and enjoyment for visitors as a place to relax and participate in outdoor pursuits such as horse riding, tennis, swimming, bike riding, dirt-bike riding and bush walking • An increase in construction traffic, particularly heavy vehicles, on the Great Western Highway and accessing work areas for this stage of the proposal potentially impacting perceptions of road safety for visitors to the farm • Changes to the landscape and visual amenity due to the presence of construction infrastructure and activities.

Socio-economic criteria	Description
	Impacts from construction activities for this stage of the proposal may discourage some people from using the holiday farm during the construction phase.
Social infrastructure	During construction, potential impacts on social infrastructure in this stage of the proposal would result from: • Noise and dust from construction activities for the new highway, resulting in temporary amenity disruptions for people visiting memorials within the Hartley Cemetery • Changes in local access and potential traffic disruptions for visitors to Hartley Cemetery and users of community facilities at Mid Hartley Road, due to changes in road conditions near to construction works and increased construction traffic. Adverse impacts on amenity at Hartley Cemetery may disrupt peoples' reflection and remembrance of loved ones. This may detract from some people's use of the cemetery for this purpose, although it is expected that any impact is likely to be minor given the relatively low numbers of people that are likely to be visiting the cemetery on a regular basis. Changes to road conditions along the Great Western Highway and local roads in the study area have potential to affect access for the Hartley Rural Fire Brigade when attending incidents, particularly to the east and west.
Access and connectivity	This stage of the proposal would mainly be constructed away from the existing highway although changes to local traffic conditions would occur where the new road crosses the existing highway at either end of this stage or at tie-ins to the highway and local roads. These have potential to result in: • Temporary traffic delays for road users due to such things as localised speed reductions and temporary lane closures, impacting on local residents and businesses, travellers on the Great Western Highway, and freight vehicle operators • Road safety risks due to temporary changes in road conditions and potential driver distractions from the presence of construction activities.
Community values	Potential impacts to the community during construction may include: • Temporary changes in local amenity due to increase noise, dust and light spill relating to construction activities for residents, businesses and facilities in proximity to the worksites • Temporary changes in local road access and connectivity • Temporary impact of increased employment relating to construction.

Operation impacts

Operation impacts within Little Hartley to River Lett section are summarised in Table 6-101.

Table 6-101 Operational socio-economic impacts – Little Hartley to River Lett

Socio-economic criteria	Description
Business and industry	Property acquisition for the proposal would not directly impact on businesses. Potential impacts on the Hartley Valley Holiday Farm would mainly be associated with changes to visual and landscape amenity due to the presence of the new road infrastructure and changes in road traffic noise from the new highway.
Social infrastructure	Property acquisition for the proposal would not directly impact on social infrastructure.

Socio-economic criteria	Description
	The new highway would improve access for local and regional communities to community facilities within the Little Hartley to River Lett stage of the proposal by reducing travel times and improved trip reliability.
Access and connectivity	The proposal would support safer and more reliable access to properties and destinations within the Little Hartley to River Lett stage of the proposal, through improved road conditions and the separation of local traffic and through traffic, including freight vehicles for much of this stage of the proposal.
Community values	The proposal will improve the regional accessibility, connectivity and safety of the highway leading to a positive community outcome. Improved traffic conditions will benefit society through improving accessibility to education, work and leisure facilities. Some local residents will be required to travel further distances to access their properties due to the direction separated lanes (refer to Section 6.2 Traffic and Transport) however this disbenefit will be offset by the increase in safety resulting from the restricted turns against ongoing highway traffic. Additionally, the reduction of regional and freight traffic passing through the main area of town will result in improved amenity through a reduction in noise, improved air quality and safety conditions for vehicles, pedestrians and cyclists.

Coxs River Road

Construction impacts

Construction impacts within Coxs River Road section are summarised in Table 6-102.

Table 6-102 Construction socio-economic impacts – Coxs River Road

Socio-economic criteria	Description
Business and industry	During construction, impacts to local businesses within the Little Hartley village and wider Little Hartley to River Lett stage of the proposal would mainly result from: • Traffic delays, disruptions and local access changes for road users where construction activities are located within or next to the road corridors for the Great Western Highway, Coxs River Road and other local roads • Adverse impacts on local amenity and the business environment due to noise, dust and construction traffic. Access would be maintained during construction to businesses near the proposal. Retail and hospitality businesses at Little Hartley and Hartley may experience an increase in business in response to the day-to-day needs of construction workers.
Social infrastructure	Social infrastructure within or near to the footprint of the Coxs River Road includes the Hartley Cemetery. Amenity impacts and changes to local access are expected as discussed in Sections 6.9 Landscape character and visual impacts and 6.2 Traffic and transport.
Access and connectivity	Construction works would be within the road corridors for the Great Western Highway, Coxs River Road, and Baaners Lane. Potential impacts of these works would result in: • Temporary traffic delays and disruptions for road users due to such things as localised speed reductions and temporary lane closures, impacting on local

Socio-economic criteria	Description
	residents and businesses, travellers on the Great Western Highway, Coxs River Road and other local roads, and freight vehicle operators • Potential road safety risks and changes to community perceptions of road safety due to temporary changes in road conditions and potential driver distractions from the presence of construction activities. - Access to private properties would be maintained during construction, although temporary access changes may be required for some properties near to construction works
Community values	Potential impacts to the community during construction may include: • Temporary changes in local amenity due to increase noise, dust and light spill relating to construction activities for residents, businesses and facilities in proximity to the worksites • Temporary changes in local road access and connectivity • Temporary impact of increased employment relating to construction.

Operation impacts

Operation impacts within Coxs River Road section are summarised in Table 6-103.

Table 6-103 Operational socio-economic impacts – Coxs River Road

Socio-economic criteria	Description
Business and industry	Partial property acquisition and temporary lease of land for the Coxs River Road would be required of land accommodating five businesses at Little Hartley and Hartley. These include The Lolly Bug, Hartley Realty & Lifestyle Properties, Adams Shed, Alchemy Woodfired Pizza, Venice Caravan Park, Hartley Vet. Potential impacts from the temporary lease or acquisition of land accommodating local businesses would generally result from: • Loss of land used for some business activities such as customer and staff parking, display or storage of goods, business signage, requiring changes to the layout of outdoor areas • Realignment of the highway resulting in the reduction of passing traffic and possible access changes for business customers, staff and deliveries. For most businesses, property acquisition or temporary lease of land for the proposal is not expected to impact ongoing business operations for individual businesses and impacts are generally not expected to be significant. However, there are a small number of businesses that may experience impacts that require changes to business operations such as Adams Shed and Hartley Valley Vets.
Social infrastructure	Property acquisition for the proposal would not directly impact on social infrastructure. Potential impacts on social infrastructure at Little Hartley and Hartley from the operation of the Coxs River Road would mainly relate to changes in traffic movement as discussed in Section 6.2 Traffic and transport.
Access and connectivity	The proposal would support safer and more reliable access to properties and destinations within Little Hartley and Hartley, through improved road conditions and the separation of local traffic and through traffic, including freight vehicles for much of this stage of the proposal.

Socio-economic criteria	Description
Community values	The proposal will improve the regional accessibility, connectivity and safety of the highway leading to a positive community outcome. Improved traffic conditions will benefit society through improving accessibility to education, work and leisure facilities. Some local residents will be required to travel further distances to access their properties due to the direction separated lanes, however this disbenefit will be offset by the increase in safety resulting from the restricted turns against ongoing highway traffic. Additionally, the reduction of regional and freight traffic passing through the main area of town will result in improved amenity through a reduction in noise, improved air quality and safety conditions for vehicles, pedestrians and cyclists. The new alignment of the highway is further away from several residential properties. This will result in the proposal having a positive impact on the surrounding amenity through reduced traffic noise and improved air quality experienced by locals.

River Lett to Forty Bends

Construction impacts

Construction impacts within River Lett to Forty Bends section are summarised in Table 6-104.

Table 6-104 Construction socio-economic impacts – River Lett to Forty Bends

Socio-economic criteria	Description
Business and industry	During construction, impacts on local businesses within the Hartley Historic Village would mainly result from: • Increased noise, dust and construction vehicles, diminishing the amenity of the village • Changed traffic conditions, resulting in potential traffic delays, disruptions and local access changes for road users where construction activities are located within or next to the road corridors for the Great Western Highway, Jenolan Caves Road and other local roads • Increased expenditure by construction workers on day-to-day goods and services, benefiting local retailers and hospitality businesses. Access would be maintained during construction to businesses near the proposal although temporary access changes would be required to facilitate construction and maintain safety.
Social infrastructure	Potential impacts on these uses would general be associated with access changes due to construction activities within the Great Western Highway and Jenolan Caves Road, and amenity impacts due to construction noise and dust impacting on St John the Evangelist Anglican Church and Hartley Historic Village Visitor Centre.
Access and connectivity	Potential impacts of construction works would result in: • Temporary traffic delays and disruptions for road users due to such things as localised speed reductions, use of roads by construction traffic, and temporary lane closures, impacting on local residents and businesses, travellers on the Great Western Highway, Jenolan Caves Road and other local roads, and freight vehicle operators

Socio-economic criteria	Description
	• Potential road safety risks and changes to community perceptions of road safety due to temporary changes in road conditions, use of roads by construction vehicles, including heavy vehicles, and potential driver distractions from the presence of construction activities. Access to private property would be maintained during the construction period, although temporary access changes may be required near to construction works.
Community values	Potential impacts to the community during construction may include: • Resumption of private properties resulting in community dissatisfaction • Temporary changes in local amenity due to increase noise, dust and light spill relating to construction activities for residents, businesses and facilities in proximity to the worksites • Temporary changes in local road access and connectivity • Temporary impact of increased employment relating to construction.

Operation impacts

Operation impacts within River Lett to Forty Bends section are summarised in Table 6-105.

Table 6-105 Operational socio-economic impacts –River Lett to Forty Bends

Socio-economic criteria	Description
Business and industry	The proposal would not require the acquisition or temporary lease of land accommodating businesses. Potential impacts on businesses within the River Lett to Forty Bends section would mainly be associated with road changes that require motorists accessing businesses within the Hartley Historic Village to change their travel route or potentially travel further leading to slight delays. Operation of the proposal also has potential to result in noise impacts for visitor accommodation businesses within the Hartley Historic Village, including both during the daytime and at night. This has potential to impact on the enjoyment of these properties for some people.
Social infrastructure	Property acquisition for the proposal would not impact on social infrastructure. Potential impacts on social infrastructure within the River Lett to Forty Bends section would mainly be associated with road changes that require motorists accessing businesses within the Hartley Historic Village to change their travel route or potentially travel further leading to slight delays. There is also potential for operational road traffic noise from the Great Western Highway to impact on amenity for the St John the Evangelist Anglican Church, although any impacts on the use and enjoyment of the church by parishioners are expected to be minor given the times and frequency that the church is used.
Access and connectivity	The proposal would support safer, quicker and more reliable access to properties and destinations through improved road conditions and the separation of local traffic and through traffic, including freight vehicles for much of this section of the proposal. A new service road linking Jenolan Caves Road to the Old Great Western Highway at the entrance to the Hartley Historic Village would continue to provide access to properties and destinations in Hartley, although changes would be required to

Socio-economic criteria	Description
	access routes and require motorists to travel additional distances to access properties and destinations.
Community values	The proposal will improve the regional accessibility, connectivity and safety of the highway leading to a positive community outcome. Improved traffic conditions will benefit society through improving accessibility to education, work and leisure facilities. The new alignment of the highway is further away from several residential properties. This will result in the proposal having a positive impact on the surrounding amenity through reduced traffic noise and improved air quality experienced by local residents.

Forty Bends to Lithgow

Construction impacts

Construction impacts within Forty Bends to Lithgow section are summarised in Table 6-106.

Table 6-106 Construction socio-economic impacts – Forty Bends to Lithgow

Socio-economic criteria	Description
Business and industry	Potential impacts on businesses near the proposal in this stage would mainly result from changes in local access and traffic conditions near to construction works and potential for traffic delays and disruptions. Given the closest businesses to the construction works are located north of the proposal, potential delays and disruptions are most likely to affect customers travelling from the south who are required to travel through the construction work areas. However, there is potential for customers travelling from other directions to experience short delays if traffic congestion extends north of the proposal for motorists heading south on the Great Western Highway. This may result in some customers using competing businesses in other towns. Retail and food outlets near to the construction works may experience a temporary increase in business and demand for local goods and services in response to the day-to-day needs of construction workers.
Social infrastructure	During construction, potential impacts on social infrastructure in the Forty Bends to Lithgow stage of the proposal would mainly result from: • Construction noise, dust, and traffic impacting on amenity for users of the community services near to proposed construction works such as the Bowenfels Presbyterian Church, South Bowenfels Cemetery and Colin McGarry Memorial Play Centre • Changes in local access and potential traffic disruptions and delays for users of community facilities at South Bowenfels and north of the proposal area.
Access and connectivity	Potential impacts of construction works would result in: • Temporary traffic delays and disruptions for road uses due to changes in road conditions near to construction works, reduced speed limits, and partial road closures, impacting local communities and travellers on the Great Western Highway, McKanes Falls Road and other local roads, including freight vehicle operators

Socio-economic criteria	Description
	• Potential road safety risks and changes to community perceptions of road safety due to temporary changes in road conditions, increased construction traffic and use of roads by construction vehicles, including heavy vehicles, and potential driver distractions from the presence of construction activities.
Community values	Potential impacts to community values during construction may include: • Temporary changes in local amenity due to increase noise, dust and light spill relating to construction activities for residents, businesses and facilities in proximity to the worksites • Temporary changes in local access and connectivity for all road users • Temporary impact of increased employment relating to construction.

Operation impacts

Operation impacts within Forty Bends to Lithgow section are summarised in Table 6-107.

Table 6-107 Operational socio-economic impacts – Forty Bends to Lithgow

Socio-economic criteria	Description
Business and industry	The proposal would not require the acquisition or temporary lease of land accommodating businesses. The proposal would have beneficial impacts for businesses through improved access and connectivity resulting in reduced travel times and travel reliability for vehicles travelling to and from the south east, and enhanced road safety.
Social infrastructure	Property acquisition for the proposal would not impact on social infrastructure. The proposal would improve access and connectivity to regional level community services and facilities such as health and medical services within the Lithgow Hospital campus, and aged care facilities, by making travel to these facilities quicker, safer and more reliable. The proposal would require minor changes to local access for community facilities at Mudgee Road, including the fire station and Presbyterian Church. During operation, road traffic noise from the proposal has potential to impact on the amenity for users of the Bowenfels Presbyterian Church. This may affect the use and enjoyment of this facility for some people.
Access and connectivity	Widening of the road to provide two lanes in each direction would support improved access and connectivity for regional traffic through improved driving conditions and road safety, reduced travel times and improved connections to the regional road network. The proposal would restrict right turning movements from some local roads and properties fronting the Great Western Highway. This would require some motorists to travel additional distances to access properties and destinations.
Community values	The proposal will improve local and regional accessibility, connectivity and safety of the highway leading to a positive community outcome. Improved traffic conditions will benefit society through improving accessibility to education, work and leisure facilities. Some local residents will be required to travel further distances to access their properties (refer to Section 6.2 Traffic and transport), however this disbenefit will be offset by the increase in safety resulting from the restricted turns against ongoing highway traffic.

Socio-economic criteria	Description
	The widening of the highway would result in the intensification of road infrastructure, potentially resulting in amenity impacts for some residential uses, including on rural properties, possibly impacting on the use and enjoyment of these properties.

6.10.4 Safeguards and management measures

Table 6-108 Safeguards and management measures – socio-economic

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
SE01	Community consultation	A Community Communication Strategy (CCS) will be prepared for the proposal to facilitate communication with the local and regional communities including relevant Government agencies, Councils, adjoining landowners and businesses, residents, motorists and other relevant stakeholders that may be affected by the proposal. The strategy will: • Identify people or organisations to be consulted during the delivery of the proposal • Set out procedures and mechanisms for the regular distribution of information about the proposal • Outline mechanisms to keep relevant stakeholders updated on construction activities, schedules and milestones • Outline avenues for the community to provide feedback (including a 24-hour, toll free proposal information and complaints line) or to register complaints and through which Transport will respond to community feedback	Transport/ Contractor	Prior to construction and construction	Appendix M	N/A

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Outline a process to resolve complaints and issues raised.				
SE02	Business impacts	Access will be maintained to local businesses near to construction works. Where temporary access changes are proposed, these will be agreed with the affected business owner.	Contractor	During construction	Appendix M	All
SE03	Business impacts	Signage would be provided to key business locations such as Little Hartley and Hartley Historic Village during construction.	Contractor	During construction	Appendix M	All
SE04	Business impacts	Ongoing consultation will be undertaken with local business owners at Little Hartley, Hartley Historic Village, Hartley and South Bowenfels that may be impacted during construction in accordance with Community Communication Strategy.	Contractor	During construction	Appendix M	All
SE05	Emergency vehicle access	Access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency (e.g. for South Bowenfels Rural Fire Brigade and Lithgow Hospital).	Contractor	During construction	Appendix M	All
SE06	Local access changes	Local communities and road users will be notified about access changes prior to implementation.	Contractor	During construction	Appendix M	All

Other safeguards and management measures that would address socio-economic impacts are identified in sections 6.2 Traffic and transport and 6.11 Property and land use.

6.11 Property and land use

This section provides an assessment of the potential impacts of the proposal on property and land use and identifies safeguards and management measures to avoid or minimise these impacts.

6.11.1 Methodology

The assessment methodology for impacts on land use and property included the following key tasks:

- A desktop assessment of property ownership and existing land uses in and around the proposal construction footprint was carried out, which included a review of available government sources and aerial photographs
- Identification of potential future uses of land required for construction but not required for operation
- Assessment of potential impacts on properties including those that would need to be acquired to construct and operate the proposal
- Assessment of the potential impacts on existing and likely future land uses during construction and operation of the proposal
- Identification measures to avoid, minimise and manage impacts on land use and property.

The impact assessment of the proposal on property and land use has been prepared in accordance with:

- Land Acquisition (Just Terms Compensation) Act 1991
- Property Acquisition- A guide for residential owners (NSW Government, 2021a)
- Property Acquisition – A guide for residential tenants (NSW Government, 2021b)
- *Land Acquisition Information Guide* (Roads and Maritime Services, 2014).

6.11.2 Existing environment

Land use zoning

The proposal is located in the Hartley Valley, from Little Hartley to Lithgow, within the Lithgow City local government area. Existing land use zones within and surrounding the construction footprint (Figure 4-1) as defined by the *Local Environmental Plan*, include:

- SP2 Roads and Traffic Facility
- R2 Low Density Residential
- R5 Large Lot Residential
- RU1 Primary Production
- E1 National Parks and Nature Reserves
- E3 Environmental Management.

Existing land use

Existing land uses within and surrounding the construction footprint comprise:

- Roads and transport infrastructure, including the existing Great Western Highway and local roads, as well as adjacent lands included within the road corridor
- General rural uses, such as large lot farming and grazing
- Rural residential uses, including rural living and smaller farm properties
- Low density residential properties
- Commercial uses, including hospitality and retail services, accommodation, visitor information and professional services
- Community significance, including places of worship, gardens and cemeteries
- Bushland.

The Little Hartley to River Lett Hill section, Coxs River Road section and River Lett Hill to Forty Bends section of the proposal are largely characterised by rural and rural residential properties. Some commercial activities are present near the Coxs River Road and along the Great Western Highway to the Hartley Cemetery and east of the River Lett on Old Great Western Highway, including hospitality and retail services, accommodation and visitor information. There are also areas of significance to the community, including places of worship, gardens and a cemetery.

The Forty Bends to Lithgow section is characterised by the large area of bushland adjacent to the north of the Great Western Highway and the rural residential properties in the valley to the south of the Great Western Highway. The western tie-in to the existing Great Western Highway is adjacent to residential and commercial properties

Properties that would be impacted by the proposal and a description of their current use are identified in Table 6-109 and shown in Figure 6-54.

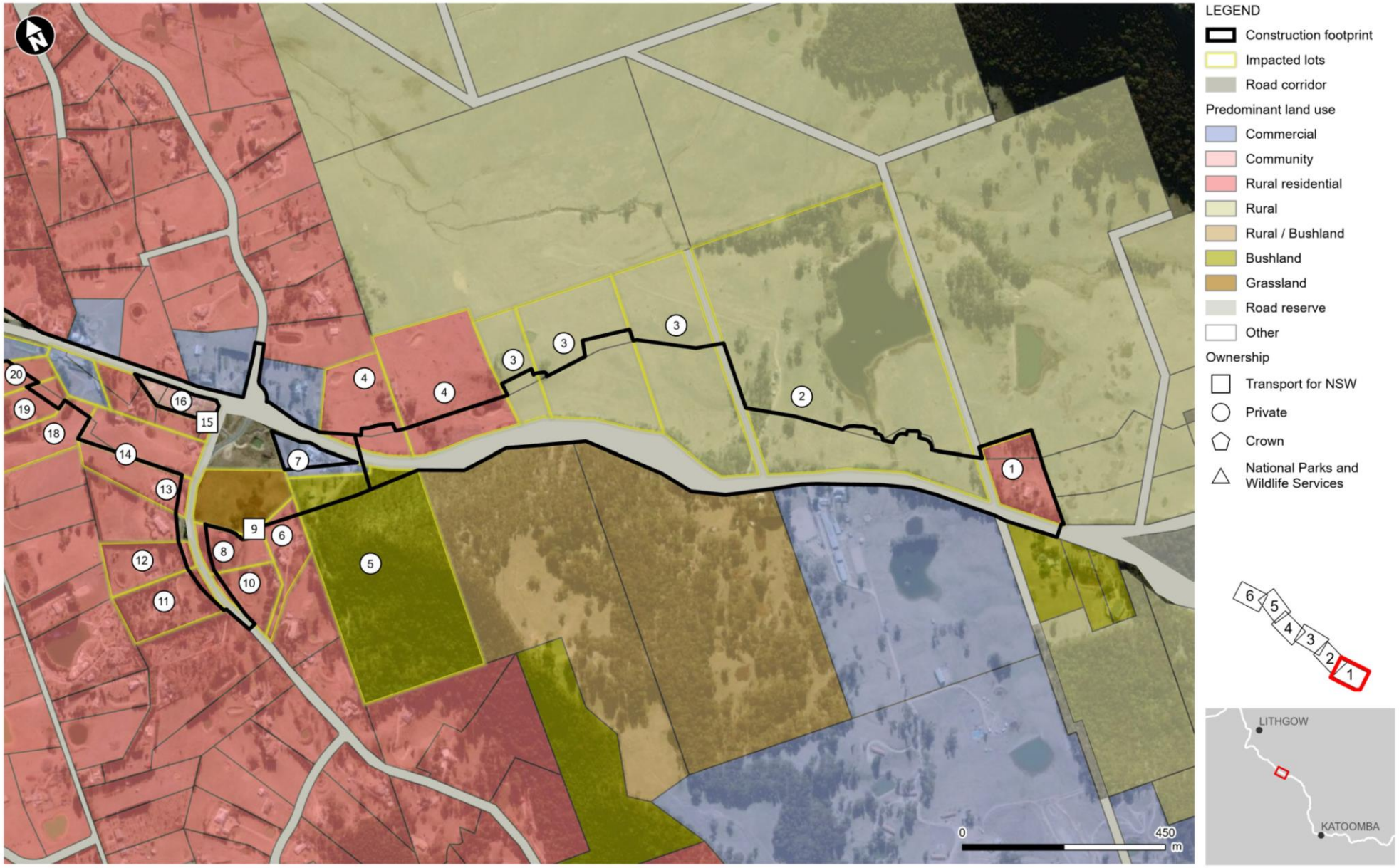


Figure 6-54 a Overview of land uses

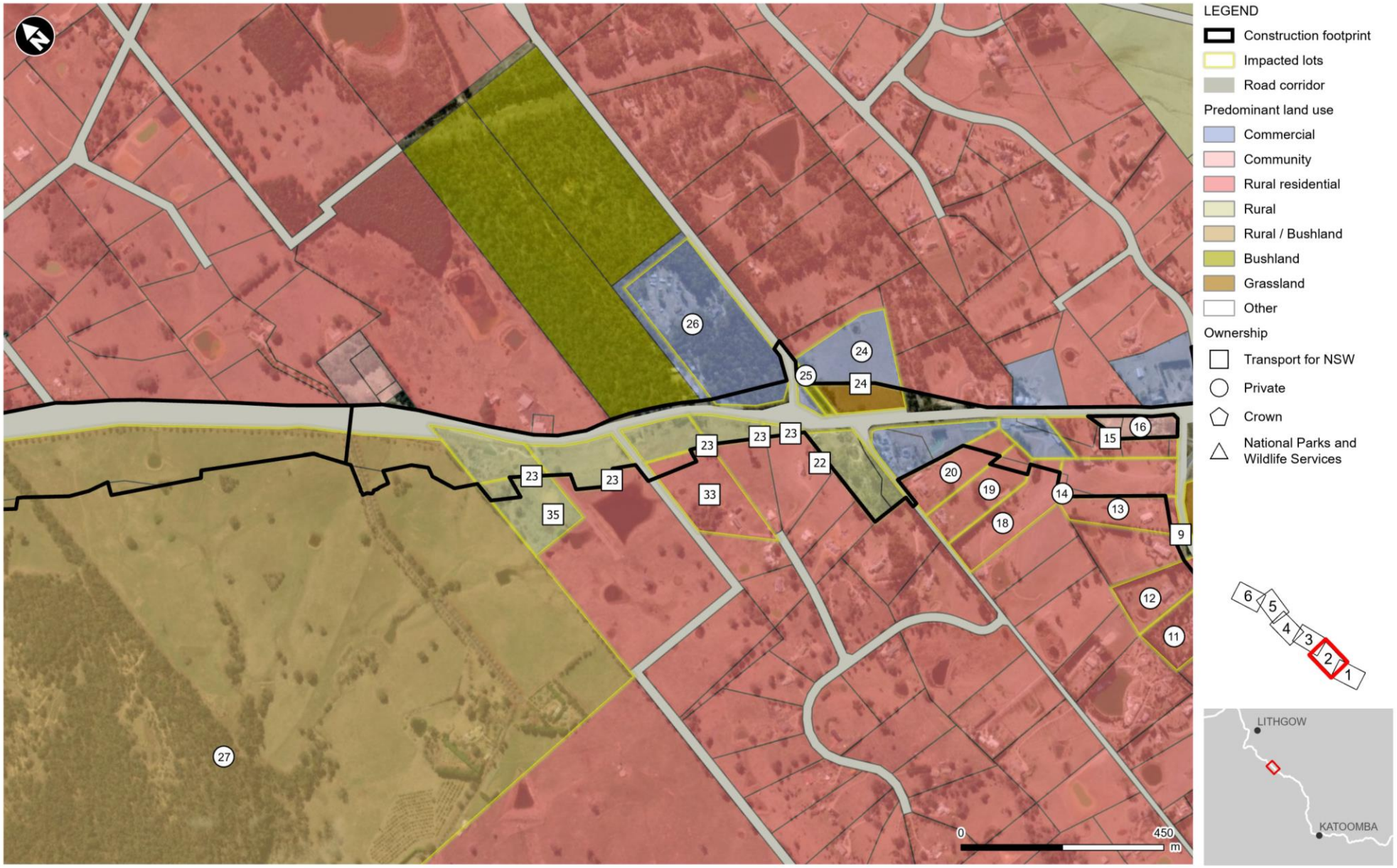


Figure 6-55 a Overview of land uses

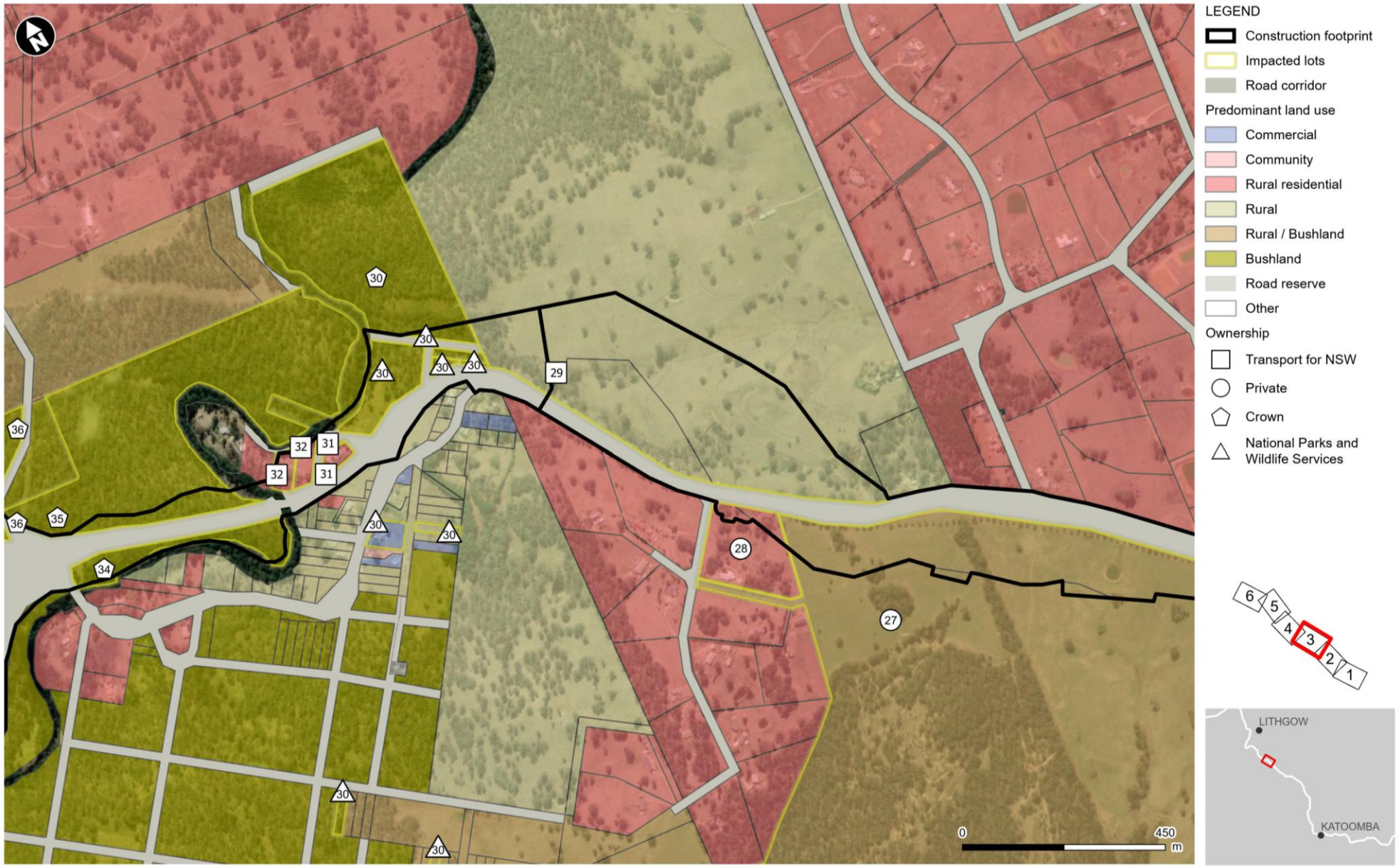


Figure 6-55 b Overview of land uses

Figure 6-55 c Overview of land uses

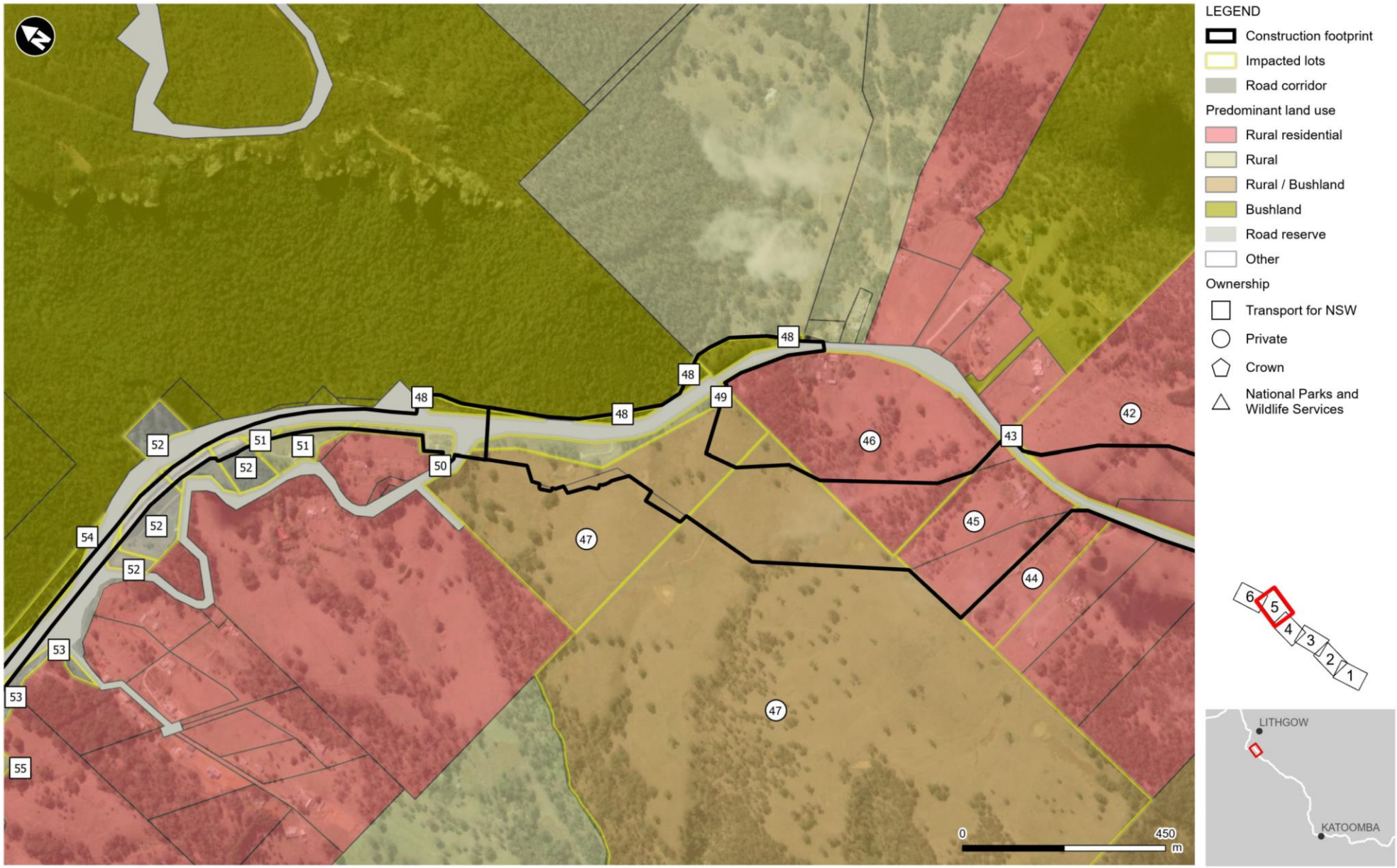


Figure 6-55 d Overview of land uses

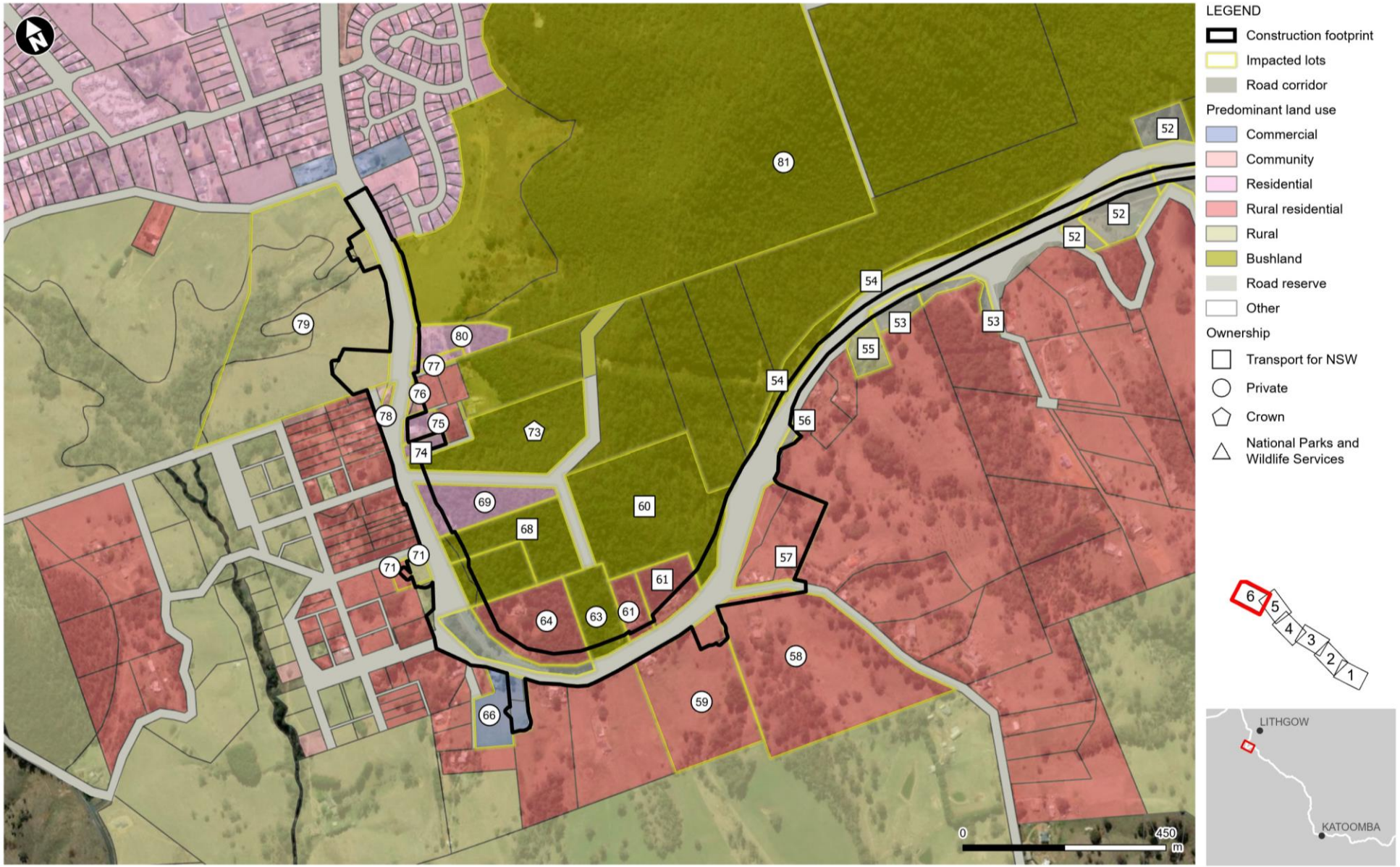


Figure 6-55 e Overview of land uses

6.11.3 Potential impacts

Construction

Long term impacts on property and land use would occur from the commencement of construction. These impacts would generally be related to property acquisition, changes to land use, changes to local road connections to the Great Western Highway and changes to property access. Although these impacts would be immediate, they are long term and permanent and have therefore been discussed below as operational impacts of the proposal.

Property impacts

Short term property impacts would potentially occur during construction as a result of activities such as land use changes and changes to property access, as well as leasing land for ancillary facilities and temporary sediment basins. Nine lots would be partially leased for the duration of construction. Consultation with landowners would be held in relation to leasing these properties (see Section 5 Consultation).

Land use impacts

During construction, potential impacts on existing land use within the proposal construction footprint would mainly relate to direct impacts from the siting of ancillary facilities. These ancillary facilities would include temporary construction support sites and stockpile areas, as described in Section 3 Proposal description.

Up to 18 ancillary facilities are proposed on road corridor, rural residential and rural land with limited biodiversity value. These areas would be managed in accordance with the construction environmental management plan and would be developed as part of the proposal or rehabilitated at the completion of construction, therefore the potential impacts are generally expected to be low.

Temporary changes to local roads and property accesses

As detailed in Section 6.2 Traffic and transport, temporary disruptions to local roads and property accesses would be expected during construction of the proposal. Local roads that would potentially experience some delays and changed traffic arrangements during construction include the Coxs River Road, Baaners Lane, Browns Gap Road, Carroll Drive, Mid Hartley Road, Kelly Street, Old Great Western Highway, Blackmans Creek Road, Jenolan Caves Road, Forty Bends Road, Mckanes Falls Road, Old Bathurst Road, Mudgee Street and Magpie Hollow Road. These roads would be directly linked to, or serviced by, the proposal and would experience temporary diversions and traffic switches before traffic is shifted to the revised permanent arrangement. These impacts would be minimised through the implementation of a Traffic Management Plan as discussed in Section 6.2 Traffic and transport.

Impacts to property access points would occur as a result of the proposal. Access to properties and businesses would be maintained for the full construction duration. Alternative access arrangements would be provided where the proposal would impact access to residential and commercial properties.

Operation

Operational impacts on property and land use as a result of the proposal would commence during construction. The below sections describe these permanent and long-term impacts.

Property impacts

Details of direct property acquisition as a result of the proposal are provided in Table 6-109, with property reference numbers corresponding to Figure 6-54.

There are 112 lots of land comprising 81 properties within the construction footprint. Of this, seven lots are Crown land, four lots are owned by National Parks and Wildlife Services, 44 lots are owned by Transport

and 56 lots are privately owned. Of the land impacted, 11 lots would be directly impacted in their entirety and require full acquisition, and 50 lots would require partial acquisition.

Table 6-109 also shows properties that are currently owned by Transport. These properties have been identified but have not been included in the property acquisition calculations required for the proposal.

The areas of direct impact to property have been calculated using the construction footprint and cadastral overlay. This would be subject to ground survey and further refinement during the detailed design phase of the proposal, which may alter the final acquisition requirements and estimates. All acquisitions would be carried out in consultation with landowners and in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, *Property Acquisition – A guide for residential owners* (NSW Government, 2021a) and *Property Acquisition – A guide for residential tenants* (NSW Government, 2021b).

Part of the proposal is on land within Hartley Historic Village which comprises land reserved under the NPW Act. Development within national park estate cannot proceed by virtue of Clause 94 of ISEPP until the land is revoked from the national park estate via an Act of Parliament. Transport submitted a proposal to revoke a section of national park estate in September 2021. The submission addresses the requirements of National Park and Wildlife Service (NPWS) *Revocation, recategorisation and road adjustment policy,* including an outline of the potential impacts of the revocation. A compensation package will also be negotiated with NPWS.

Land use impacts

Some areas of the construction footprint is already used as transport (road) infrastructure. This overall transport corridor land use would remain with the infrastructure upgraded and/or used as local service roads.

Most of the land affected by the proposal is classified as rural and bushland land, comprising about 64 per cent of directly impacted land to be acquired, and rural residential land, comprising about 34 per cent. The remaining 2 per cent is classified as residential, commercial use or community use.

Most properties would be only partially impacted, with many requiring partial acquisition where the proposal would have no substantial effect on the functionality or viability of the current or future use of the remainder of the property.

While the proposal design has sought to minimise impacts on property as far as practicable, permanent property adjustments would be required to some private properties, including adjustments to fencing and farm infrastructure (eg farm dams), due to partial property acquisitions. The proposal design, including evaluation of route options (described in Section 2 Needs and options considered), has sought to minimise any impact of severance on farming operations as far as practicable. Any adjustments to properties required for the proposal would be carried out in consultation with the property owner.

Changes in external property accesses

External property access refers to the connection of a property to the external road network. This may be a direct driveway connection at the property via a private road or by a right of way access through a neighbouring property.

Changes to external property access would be required for numerous properties as a result of the proposal. These changes are discussed and assessed in Section 6.2 Traffic and transport.

Table 6-109 Impacted properties and proposed property acquisition

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
1	Private	Rural residential	Yes	20,393.4	20,393.4	100.0		
2	Private	Rural	Yes	272,672.4	43,515.3	16.0	3,991.1	1.5
3	Private	Rural	Yes	21,815.9	5,811.5	26.6	2,049.6	9.4
	Private	Rural	Yes	69,326.6	47,339.2	68.3		
	Private	Rural	Yes	79,439.4	34,208.2	43.1	3,122.0	3.9
4	Private	Rural residential	Yes	31,511.8	6,056.3	19.2	1,465.4	4.7
	Private	Rural residential	Yes	64,367.0	15,793.9	24.5		
5	Private	Bushland	Yes	138,236.7	13,464.2	9.7		
6	Private	Rural residential	Yes	14,683.5	1,991.3	13.6		
7	Private	Commercial	Yes	10,936.4	3,810.3	34.8		
8	Private	Rural residential	Yes	13,063.9	2,205.1	16.9		
9	Transport for NSW	Grassland	No	24,861.3				
10	Private	Rural residential	Yes	13,978.0	1,006.2	7.2		
11	Private	Rural residential	Yes	23,252.9	1,513.5	6.5		
12	Private	Rural residential	Yes	17,612.2	1,255.1	7.1		

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
13	Private	Rural residential	Yes	17,361.7	1,808.0	10.4		
14	Private	Rural residential	Yes	22,138.7	22,138.7	100.0		
15	Transport for NSW	Rural residential	No	15,564.2				
16	Private	Community	Yes	8,093.5	50.6	0.6		
17	Transport for NSW	Commercial	No	10,144.2				
18	Private	Rural residential	Yes	24,016.7	1,532.6	6.4		
19	Private	Rural residential	Yes	19,935.6	1,574.7	7.9	1,823.5	9.1
20	Private	Rural residential	Yes	18,912.7	3,674.2	19.4		
21	Transport for NSW	Commercial	No	19,753.9				
22	Transport for NSW	Rural	No	19,395.9				
23	Transport for NSW	Rural	No	1,929.4				
	Transport for NSW	Rural	No	7,753.9				
	Transport for NSW	Rural	No	12,118.0				
	Transport for NSW	Rural	No	16,662.3				
	Transport for NSW	Rural	No	17,324.3				
24	Transport for NSW	Grassland	No	10,546.3				

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
25	Private	Bushland	Yes	2,538.3	1,737.9	68.5		
26	Private	Commercial	Yes	69,367.5	6,751.7	9.7		
27	Private	Rural / Bushland	Yes	1,746,272.4	143,909.8	8.2	2,170.9	0.1
28	Private	Rural residential	Yes	33,891.0	3,549.0	10.5	2,568.7	7.6
29	Transport for NSW	Rural	No	198,485.2				
30	National Parks and Wildlife Services	Bushland	Yes	2,340.5	2,340.5	100.0		
	National Parks and Wildlife Services	Bushland	Yes	19,883.7	19,883.7	100.0		
	National Parks and Wildlife Services	Bushland	Yes	522.6	522.6	100.0		
	National Parks and Wildlife Services	Bushland	Yes	1,454.5	1,454.5	100.0		
	Private	Bushland	Yes	121,622.1	3,603.9	3.0		
31	Transport for NSW	Rural residential	No	489.1				
	Transport for NSW	Rural residential	No	2,992.6				
32	Transport for NSW	Rural residential	No	3,960.4				
	Transport for NSW	Rural residential	No	3,832.5				

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
33	Transport for NSW	Rural residential	No	30,275.1				
	Private	Rural residential	Yes	6,165.8	535.8	8.7		
34	Private	Bushland	Yes	21,026.6	19,090.0	90.8		
35	Transport for NSW	Rural	No	22,635.1				
	Private	Bushland	Yes	195,439.8	13,063.5	6.7		
36	Private	Bushland	Yes	4,266.3	4,266.3	100.0		
	Private	Bushland	Yes	59,373.9	2,485.4	4.2		
37	Transport for NSW	Bushland	No	216.9				
38	Transport for NSW	Rural	No	76.2				
39	Private	Rural residential	Yes	20,000.3	13,931.3	69.7		
	Private	Rural / Bushland	Yes	854,730.8	85,318.6	10.0		
40	Private	Rural residential	Yes	286,210.4	40,257.4	14.1	17,729.9	6.2
41	Private	Rural residential	Yes	23,164.0	651.2	2.8		
42	Private	Rural residential	Yes	428,780.1	49,974.4	11.7	27,849.1	6.5
43	Transport for NSW	Road reserve	No	596.7				
44	Private	Rural residential	Yes	32,526.1	228.7	0.7		

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
45	Private	Rural residential	Yes	73,078.0	73,078.0	100.0		
46	Private	Rural residential	Yes	149,559.1	27,343.8	18.3		
47	Private	Rural / Bushland	Yes	2,004,595.0	66,695.7	3.3		
	Private	Rural / Bushland	Yes	167,637.8	42,548.6	25.4		
48	Transport for NSW	Bushland	No	8,406.8				
	Transport for NSW	Bushland	No	2,020.1				
	Transport for NSW	Bushland	No	2,189.1				
	Transport for NSW	Bushland	No	4,056.6				
49	Transport for NSW	Rural	No	18,230.9				
50	Transport for NSW	Rural	No	7,033.5				
51	Transport for NSW	Rural	No	11,722.2				
	Transport for NSW	Rural	No	1,999.0				
52	Transport for NSW	Road reserve	No	18,529.4				
	Transport for NSW	Road reserve	No	15,981.2				
	Transport for NSW	Road reserve	No	10,064.3				
	Transport for NSW	Road reserve	No	4,117.2				

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
53	Transport for NSW	Road reserve	No	6,042.9				
	Transport for NSW	Road reserve	No	5,097.7				
54	Transport for NSW	Bushland	No	22,317.8				
	Transport for NSW	Bushland	No	2,351.3				
55	Transport for NSW	Rural	No	7,990.3				
56	Transport for NSW	Road reserve	No	1,684.3				
57	Transport for NSW	Rural residential	No	28,232.0				
58	Private	Rural residential	Yes	106,031.4	1,906.1	1.8		
59	Private	Rural residential	Yes	59,524.3	3,945.4	6.6		
60	Transport for NSW	Bushland	No	77,687.4				
61	Transport for NSW	Rural residential	No	14,182.6				
62	Private	Rural residential	Yes	8,476.1	962.9	11.4		
63	Private	Bushland	Yes	18,032.5	2,306.3	12.8		
64	Private	Rural residential	Yes	32,403.5	8,427.0	26.0		
65	Vested in Lithgow City Council (limited in depth)	Public road	No	12,710.6				

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
66	Private	Commercial	Yes	16,199.8	4,679.0	28.9		
67	Private	Bushland	Yes	16,901.2	16,373.5	96.9		
68	Transport for NSW	Bushland	No	29,151.1				
69	Private	Rural residential	Yes	21,249.9	1960	9.2		
70	Private	Rural	Yes	2,643.3	742.5			
71	Private	Rural	Yes	2,471.5	2,231.2			
	Private	Rural residential	Yes	2,451.7	458.4	18.7		
72	Private	Rural residential	Yes	2,006.5	39.6	2.0		
73	Private	Bushland	Yes	44,275.9	646.9	1.5		
74	Transport for NSW	Residential	No	2,907.6				
75	Private	Residential	Yes	4,235.5	572.4	13.5		
76	Private	Community	Yes	1,855.7	1,855.7	100.0		
77	Private	Residential	Yes	2,429.2	325.4	13.4		
78	Private	Community	Yes	1,053.5	1,053.5	100.0		
	Private	Community	Yes	614.6	614.6	100.0		
79	Private	Rural	Yes	151,584.7	13,010.9	8.6		

Property ID	Ownership	Predominant land use	Acquisition required (Yes/No)	Total area (square metres)	Area of land to be acquired (square metres)	Percentage of area to be acquired	Area of land to be temporarily leased (square metres)	Percentage of area to be leased
80	Private	Residential	No	13,070.2				
81	Private	Bushland	No	696,140.2				
			TOTAL		912,515.90		62,770.2	

6.11.4 Safeguards and management measures

Table 6-110 Safeguards and management measures – property and land use

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
PL01	Leased land	Areas of land leased for the purposes of construction will be reinstated at the end of the lease to at least equivalent standard in consultation with the landowner.	Contractor	Construction	N/A	All
PL02	Property	All partial and full acquisitions and associated property adjustments will be carried out in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* and the *Transport for NSW Land Acquisition Information Guide* in consultation with landowners. This will include the provision of monetary compensation determined in accordance with the provisions of the Act.	Transport	Prior to construction	Appendix M	All
PL03	Property	Property adjustments for the proposal will be completed in consultation with property owners.	Transport/ Contractor	Prior to construction/ during construction	Appendix M	All
PL04	Property	Existing property access will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided following consultation with the affected property owners.	Transport/ Contractor	During construction	Appendix M	All

Other safeguards and management measures that would address property and land use impacts are identified in Sections 6.2 Traffic and transport and 6.10 Socio-economic.

6.12 Contamination

This section provides a summary of the assessment of potential contamination impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A stage 1 contamination assessment has been completed as part of this REF and is presented in the technical working paper – contamination (Appendix N).

6.12.1 Methodology

The Stage 1 contamination assessment involved the following:

- A desktop review of available information relevant to each of the four design sections to understand the site history, existing environment and potential risk for contamination. The assessment was completed for the area generally within 500 metres of the construction footprint ('the study area') and included a review of:
  - Landform topography, drainage, geology, soils (including erosion hazard, acid sulfate soils risk and salinity potential), hydrogeology and receiving environments in the study area
  - Site history including historical aerial photographs (from each decade from 1950 to 2005 (where available) and available aerial imagery services (Google Earth and SIX Maps)
  - Publicly available information from the NSW Environment Protection Authority, the Commonwealth Scientific and Industrial Research Organisation 'Australian Soil Resource Information System' database and the former NSW Department of Primary Industries groundwater database
  - A review of previous publicly available contamination investigations undertaken for other proposals within the vicinity of the construction footprint
- Site inspection in April 2021 of the construction footprint, nearby land uses and potential areas of environmental concern (areas with known or potential contamination associated with current or historical land uses)
- A high level risk prioritisation exercise to:
  - Identify areas of environmental concern (with respect to contamination)
  - Identify unmitigated risks to environmental and human receptors
  - Consider the nature of proposed construction activities
  - Determine the level of risk that the proposal could intersect areas of potential contamination
- Identification of appropriate mitigation and management measures, or where further investigation or remediation may be required.

6.12.2 Existing environment

Site history

Historical aerial photographs were reviewed for the years 1958, 1966, 1975, 1989, 1994 and 2005. The aerial photography review focused on the study area to identify potential sources of contamination. There are limitations to the depth of this historical review based on the availability and quality of historical imagery for the study area.

A summary of the historical aerial review findings for each design section is presented in Table 6-111.

Table 6-111 Historical aerial photograph review for each the proposals

Site	Year	Description of changes to surrounding area
Little Hartley to River Lett and Coxs River Road	1958	Primarily agricultural (farmland), several farm buildings, bushland, some residential buildings and several churches.
	1966	Increase in agricultural use and construction of water storage dams on farms
	1975	Further increase in agricultural use including clearing of trees and larger water storage dams. New road constructed near Hartley historic village
	1989	Continued expansion of agricultural uses including some additional clearing.
	1994	No major changes. Little Hartley Airfield established.
	2005	No major changes. Some land clearing.
River Lett to Forty Bends	1958	Primarily agricultural (farmland), several farm buildings, bushland, some residential buildings and several churches.
	1966	Increase in agricultural use and construction of water storage dams on farms
	1975	Further increase in agricultural use including some clearing of vegetation
	1989	Continued expansion of agricultural uses. Additional houses constructed adjacent to roads.
	1994	No major changes.
	2005	No major changes.
Forty Bends to Lithgow	1958	Primarily agricultural (farmland), several farm buildings, bushland, some residential buildings and several churches.
	1966	Increase in agricultural use and construction of water storage dams on farms
	1975	Further increase in agricultural use including some clearing of vegetation
	1989	Continued expansion of agricultural uses. Increase in residential land use in Lithgow.
	1994	No major changes.
	2005	No major changes.

Database searches

A search of the NSW EPA Contaminated Sites Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997)* and the list of contaminated sites notified to the NSW EPA (under Section 60 of the *Contaminated Land Management Act 1997)* was carried out in March 2021 and identified one site; the Shell Coles Express Service Station on the Great Western Highway in South Bowenfels, approximately 50 metres north west of the Lithgow end of the Forty Bends to Lithgow section.

A search conducted on 25 March 2021 of the NSW EPA Protection of the Environment Operations (POEO) Act public register (under Section 308 of the POEO Act 1997) indicated there were no sites within the study area that have current environmental protection licences (EPL).

One site, Little Hartley airfield, located to the south west of Little Hartley and shown in Figure 6-55, was identified as a potential PFAS source. Further consideration during the site inspection indicated that there

does not appear to be large scale fuel storage and it is unlikely that aviation fire training activities occurred at the site.

6.12.3 Potential impacts

Construction

Based on the findings of the desktop review and site inspections, a number of potential contamination sources (Areas of Environmental Interest – AEIs) have been identified within the study areas. A high level prioritisation exercise was undertaken to understand the interaction of the construction activities and the AEIs and to categorise (very low, low, moderate, high and very high) the associated contamination risks.

The high level prioritisation for each of the proposals is provided in Section 5 of Appendix N. Construction areas and activities that were identified as having a medium to high contamination impact are outlined below for each proposal. A Detailed Site Investigation would be carried out prior to construction to better understand the nature and extent of contamination in accordance with the NEPM (2013) and other guidelines made or endorsed by the NSW EPA.

Little Hartley to River Lett and Coxs River Road

The following construction areas or activities within the construction footprint for the Little Hartley to River Lett section and the Coxs River Road section have been identified as having a moderate to high contamination impact potential:

- Cutting, bridge construction (potential piling) and construction of water quality control basins near Coxs River Road have a high impact potential to construction worker health, operational users and the environment associated with soil and/or groundwater contamination and contaminated vapour that may be present from underground fuel storage associated with the former service station adjacent to the alignment
- Disturbance of soil stockpiles is considered to represent a moderate impact potential to construction worker health or the environment (if contamination is present)
- Disturbance of soil near and within the former Little Hartley Airfield is considered to represent a moderate impact potential to construction worker health or the environment (if contamination is present)
- If groundwater is intersected within the cut adjacent to the Hartley Cemetery, contamination (if present) is considered to represent a moderate risk to construction worker health or the environment, and operational users if ongoing seepage within the cut occurs
- Disturbance of soil through agricultural areas is considered to represent a moderate impact potential to construction worker health or the environment if waste dumping/burial, sheep/cattle dips, septic tanks and chemical or fuel use and storage are disturbed during construction.

Figure 6-55 shows the location of AEIs within or immediately adjacent to the Little Hartley to River Lett and Coxs River Road construction footprint.

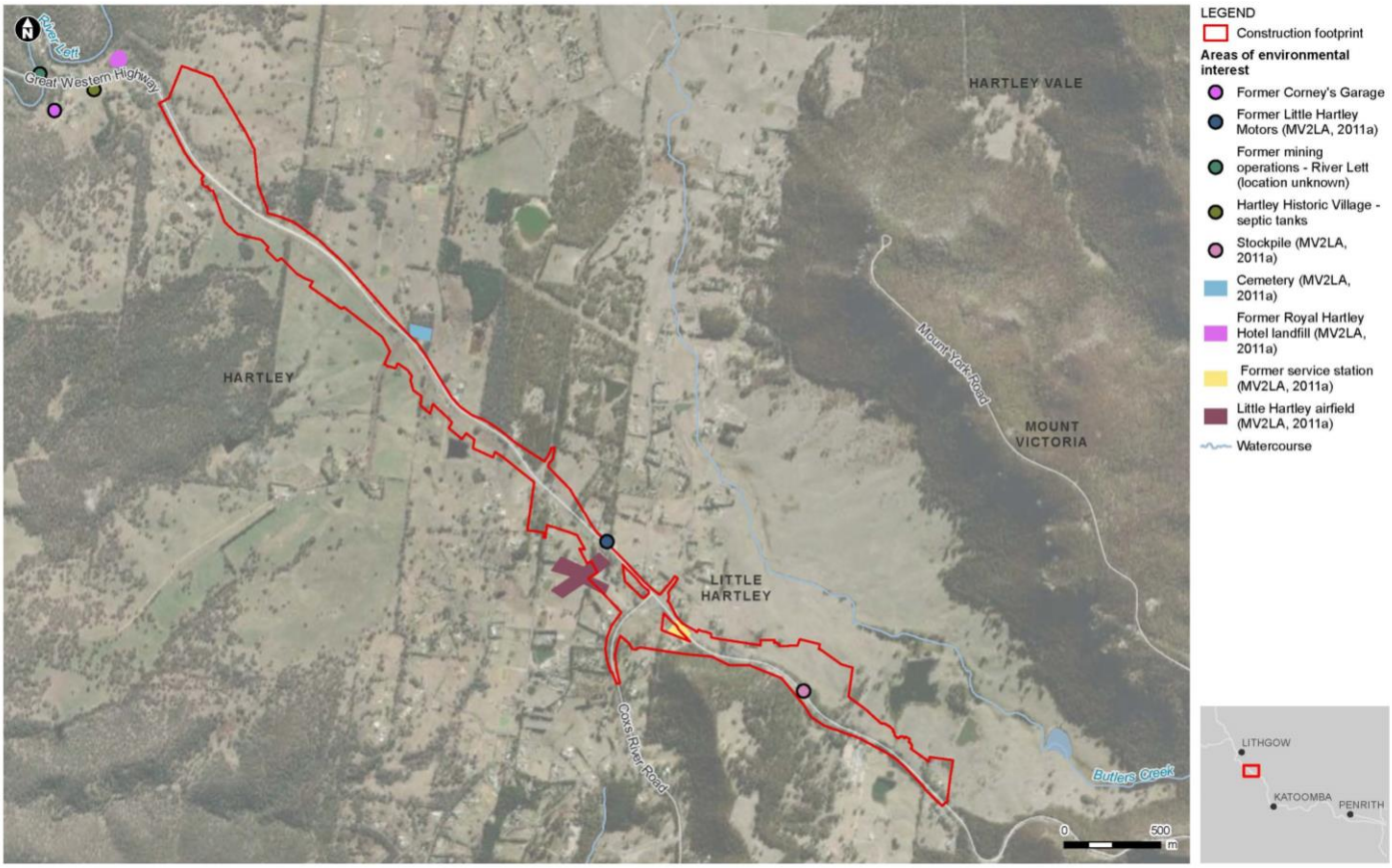


Figure 6-55 Areas of environmental interest within Little Hartley to River Lett and Cox River Road construction footprint

River Lett to Forty Bends

The following construction areas or activities within the River Lett to Forty Bends construction footprint have been identified as having a moderate to high contamination impact potential:

- Disturbance of contaminated soil or groundwater (if present) in the vicinity of River Lett (cutting or construction of the new bridge) or as a result of ongoing groundwater seepage during operation due to historic mining operations (exact location unknown) has been assessed as representing a moderate impact potential to construction worker health, the environment or ongoing operations
- Disturbance of soil stockpiles is considered to represent a moderate impact potential to construction worker health or the environment (if contamination is present)
- Disturbance of soil through agricultural areas is considered to represent a moderate impact potential to construction worker health or the environment if waste dumping/burial, sheep/cattle dips, septic tanks and chemical or fuel use and storage are disturbed during construction.

Figure 6-56 shows the location of AEIs within or immediately adjacent to the River Lett to Forty Bends construction footprint.

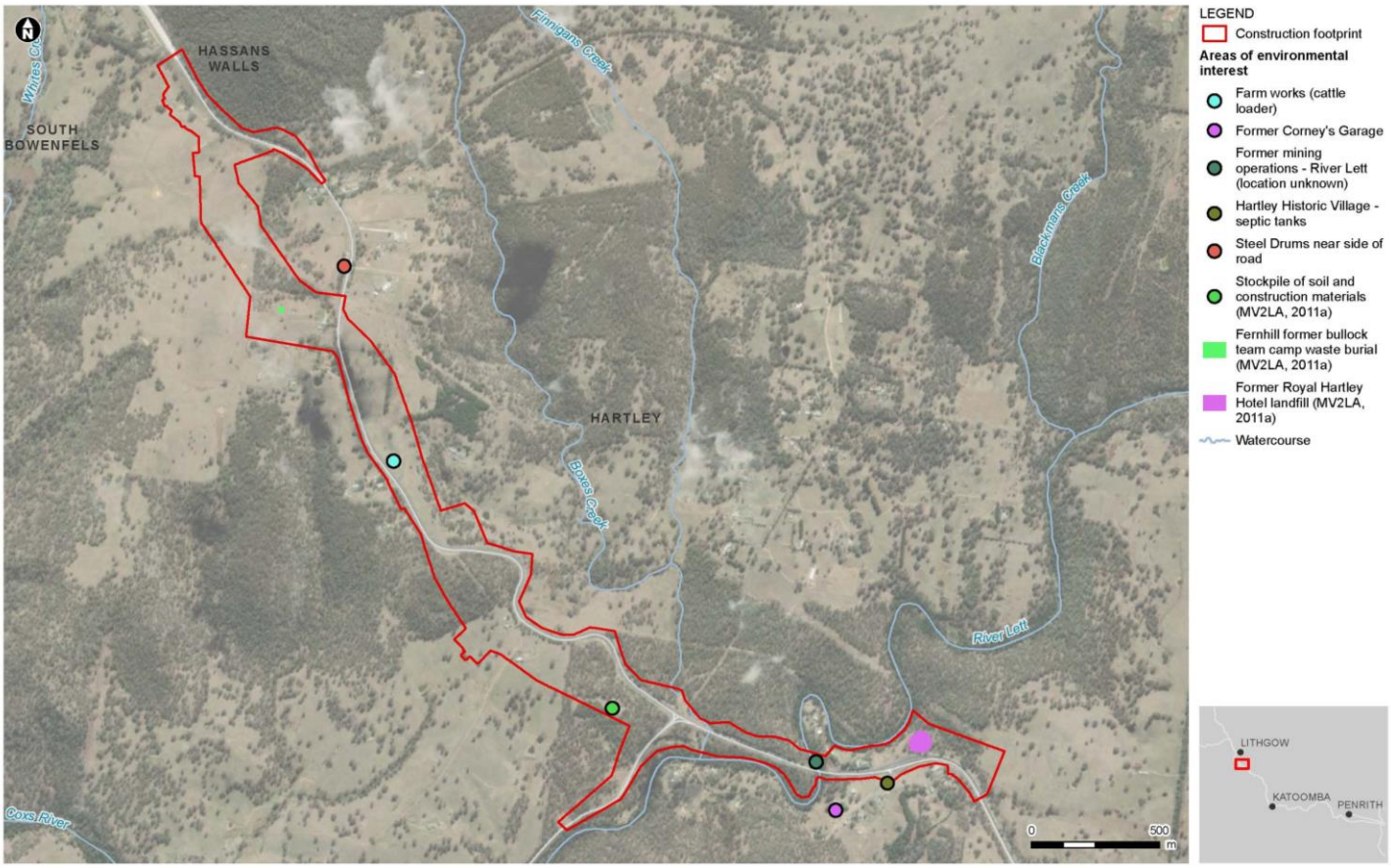


Figure 6-56 Areas of environmental interest within River Lett to Forty Bends construction footprint

Forty Bends to Lithgow

The following construction areas or activities within the Forty Bends to Lithgow construction footprint have been identified as having a moderate to high contamination impact potential:

- Previously reported groundwater contamination from the former service station in South Bowenfels has been assessed as representing a moderate impact potential to construction worker or environmental health
- Disturbance of soil stockpiles is considered to represent a moderate impact potential to construction worker health or the environment (if contamination is present)
- Disturbance of soil through agricultural areas is considered to represent a moderate impact potential to construction worker health or the environment if waste dumping/burial, sheep/cattle dips, septic tanks and chemical or fuel use and storage are disturbed during construction.

Figure 6-57 shows the location of AEIs within or immediately adjacent to the Forty Bends to Lithgow construction footprint.

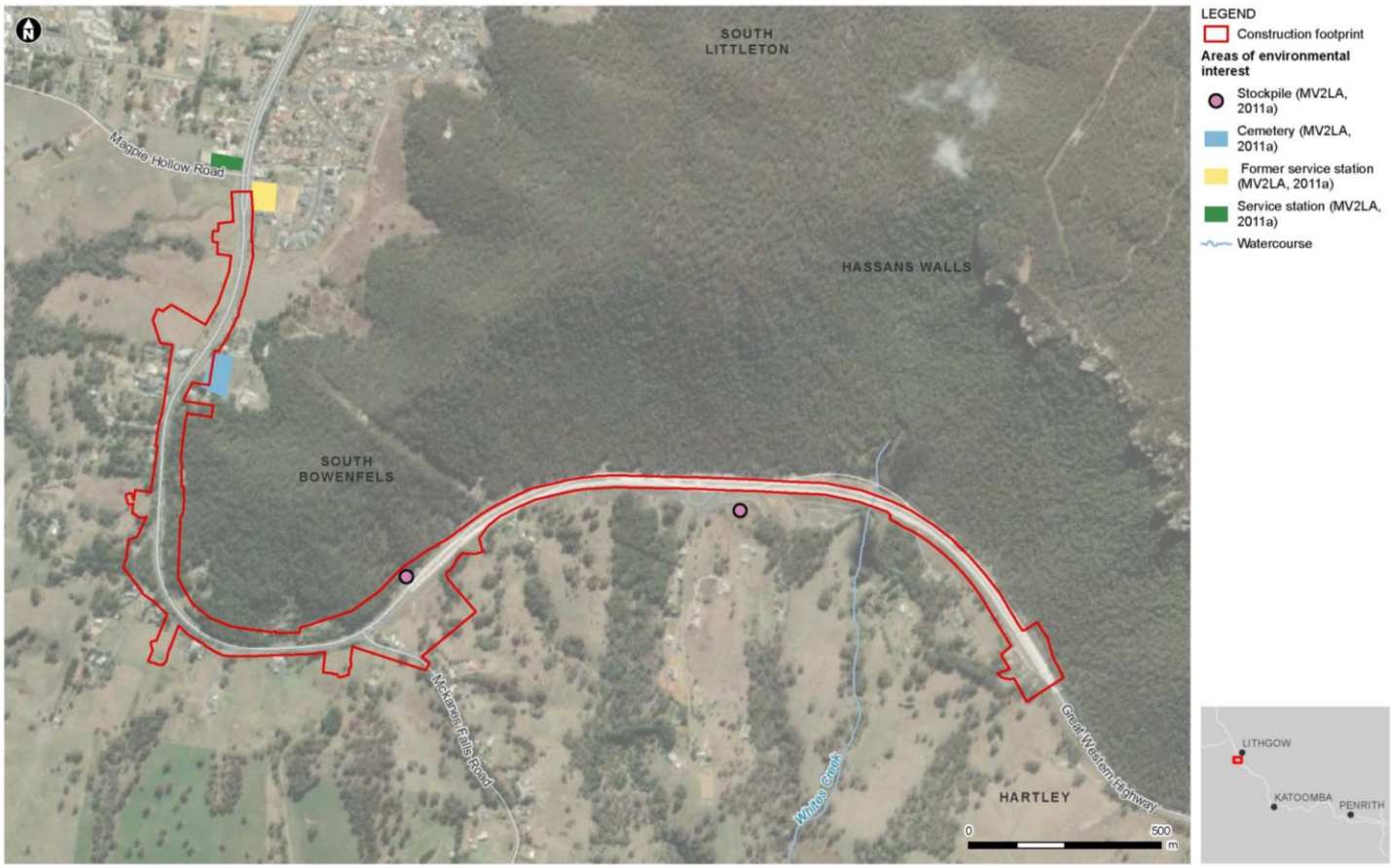


Figure 6-57 Areas of environmental interest within Forty Bends to Lithgow construction footprint

Operation

Soil contamination

Environmental management plans would need to be prepared and implemented during operation of the proposal where existing soil contamination is to be managed on site, for example reuse of potentially contaminated stockpiled material. Implementation of appropriate environmental management plans would reduce the potential impacts from contaminated soil associated with the operation of the proposal.

There is potential for traffic accidents to result in contamination as a result of spills and leaks from ruptured fuel tanks, spillage of hazardous load being carried by a vehicle (ie fuel, chemicals) and use of firefighting foam or fire retardants after an accident. Potential impacts would be managed via the existing emergency response procedures using Transport emergency response teams.

Groundwater contamination

Where existing groundwater contamination is identified within and/or adjacent to the operational areas of the proposal, appropriate engineering controls would need to be installed to either remove the risk of contaminated groundwater ingress (namely seepage of contaminated groundwater from cuttings) or manage the risk to receptors via appropriate treatment prior to disposal, discharge or reuse. Implementation of appropriate engineering controls would reduce the potential impacts from contaminated groundwater to the operation of the proposal and receptors from discharge.

Potential contamination of groundwater within and directly adjacent to the proposal could occur as a result of spills and leaks of hydrocarbons from vehicles and accidents during operation.

Vapour

Where soil or groundwater contamination with volatile chemicals is present within and/or adjacent to the operational areas of the proposal, appropriate engineering controls would be installed to reduce the ongoing risk of vapour ingress during operation of the proposal. Engineering controls could include surface or sub-surface extraction, or remediation of the contaminated soil or groundwater. Implementation of appropriate engineering controls would reduce the potential impacts from vapour to the operation of the proposal.

6.12.4 Safeguards and management measures

Table 6-112 Safeguards and management measures - contamination

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
CN01	Detailed site investigation	A Detailed Site Investigation (DSI) is being undertaken prior to construction to better understand the nature and extent of contamination in accordance with the NEPM (2013) and other guidelines made or endorsed by the NSW EPA.	Contractor	Prior to construction	Appendix N	To be determined
CN02	Management of low risk contamination	Where site investigation data confirms that contamination is likely to have a very low, low or moderate impact potential, the site would then be managed in accordance with Construction Environmental Management Framework.	Contractor	Prior to construction	Appendix N	All
CN03	Remediation Action Plan	If identified as required following detailed site investigations, a Remedial Action Plan (RAP) would be developed for identified risk areas within the construction footprint. Each RAP would detail the remediation works required to	Contractor	Prior to construction	Appendix N	To be determined

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		mitigate risks from contamination throughout and following completion of construction. The RAP would be prepared in accordance with relevant NSW EPA guidelines and where applicable, detail remediation methodologies in accordance with Australian Standards and other relevant government guidelines and codes of practice.				
CN04	Site audit statement	If identified as required following detailed site investigations, an accredited Site Auditor would review and approve the RAP and remediation activities and will develop a Site Audit Statement (SAS) and Site Audit Report (SAR) upon completion of remediation.	Contractor	Prior to construction	Appendix N	To be determined
CN05	Residual contamination following construction	Ongoing management and monitoring measures would be documented in an appropriate form, for example an environmental management plan, and implemented for any areas where minor, residual contamination remains following construction.	Contractor	Construction	Appendix N	All

Other safeguards and management measures that would address contamination impacts are identified in sections 6.6 Soils and surface water and 6.7 Groundwater.

6.13 Air quality

This section provides a summary of the assessment of potential air quality impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of air quality impacts is presented in the Technical working paper – Air quality (Appendix O).

6.13.1 Methodology

The air quality assessment involved the following:

- Identifying the key air quality related risks from the proposal
- Establishing prevailing climate and meteorological conditions around the proposal using publicly available data from the Bureau of Meteorology monitoring station at Marrangaroo
- Establishing prevailing ambient air quality conditions around the proposal using publicly available data from Department of Planning, Industry and Environment (DPIE) air quality monitoring stations at Richmond, Bathurst and Camden (the closest monitoring stations to the proposal). Parameters measured include particulate matter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$), nitrogen dioxide ($N0_2$), carbon monoxide (CO)
- Identifying air quality sensitive receivers with the potential to be adversely affected by the proposal
- Assessing potential air quality impacts during construction and operation of the proposal. TRAQ dispersion modelling was used to predict the potential changes to air quality as a result of the operation of the proposal. Pollutants modelled include CO, N02, $PM_{10,}$, $PM_{2.5}$, and benzene. This was then compared against Environment Protection Authority air quality criteria to determine if further detailed air quality modelling would be required
- Identifying mitigation measures to address or manage potential air quality impacts.

6.13.2 Existing environment

The nearest automatic weather station (AWS) with long-term records in relation to the proposal is located at Marrangaroo, approximately 17 kilometres to the north. Key meteorological statistics recorded at the station between 2018 and 2020 are summarised in Table 6-113.

Meteorological conditions

Table 6-113 Local meteorological statistics (Marrangaroo)

Statistic	2018	2019	2020
Mean wind speed (m/s)	1.7	1.6	1.7
99th percentile wind speed (m/s)	5.5	5.8	5.3
Per centage of calm winds (%) (wind speeds less than 0.5 m/s)	27.7	30.8	27.1
Per centage of winds >6 m/s (%)	0.4	0.7	0.3

Hourly records of wind speed and wind direction were examined and the data showed that the wind speed statistics do not vary significantly from year to year. Wind patterns in the vicinity of the proposal are characteristic of the western foothills of the Blue Mountains, with the prevailing winds being from the east and west.

Air quality conditions

DPIE has established a network of monitoring stations across NSW to understand current air quality conditions and impacts, and to help identify programs to improve air quality. The closest air quality monitoring stations to the proposal are located at Richmond, Bathurst and Camden. Data from these stations have been examined and compared to relevant impact assessment criteria in order to understand the existing air quality conditions for the key pollutants that are relevant to the proposal. Table 6-114 identifies the parameters measured at each site.

Table 6-114 Measured parameters at nearby DPIE monitoring stations

Station	Distance from proposal	Measured parametres
DPIE Richmond	60 kilometres	PM_{10}, $PM_{2.5}$,
DPIE Bathurst	50 kilometres	PM_{10}, $PM_{2.5}$, NO_2
DPIE Camden	70 kilometres	CO

Table 6-115 shows the assumed background levels that apply in the vicinity of the proposal. The justification for these background levels is also provided, with conservative approaches adopted in most instances.

Measured CO and NO2 concentrations have been consistently below NSW EPA air quality impact assessment criteria.

Particle levels (as PM_{10} and $PM_{2.5}$) is influenced by many sources including mining activities, construction works, bushfires and 'burning off', industry, vehicles, roads, wind-blown dust from nearby and remote areas, fragments of pollen, mould, and domestic wood fires.

Concentrations of PM_{10} and $PM_{2.5}$ increased across NSW from 2018 to 2020 due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019). These events adversely influenced air quality with multiple days observed when PM_{10} and $PM_{2.5}$ concentrations exceeded NSW EPA criteria.

Table 6-115 Assumed background levels in the vicinity of the proposal.

Pollutant	Averaging time	Assumed background level	Notes
CO	1-hour	5.6 mg/m3	Maximum 1-hour concentration from DPIE Camden (2016 to 2020)
	8-hour	2.3 mg/m3	Maximum 8-hour concentration from DPIE Camden (2016 to 2020)
NO_2	1-hour	66 µg/m3	Maximum 1-hour concentration from DPIE Richmond (2016 to 2020)
	Annual	10 µg/m3	Highest annual concentration from DPIE Richmond (2016 to 2020)
PM_{10}	24-hour	49.9 µg/m3	Maximum 24-hour average in 2016 and 2017 from DPIE Bathurst, noting that data collected 2018 to 2020 were affected by drought, dust storms and bushfires. Air quality data from DPIE Bathurst is considered to be more representative of the

Pollutant	Averaging time	Assumed background level	Notes
			proposal area than DPIE Richmond which is located to the east within the Sydney Greater Metropolitan Area (GMA).
	Annual	14.1 µg/m3	Highest annual concentration from DPIE Bathurst in 2016 and 2017 noting the issues with the data collected in 2018 and 2020, and preference compared to DPIE Richmond outlined above.
$PM_{2.5}$	24-hour	17.5 µg/m3	As above for 24-hour averaged PM_{10}.
	Annual	6.1 µg/m3	As above for annually averaged PM_{10}.

6.13.3 Potential impacts

Construction

The potential construction air quality risks for each section of the proposal are outlined in Table 6-116. The Little Hartley to River Lett and Coxs River Road sections were considered together due to their proximity and concurrent construction programs.

Table 6-116 Summary of unmitigated air quality risks

Construction air quality risk	Consequence	Sensitivity	Risk rating
Little Hartley to River Lett and Coxs River Road			
Dust	Moderate	Likely	High
Exhaust emissions	Insignificant	Unlikely	Low
Blast emissions	N/A	N/A	N/A
Odours and hazardous substances	Moderate	Possible	High
River Lett to Forty Bends			
Dust	Moderate	Likely	High
Exhaust emissions	Insignificant	Unlikely	Low
Blast emissions	Moderate	Possible	High
Odours and hazardous substances	Minor	Unlikely	Low
Forty Bends to Lithgow			
Dust	Minor	Almost certain	High
Exhaust emissions	Insignificant	Unlikely	Low
Blast emissions	N/A	N/A	N/A
Odours and hazardous substances	Minor	Unlikely	Low

The key air quality issue during construction of the proposal is expected to be dust generated from construction activities as well as from wind erosion of exposed areas. Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. Dust impacts during construction would largely result from cutting, embankment filling, vegetation clearing, topsoil stripping, stockpiling of soil, general material handling, driving on unsealed roads and demolition of redundant assets and structures.

The total amount of dust generated would depend on the quantities of material handled, silt and moisture content of the soil, the types of operations being carried out, exposed areas, frequency of water spraying and speed of vehicles and machinery operating on unpaved roads and areas.

All four sections of the proposal are determined to present a 'high' risk of dust impacts during construction and measures commensurate to this level of risk have been recommended.

In addition to construction dust, there are a range of other potential air quality issues. These include:

- Exhaust emission from the combustion of fossil fuels generated by equipment and construction plant
- Blast emissions such as NOx and particulate emissions where blasting is required to remove hard rock in cuttings
- Odours arising from uncovered contaminated and/or hazardous materials, and other airborne hazardous materials, which may be generated during demolition and excavation activities.

Potential impacts from construction plant and equipment exhaust emissions are anticipated to be low, owing to the expected intensity of construction operations, setback distances from surrounding sensitive receivers, and the linear nature of the proposal.

Blasting would be limited to the River Lett to Forty Bends section of the proposal and would represent a high risk for air quality impacts. Where possible, blasting would be timed to avoid the early morning and late afternoon when meteorological conditions are typically least favourable.

There is potential for odours and impacts from airborne hazardous materials during demolition activities. These risks may also be present during excavation works, noting the presence of potentially contaminated soils and areas of illegal dumping within the construction area.

With the implementation of the safeguards and management measures outlined in Section 6.13.4, significant air quality impacts associated with dust, exhaust emissions, odours, and airborne hazardous materials are not anticipated.

Operation

The potential operational impacts of the proposal have been quantified using dispersion modelling. Results from the modelling have been assessed by examining the spatial differences between, with and without proposal scenarios, and also in terms of the potential for the proposal to cause exceedances of the EPA air quality impact assessment criteria at sensitive receivers. Potential impacts to specific sensitive receivers are described in Section 5.2 of Appendix O.

Little Hartley to River Lett

Results at the most-affected receiver along the eastern component of the Little Hartley to River Lett section of the proposal are listed in Table 6-117. This represents the receiver where the change from the background level is highest.

The Great Western Highway would move around 20 metres closer to some receivers as a result of the proposal. This would have the potential to increase 24-hour average PM_{10} concentrations greater than the EPA's 50 micrograms per cubic metre criterion at one sensitive receiver. It is noted that the predicted contribution of the proposal to this exceedance was up to 0.2 micrograms per cubic metre or 0.4 per cent, noting that the adopted background concentration was 49.9 micrograms per cubic metre. The proposals

contribution represents a minor increase and in and of itself is not considered likely to adversely impact on nearby sensitive receivers. The maximum 24-hour averaged PM_{10} cumulative concentration of 50.2 micrograms per cubic metre is within the range of historical maximum values recorded at the nearest DPIE monitoring stations in Bathurst and Richmond, which have been measured as high as 320 ug/m3 and 238 ug/m3 respectively.

Concentrations of the other pollutants, as well as annually averaged PM_{10} were predicted to remain below the relevant EPA assessment criteria.

Table 6-117 Predicted air quality impacts at the most-affected receiver – Little Hartley to River Lett (east)

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
CO (mg/m^3)	1-hour	30	5.6	5.7	5.7
	8-hour	10	2.3	2.3	2.4
NO_2 ($\mu g/m^3$)	1-hour	246	66	66.2	66.9
	Annual	62	10	10.2	10.2
PM_{10} ($\mu g/m^3$)	24-hour	50	49.9	50.1	50.2
	Annual	25	14.1	14.2	14.2
$PM_{2.5}$ ($\mu g/m^3$)	24-hour	25	17.5	17.7	17.8
	Annual	8	6.1	6.2	6.2
Benzene ($\mu g/m^3$)	1-hour	29	-[1]	0	0.1

Note 1: No assumed background level for benzene as this is not measured at DPIE air quality monitoring stations

Results at the most-affected receiver along the western component of the Little Hartley to River Lett section of the proposal are listed in Table 6-118. This represents the receiver where the change from the background level us highest.

The concentrations of each pollutant at the most-affected receiver were predicted to remain at or below the EPA's impact assessment criteria. This section of the proposal would not result in any adverse local operational air quality impacts.

Table 6-118 Predicted air quality impacts at the most-affected receiver – Little Hartley to River Lett (west)

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
CO (mg/m^3)	1-hour	30	5.6	5.7	5.7
	8-hour	10	2.3	2.4	2.5
NO_2 ($\mu g/m^3$)	1-hour	246	66	65.9	66
	Annual	62	10	10	10
PM_{10} ($\mu g/m^3$)	24-hour	50	49.9	50	50
	Annual	25	14.1	14.1	14.1
$PM_{2.5}$ ($\mu g/m^3$)	24-hour	25	17.5	17.6	17.6

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
	Annual	8	6.1	6.1	6.1
Benzene (µg/m^3)	1-hour	29	-[1]	0	0

Note 1: No assumed background level for benzene as this is not measured at DPIE air quality monitoring stations

Coxs River Road

Results at the most-affected receiver along the Coxs River Road section of the proposal are listed in Table 6-119. This represents the receiver where the change from the background level is highest.

Changes in concentrations as a result of the proposal concentrations were predicted to remain below the EPA's impact assessment criteria, except for 24-hour averaged PM_{10} where the exceedances would be experienced at six sensitive receivers. Exceedances at these locations are a result of the Great Western Highway alignment moving closer to the receivers. These exceedances primarily remain the result of the elevated adopted 24-hour averaged PM_{10} background concentration of 49.9 micrograms per cubic metre, with the proposal's contribution to the highest cumulative value of 51.5 micrograms per cubic metre being 1.6 micrograms per cubic metre or less than 3.1 per cent. The proposals contribution represents a minor increase and in and of itself is not considered likely to adversely impact on nearby sensitive receivers. Further, the maximum 24-hour averaged PM_{10} cumulative concentration of 51.5 micrograms per cubic metre is within the range of measured historical maximum values which have been measured as high as 320 ug/m3 and 238 ug/m3 respectively.

Table 6-119 Predicted air quality impacts at the most-affected receiver – Coxs River Road

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
CO (mg/m^3)	1-hour	30.0	5.6	5.8	5.8
	8-hour	10.0	2.3	2.5	2.5
NO_2 (µg/m^3)	1-hour	246.0	66.0	71.5	71.2
	Annual	62.0	10.0	11.1	11.0
PM_{10} (µg/m^3)	24-hour	50.0	49.9	51.4	51.5
	Annual	25.0	14.1	14.6	14.7
$PM_{2.5}$ (µg/m^3)	24-hour	25.0	17.5	19	19.1
	Annual	8.0	6.1	6.6	6.7
Benzene (µg/m^3)	1-hour	29.0	-[1]	0.1	0.2

Note 1: No assumed background level for benzene as this is not measured at DPIE air quality monitoring stations

River Lett to Forty Bends

Results at the most-affected receiver along the River Lett to Forty Bends section of the proposal are listed in Table 6-120. This represents the receiver where the change from the background level is highest.

Changes in concentrations as a result of the proposal concentrations were predicted to remain below the EPA's impact assessment criteria, except for 24-hour averaged PM_{10} where the exceedances would be experienced at eight receivers. Exceedances at these locations are a result of the Great Western Highway alignment moving closer to the receivers. These exceedances primarily remain the result of the elevated

adopted 24-hour averaged PM_{10} background concentration of 49.9 micrograms per cubic metre, with the proposal's contribution to the highest cumulative value of 51.1 micrograms per cubic metre being 1.2 micrograms per cubic metre or less than 2.4 per cent. The proposals contribution represents a minor increase and in and of itself is not considered likely to adversely impact on nearby sensitive receivers. Further, the maximum 24-hour averaged PM_{10} cumulative concentration of 51.1 micrograms per cubic metre is within the range of measured historical maximum values which have been measured as high as 320 ug/m3 and 238 ug/m3 respectively.

Table 6-120 Predicted air quality impacts at the most-affected receiver – River Lett to Forty Bends

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
CO (mg/m^3)	1-hour	30.0	5.6	6.2	6.4
	8-hour	10.0	2.3	2.8	2.8
NO_2 ($\mu g/m^3$)	1-hour	246.0	66.0	71.1	70.9
	Annual	62.0	10.0	11.0	11.0
PM_{10} ($\mu g/m^3$)	24-hour	50.0	49.9	50.9	51.1
	Annual	25.0	14.1	14.5	14.6
$PM_{2.5}$ ($\mu g/m^3$)	24-hour	25.0	17.5	18.5	18.7
	Annual	8.0	6.1	6.5	6.6
Benzene ($\mu g/m^3$)	1-hour	29.0	-[1]	0.1	0.1

Note 1: No assumed background level for benzene as this is not measured at DPIE air quality monitoring stations

Forty Bends to Lithgow

Results at the most-affected receiver along the Forty Bends to Lithgow section of the proposal are listed in Table 6-121. This represents the receiver where the change from the background level is highest.

Changes in concentrations as a result of the proposal concentrations were predicted to remain below the EPA's impact assessment criteria, except for the 24-hour averaged PM_{10} concentration for the 2031 assessment horizon which would be experienced at four sensitive receivers. The contribution of the proposal to this exceedance was up to 0.2 micrograms per cubic metre or 0.4 per cent, noting that the adopted background concentration of 49.9 micrograms per cubic metre. Again, the maximum 24-hour averaged PM_{10} cumulative concentration of 50.1 micrograms per cubic metre is within the range of historical maximum values which have been measured as high as 320 ug/m3 and 238 ug/m3 respectively. The proposals contribution represents a minor increase and in and of itself is not considered likely to adversely impact on nearby sensitive receivers.

Table 6-121 Predicted air quality impacts at the most-affected receiver – Forty Bends to Lithgow

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
CO (mg/m^3)	1-hour	30.0	5.6	5.7	5.7
	8-hour	10.0	2.3	2.3	2.4
NO_2 ($\mu g/m^3$)	1-hour	246.0	66.0	66.5	66.7

Pollutant	Averaging time	EPA assessment criteria	Assumed background level	Concentration with proposal 2026	Concentration with proposal 2036
	Annual	62.0	10.0	10.1	10.1
PM_{10} (µg/m^3)	24-hour	50.0	49.9	50.0	50.1
	Annual	25.0	14.1	14.1	14.2
$PM_{2.5}$ (µg/m^3)	24-hour	25.0	17.5	17.6	17.7
	Annual	8.0	6.1	6.1	6.2
Benzene (µg/m^3)	1-hour	29.0	-[1]	0.0	0.0

Operation greenhouse gases

Total annual CO_2 equivalent (CO_2-e) greenhouse gas emissions were modelled for five scenarios (refer Table 6-122):

- Do nothing 2021 – Existing traffic conditions in the year 2021
- With proposal 2026 – Traffic conditions the planned opening year, with the proposal
- Do nothing 2026 – Traffic conditions in the planned opening year, without the proposal
- With proposal 2036 – Traffic conditions 10 years after the planned opening year, with the proposal
- Do nothing 2036 – Traffic conditions 10 years after the planned opening year, without the proposal

With the proposal CO_2 equivalent greenhouse gas emissions were predicted to increase by 10.9 per cent compared to emissions from existing operations. Compared with the relevant no proposal options (i.e. Do nothing 2026 and Do nothing 2036), relative increases of up to 3.7 per cent and 3.1 per cent were predicted at the year of opening (2026) and 2036 respectively. These increases are a result of marginal increases in heavy vehicle flows, as well as speeds facilitated by the proposal.

Table 6-122 Predicted annual CO2 equivalent operational greenhouse gas emissions

Assessment scenario	Predicted annual greenhouse gas emission (CO_2-e tonnes)	Percentage change compared with existing traffic conditions (2020)	Percentage change compared with equivalent 2026 or 2036 Do nothing scenario
Do nothing 2021	19,981	-	-
With proposal 2026	21,129	+5.8 per cent	+3.7 per cent
Do nothing 2026	20,369	+1.9 per cent	-
With proposal 2036	22,136	+10.9 per cent	+3.1 per cent
Do nothing 2036	21,470	+7.5 per cent	-

6.13.4 Safeguards and management measures

Table 6-123 Safeguards and management measures – air quality

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
AQ01	Air quality management	Develop and implement an Air Quality Management Plan (AQMP) as part of the Construction Environmental management Plan (CEMP). In addition to detailing how the measures above should be implemented, the AQMP should also identify: • Potential sources of air pollution (including odours and dust) during construction. • Air quality management objectives consistent with any relevant published guidelines. • Methods to manage works during strong winds or other adverse weather conditions. • A progressive rehabilitation strategy for exposed surfaces. • When the air quality, suppression and management measures need to be applied, who is responsible, and how effectiveness will be assessed. • A monitoring program to record whether the air quality mitigation, suppression and management measures have been applied; and assess the effectiveness of the applied measures.	Construction contractor	Prior to and during construction	Appendix O	All
AQ02	Dust emissions	Minimise the extent of disturbed and exposed areas, and revegetate	Construction contractor	During construction	Appendix O	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
	during construction	finished areas as soon as possible				
AQ03		Minimise the drop heights of materials	Construction contractor	During construction	Appendix O	All
AQ04		Review and where necessary modify or suspend activities during dry and windy weather and background air quality conditions.	Construction contractor	During construction	Appendix O	All
AQ05		Cover or otherwise regularly stabilise (with water sprays or binders) stockpiles	Construction contractor	During construction	Appendix O	All
AQ06		Regularly water haul routes and ensure that all loads are covered	Construction contractor	During construction	Appendix O	All
AQ07		Regularly inspect and remove debris from plant and equipment to avoid the tracking of materials on to the adjacent road network	Construction contractor	During construction	Appendix O	All
AQ08		To the extent practical, position ancillary sites and stockpiles away from nearby sensitive receivers	Construction contractor	Prior to construction	Appendix O	All
AQ09	Exhaust emissions from plant and equipment used during construction	Inspect all plant and equipment before it is used on-site	Construction contractor	Prior to and during construction	Appendix O	All
AQ10		Ensure all vehicles, plant, and equipment operate in a proper and efficient manner.	Construction contractor	During construction	Appendix O	All
AQ11		Switch off all vehicles, plant and equipment when not in-use	Construction contractor	During construction	Appendix O	All
AQ12		Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable.	Construction contractor	During construction	Appendix O	All
AQ13	Odours and airborne	Apply odour supressing agents to materials as	Construction contractor	During construction	Appendix O	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
	hazardous substances from uncovered contaminated materials	necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works				
AQ14		Adhere to relevant requirements for removal and disposal listed in the Work Health and Safety Act 2011, and Work Health and Safety Regulation 2017.	Construction contractor	During construction	Appendix O	All
AQ15	Emissions to air and visual impacts from blasting activities	Prior to firing, review and confirm that the blast would not likely result in any dust or fume-related impacts. This should include a review of whether meteorological conditions (ie inversions, wind speeds and directions, stability, time of day, cloud cover, temperature and humidity are suitable	Construction contractor	During construction	Appendix O	River Lett to Forty Bends
AQ16		Where possible, avoid blasting during early morning and late afternoon when meteorological conditions are typically least favourable in terms of the potential for blast-related impacts	Construction contractor	During construction	Appendix O	River Lett to Forty Bends

Other safeguards and management measures that would address air quality impacts are identified in sections 6.2 Traffic and transport

6.14 Bushfire

This section provides a summary of the assessment of potential bushfire risks during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of bushfire risk is presented in the technical working paper – bushfires (Appendix P).

6.14.1 Methodology

The bushfire risk assessment involved the following:

- Review of the existing bushfire management arrangements for the proposal area
- Desktop review of the existing environment including weather patterns, climate change projections, topography, vegetation, historic fires and potential ignition sources
- Development of most likely bushfire scenarios
- Assessment of the bushfire attack level for the proposal in accordance with AS3959:2018 Construction of building in bushfire prone areas.

6.14.2 Existing environment

Bushfire weather

The study area experiences a temperate climate, characterised by cool and relatively dry winters and warm and relatively wet summers. Afternoon winds in the study area are predominantly from the west, south-west or east during the main fire danger period. These winds tend to be associated with more dangerous fire weather conditions (characterised by higher temperature, lower humidity and elevated wind speed).

Average monthly fire danger ratings are generally in the low to moderate range throughout the year. Days of very high fire danger rating have been recorded in every month apart from May, June and July. Days with severe fire weather conditions have only been recorded between November and February (18 days over 26 years).

The bushfire season generally runs in the study area between October and March (Lithgow BFMC, 2020), but may be extended earlier or later depending on seasonal conditions. The most extreme fire weather conditions occur on days with temperature, low humidity and strong, gusty north-westerly winds. Lightning storms are common in the mountains throughout the region during the bushfire season and are one of the main causes of bushfire ignition.

Climate change is projected to alter fire weather conditions in the study area resulting in increased temperatures, decreased cool season rainfall and increased warm season rainfall, decreased relative humidity and small changes to wind. These projections indicate that bushfire weather will generally become harsher, although some extreme values may be moderated as a result of projected increases in summer rainfall. Days with more dangerous fire weather conditions (fire danger rating of very high or above) are projected to become more frequent and occur through more months of the year. Fire danger is projected to extend into the extreme range by 2050, although such days would be uncommon.

Topography and vegetation

Landforms in the area surrounding the proposal are highly variable. Elevation ranges from less than 750 metres along the valley of the River Lett to over 1100 metres at the Hassans Walls and over 1000 metres around Mount Victoria. Slopes along the ridges connected to the Blue Mountains (e.g. Hassans Walls, Mount Victoria, and Mount York) are typically very steep. The hills to the west of Hartley are lower (typically less than 900 metres) and their slope is more subdued.

Fire behaviour is strongly influenced by slope and aspect. The rate of spread of a fire approximately doubles for each 10 degree increase in slope. Vegetation and bushfire fuels on southerly aspects (particularly in areas with significant topographic relief) are typically wetter and less fire prone than vegetation on more northerly aspects. While vegetation and other bushfire fuels may become highly flammable after prolonged drought and under extreme fire weather conditions, fires in these areas are typically less intense and slower moving.

Bushfires in elevated areas are typically exposed to stronger winds. This may exacerbate fire behaviour and contribute to long-distance spotting activity.

Topography and the location of native vegetation will strongly influence fire conditions experienced along the proposed route of the proposal. Where the highway is located below areas of vegetation and steep slope (e.g. below Hassans Walls), it is likely to be relatively protected from fire. However, where the proposal is located at the top of steep, vegetated slopes (e.g. in the hills to the west of Little Hartley village), it may be exposed to a rapidly moving, intense wildfire.

In higher elevation areas, vegetation typically comprises dry or wet sclerophyll forest. Along lower sections of the Greater Western Highway between Hartley and Little Hartley the vegetation consists of fragmented areas of grassy woodland. A riparian corridor (forested woodlands) has been retained along at the River Lett. Apart from the ranges areas that are connected with the Blue Mountains, native vegetation throughout the study area is quite fragmented, as a result of the long history of agricultural clearing and land use.

Most reasonably intact areas of native vegetation in the study area are classified category 1 (high risk) bushfire prone vegetation. The remainder of the study areas supports category 2 (moderate risk) vegetation, apart from Mount Victoria township.

Fire history and ignition sources

The Lithgow Bush Fire Management Committee (BFMC) area, which includes the area surrounding the proposal, has on average 128 bush or grass fires each year, of which about three per year develop into major fires (greater than 20 hectares). The two largest bushfires in the landscape around the study area were at Mount Victoria and Mount York region in the 2013-14 and 2019-20 seasons, respectively. The 2019-20 bushfires affected over 200,000 hectares of land in the Lithgow BFRMP area (Lithgow BFMC, 2020).

The main ignition sources in the landscape surrounding the study area are (Lithgow BFMC, 2020):

- Lightning activity
- Escaped fires from legal burning activities by private landholders
- Illegal or careless burning activities by private landholders, mostly in grasslands or vegetated areas near villages

While bushfires occur at relatively high frequency in the Blue Mountains, they are uncommon in the immediate proposal environs.

6.14.3 Potential impacts

Potential bushfire scenarios

There are a variety of circumstances that could give rise to bushfire risk to the proposal and study area. Three key scenarios that pose the greatest risk are:

Scenario 1

A fire ignites in one of the large patches of native vegetation areas within or to the north-west of the study area (e.g. Marrangaroo National Park, Hassans Walls) on a day with elevated fire weather conditions and strong winds from the north-west. The fire descends or spots into lower lying rural land and then runs to the south-east as a grass/bushfire through the South Bowenfels, Little Hartley and/or Hartley areas – roughly parallel to the Great Western Highway. The fire would burn rapidly up vegetated north-west facing slopes of the low hills in this area and more slowly down the hills. Depending on wind direction, the fire could then burn rapidly uphill along a wide front from south of Mount Victoria to Mount York.

The fire would spread rapidly along the path of the highway and generate flames, smoke and embers that could affect signs, guard rails and other road furniture, as well as pose a safety risk to any road users (or construction crews, if the fire occurred during that phase of the proposal). Farming land and settlements in the study area would be threatened. Large trees along on the roadside with hollows or other defects may be further damaged by the fire and could burn out at the base and collapse or pose a safety risk after the fire has passed.

This scenario describes circumstances where the most severe bushfires are likely to occur within the study area. Based on fire history in the landscape surrounding the study area, a fire of this nature could occur every decade or so, although not every such fire would actually affect the immediate proposal environs

Scenario 2

A fire ignites within grassy woodland areas on either side of the highway corridor during a period of moderately elevated fire weather, with strong winds blowing from the west or east. Depending on the ignition point, prevailing winds could drive the fire towards and (most likely) across the Great Western Highway (towards Mount Blaxland or the Blue Mountains). Embers, smoke and radiant heat from the fire would affect road furniture, road users, construction crews and construction equipment (during this phase) but not likely to the same extent as under scenario 1. Fire impacts would be greatest where fires were driven up heavily vegetated slopes towards the highway

Scenario 3

Road accident, careless behaviour of road users or construction activity resulted in fire ignition allow the Great Western Highway on a day with highly elevated fire weather conditions. Depending on the location of the ignition point, the fire could burn in grassland or grassy woodland along the highway corridor or divert to the south or north, affecting road users, the smaller settlements within and near the study area and/or burn into the Blue Mountains (where it would be difficult to contain).

This scenario is similar to scenario 1, although that the fire in this scenario would be attributable to construction or operation of the proposal. Since the fire would ignite in close proximity to the proposal, it may not affect as much of the highway corridor as scenario 1 and may not affect the smaller settlements in the study area to the same extent. If such a fire reached the Blue Mountains, it would be difficult to contain and could grow to a significant size.

Bushfire attack level exposure

Bushfire Attack Level (BAL) is a quantitative measure of potential bushfire risk calculated using AS3959:2018 Construction of building in bushfire prone areas (Standards Australia, 2018). Bushfire attack level is affected by the area, vegetation, distance from the vegetation, and the slope of the area. There are six bushfire attack levels (refer to Table 6-124).

Table 6-124 Bushfire attack level

BAL	Description of risk
Low	Lowest risk from a potential fire

BAL	Description of risk
12.5	Risk is primarily from potential embers during a fire
19	Moderate risk, particularly from embers and burning debris
29	High risk, particularly from embers, debris and heat
40	Very high risk, likely to be impacted by embers, debris, heat and potentially flames
Fire Zone	Extreme risk, directly exposed to the flame of a potential fire front

Should native vegetation in the vicinity of the proposal be ignited in a bushfire, it would potentially expose infrastructure, construction crews and road users to radiant heat and embers. BAL was calculated for sections of the road where there were forests or woodlands adjacent to the construction footprint. A slope of five to ten degrees was assumed for sections where the terrain was sloping up towards the road. A flat surface was assumed elsewhere. Areas of bushfire attack level within the proposal are shown in Figure 6-58 and Figure 6-59.

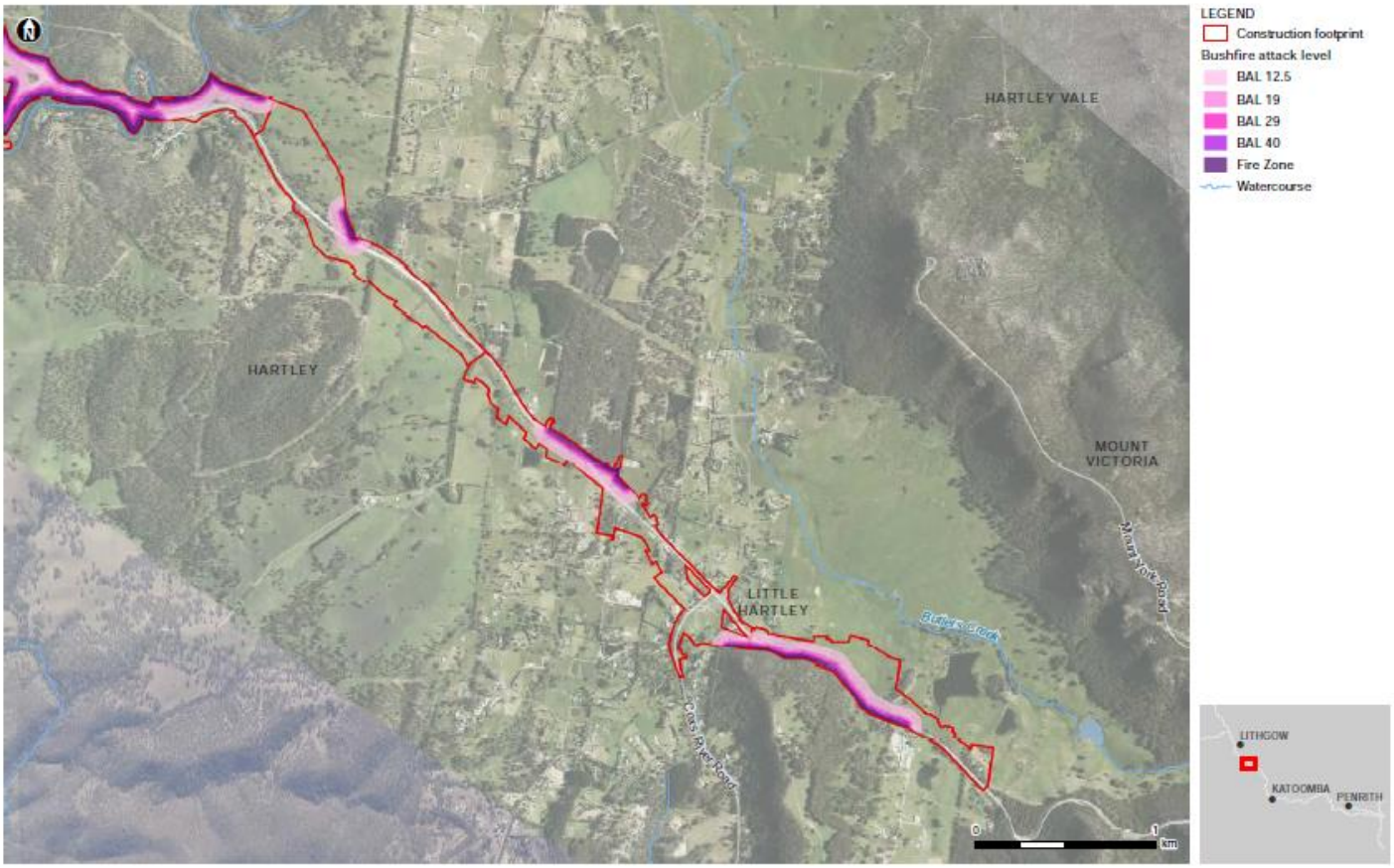


Figure 6-58 Bushfire attack level in the southern portion of the proposal

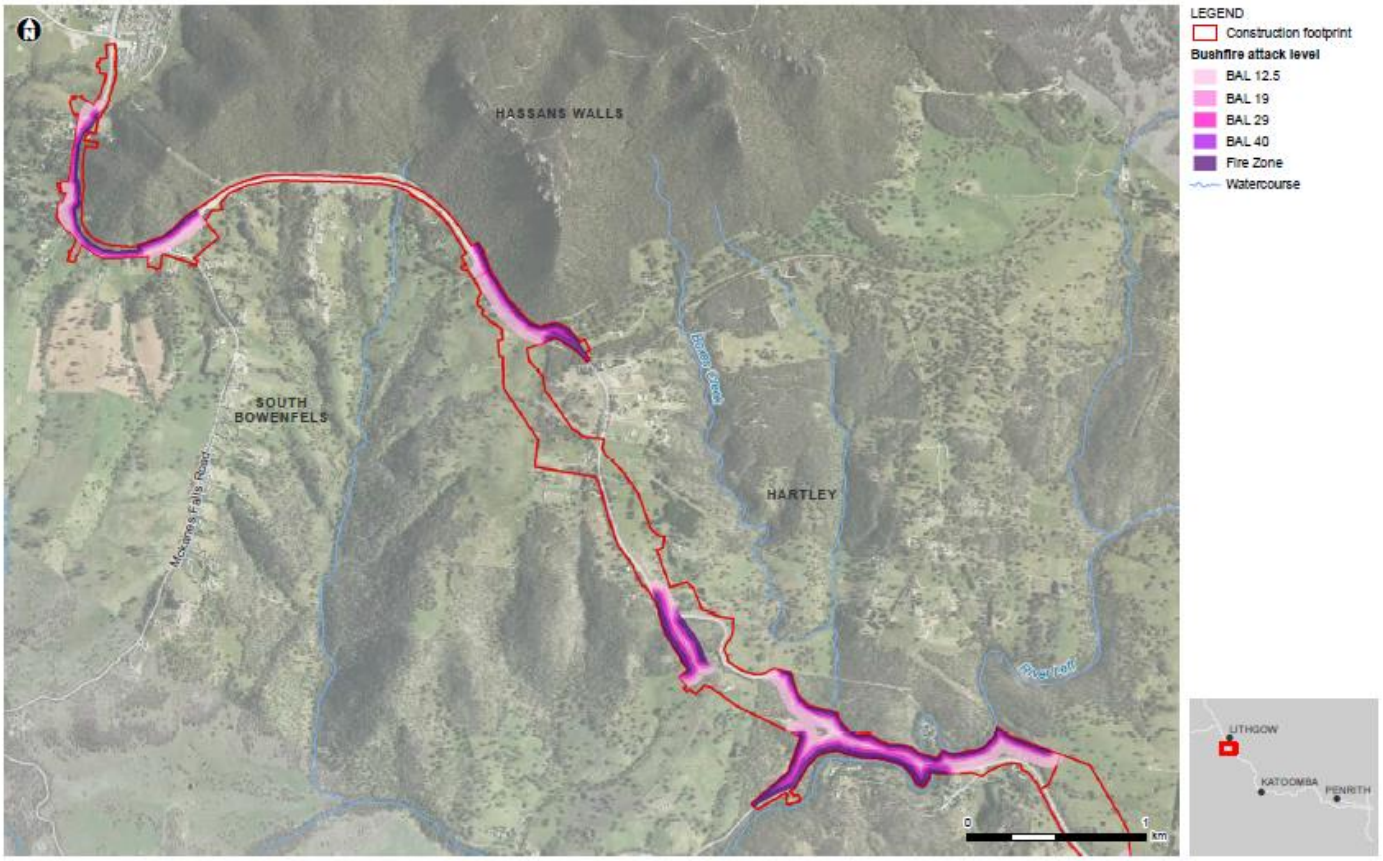


Figure 6-59 Bushfire attack level in the northern portion of the proposal

6.14.4 Safeguards and management measures

Table 6-125 Safeguards and management measures – bushfire

Ref	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
BF01	Emergency access during construction	In the event of a fire, emergency services will be able to gain access via existing Great Western Highway or tracks used for construction activities. Access and egress to/from private properties in bushfire prone areas adjoining the construction corridor will be maintained, with advice on any access changes provided to RFS in advance of the bushfire season.	Construction contractor	Construction	Appendix P	All
BF02	Hot works	Works that have potential to generate sparks or heat and ignite fires will be subject to the contractor's hot works safety	Construction contractor	Construction	Appendix P	All

Ref	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		management procedures. Hot works will not be undertaken on total fire ban days except where permission has been given by the RFS. Construction equipment and contractor's vehicles will carry fire extinguishers or knap sacks to help extinguish any small fires that may be ignited by construction activities.				
BF03	Hazardous materials storage	Storage of hazardous and flammable materials should follow environmental protection guidance and be located in areas with low radiant heat exposure in the event of a bushfire. Any hazardous fuel storage areas should be free of vegetation or any other combustible materials that could contribute to a fire ignition.	Construction contractor	Construction	Appendix P	All
BF04	Emergency management	On site bushfire emergency management arrangements will be addressed through the construction contractor's site emergency management plan. This plan will specify notifications to emergency services in case of fire, emergency assembly areas and evacuation procedures. If a fire is ignited and cannot be safely contained using fire extinguishers or other materials at hand, construction crews will dial 000 and seek emergency service assistance.	Construction contractor	Construction	Appendix P	All
BF05	Operational bushfire risks	Grass within the highway corridor should be inspected and maintained at the commencement of	Transport	Operation	Appendix P	All

Ref	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		the fire season (and through the fire season, if required) to reduce fuel loading and the potential for fire ignition and to create a low bushfire fuel zone in the immediate vicinity of the road. Woody vegetation in the vicinity of the road should also be actively managed to remove dead plants. Roadside trees should be inspected for stability and safety following any fire event to minimise the risk posed to road users.				
BF06	Operational access	Design would incorporate the need for safe emergency vehicle access at all times.	Transport	Operation	Appendix P	All
BF07	Fire weather signage	Roadside signage should be erected at either end of the proposal that informs road users of the daily fire weather forecast (i.e. the daily Fire Danger Rating). On days of highly elevated fire danger (extreme or catastrophic fire danger), additional advice should be posted that advises road users to reconsider the need for travel.	Transport	Operation	Appendix P	All
BF08	Road closures	During active fire events in the landscape surrounding the proposal, emergency services should consider temporary road closures to all but emergency service vehicles.	Transport	Operation	Appendix P	All

6.15 Waste

Transport is committed to ensuring the responsible management of unavoidable waste and promotes the reuse of such waste in accordance with the resource management hierarchy principles outlined in the *Waste Avoidance and Resource Recovery Act 2001*. These resource management hierarchy principles, in order of priority, are:

- Avoidance of unnecessary resource consumption in operations, maintenance, construction and management
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal.

By adopting the above principles, Transport aims to efficiently reduce resource use, reduce costs and reduce environmental harm in accordance with the principles of ecologically sustainable development, as outlined in Section 8 of this review of environmental factors.

6.15.1 Legislative framework and guidelines

Legislative framework

The key waste related legislation relevant to the proposal include:

- *Protection of the Environment Operations Act 1977*
- *Protection of the Environment Operations (Waste) Regulation 2014*
- *Waste Avoidance and Resource Recovery Act 2001*.

A description of these legislative instruments and relevance to the proposal is presented in Section 4.

Waste Classification Guidelines

The NSW Waste Classification Guidelines (EPA, 2014a) provides guidance on the assessment, classification, management and disposal for all waste on the proposal. The waste classification process under the guidelines follows the principles:

- Where practicable, safe and appropriate, it is desirable to separate a mixture containing different classes of wastes before classifying them separately
- Two or more classes of waste must not be mixed in order to reduce the concentration of chemical contaminants. Dilution of contaminants is not an acceptable waste management option. This includes the addition of water to any waste before laboratory analysis for the purpose of waste classification
- When classifying waste using chemical assessment it is not appropriate to exclude sample results. Selectively choosing sample results to classify waste introduces bias and violates fundamental statistical principles. There must be scientifically valid reasons for the exclusion of sample results.

6.15.2 Potential impacts

Construction

The proposal has the potential to generate waste from the following activities:

- Excavation and earthworks
- Vegetation clearing
- Demolition
- Utilities adjustment

- Surplus construction material
- Plant and equipment maintenance
- General site office activities at ancillary facilities.

The waste types likely to be generated from the proposal are listed in Table 6-126. Refer to Section 6.12 for measures to manage potential contamination from some of the waste types discussed below.

Table 6-126 Construction waste streams

Waste type	Description
Spoil and excavation waste	• The proposal would have a fill deficit (refer to Section 3.3.5 for information on cut and fill material amounts). Excavated material from cuts would be used as fill, where suitable, however there may be material unsuitable for use that would require disposal offsite.
Green waste	• This waste type would be generated from clearing existing vegetation (refer to Section 6.1 for estimated amounts of vegetation to be cleared by the proposal) and landscaped areas on the Princes Highway road reserve. Waste would include tree branches, green waste and weeds.
Demolition waste	• The proposal would require the demolition of building structures (eg houses and sheds) and the removal and relocation of road pavement, roadside furniture and utilities infrastructure resulting in bricks, asphalt, concrete, gravel, steel and other related waste.
Excess building materials	• For example, concrete, asphalt, steel, timber, plastics and packaging materials.
Liquid Waste	• Mainly from maintenance of various construction plant and equipment including liquid hazardous waste, fuel and oils. Generation of this waste would generally occur at the proposed construction ancillary facilities, including compound areas where plant is stored.
General waste	• For example, food, paper and other waste generated from site compounds and offices.
Contaminated material	• Potential contamination is present on site, including (but not limited to) groundwater contamination from underground fuel storage associated with a former service station, groundwater in vicinity of Hartley Cemetery, soil contamination from disturbance of waste dumping/burial, sheep/cattle dips, septic tanks and chemical or fuel use and ground storage areas (refer to Section 6.12 for further information) • There is also potential Acid Sulfate Rock that may require disposal if it can not be treated or reused on site.

Waste type	Description
Wastewater	• From washdown and bunded areas within ancillary facilities.
Redundant erosion and sediment controls	• Erosion and sediment controls would be removed at the completion of construction.

These waste types could have potential impacts in terms of:

- Excessive volumes of waste generated on-site
- Excessive volumes of waste sent to landfill from the inadequate collection, classification and disposal of waste
- Contamination of soil, surface water and groundwater from inadequate waste handling.

The potential to reuse excavated material would be further investigated during detailed design and construction planning. Unsuitable fill material and all other wastes would be classified in accordance with the *NSW Waste Classification Guidelines* (EPA, 2014a) and disposed of to an appropriately licensed facility. While the proposal would have a net fill requirement, some unsuitable material (such as Acid Sulfate Rock) may be generated during the construction of the proposal. Unsuitable material is surplus material that cannot be used beneficially elsewhere onsite. This material would need to be disposed of offsite. Green waste would be mulched (where not contaminated by weeds) and beneficially reused for the proposed interchange landscaped areas as a first preference.

Management of potential contamination is discussed in Section 6.12.

Operation

Limited volumes of waste are currently generated from the operation of the intersection, derived from maintenance activities and road users. Waste includes:

- General waste along the road, including litter
- Trimmed vegetation from landscaped areas
- Excess concrete and asphalt from road maintenance and repair activities
- Vehicle oils and greases from maintenance vehicles
- Vegetation, soil and silt from the clearing of drains and culverts
- Contaminated waste as a result of fuel spills, accidents or leaks.

The proposal would not result in additional waste or potential waste impacts once operational.

6.15.3 Safeguards and management measures

Table 6-127 Safeguards and management measures – Waste

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
WM01	Waste management	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The	Contractor	Prior to construction	Environmental Procedure - Management of Wastes on Transport Land (Roads and Maritime	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		WMP will include but not be limited to: • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (reuse, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Transport for NSW Land (Roads and Maritime Services, 2014) and relevant Transport for NSW Waste Fact Sheets.			Services, 2014)	
WM02	Waste management	All wastes will be managed and disposed of in accordance with the Protection of the Environment Operations Act 1997 and the Protection of the Contractor	Contractor	Construction	N/A	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		Construction Environment Operations (Waste) Regulation 2014				
WM03	Disposal of waste	Excavated material would be assessed for reuse as backfill material as part of the proposal. If material is unable to be used as backfill material it would be appropriately tested and classified against the NSW EPA Waste Classification Guidelines Part 1: Classifying Waste (NSW EPA, 2014) and Addendum 1 (NSW EPA, 2016) prior to being disposed of off-site.	Contractor	Construction	Appendix N	All
WM04	Green waste	Where possible and suitable for use, cleared vegetation will be used as mulch or coarse woody debris for site erosion and sedimentation controls or rehabilitation.	Contractor	Construction	N/A	All
WM05	Fill material	Any required additional fill material will be sourced from appropriately licensed facilities and/or other construction projects wherever possible. Additional fill material will be sourced and verified as suitable for use in accordance with relevant EPA and Transport guidelines.	Contractor	Construction	N/A	All

6.16 Sustainability, greenhouse gas and climate change

This section provides a summary of the assessment of potential climate change impacts and greenhouse gas emissions during construction and operation of the proposal and identifies mitigation measures to address these impacts. A detailed assessment of climate change and greenhouse gas risks and impacts is presented in the technical working paper – greenhouse gas and climate change risk assessment (Appendix Q). This section also provides a summary of the sustainability objectives of the proposal and outlines specific targets to achieve these objectives.

6.16.1 Methodology

Sustainability

The sustainability assessment for the REF areas of the proposal broadly involved:

- Defining the sustainability context for the proposal within the broader context of NSW's objective of improving transport efficiency, and the relevant Transport policies and guidelines
- Reviewing the sustainability focus areas, associated objectives from the Great Western Highway Environment and Sustainability Policy and responding to how these focus areas apply to the proposal
- Identifying requirements for managing sustainability during detailed design, construction, and operation.

The assessment considered whole of life mitigation in response to the focus areas and objectives.

Greenhouse gas

Greenhouse gases are gases that when released into the atmosphere effectively trap heat influencing global temperatures. The release of greenhouse gases into the atmosphere is caused by both natural processes (such as bushfires) and human activities (e.g. burning fossil fuels and land clearing).

Since the industrial revolution the concentration of greenhouse gases, in parts per million, has rapidly increased, leading to an increase in the earth's average surface temperature and contributing to the phenomenon of 'climate change'.

Greenhouse gas emissions are reported as tonnes of carbon dioxide equivalent (tCO2-e) and categorised into three different scopes (either scope 1, 2 or 3) in accordance with the Greenhouse Gas Protocol (World Resources Institute, 2014), Intergovernmental Panel on Climate Change and Australian Government greenhouse gas accounting/classification systems.

The three emission categories (known as 'scopes') help differentiate between direct emissions from sources that are owned or controlled by a proposal, and upstream indirect emissions that are a consequence of proposal activities, but which occur at sources owned or controlled by another entity. The three greenhouse gas scopes are:

- Scope 1 emissions, also referred to direct emissions
- Scope 2 emissions, also referred to as indirect emissions
- Scope 3 emissions, includes all indirect emissions (not included in scope 2) due to upstream or downstream activities.

The objectives of the greenhouse gas assessment were to:

- Identify the likely sources of greenhouse gas emissions associated with the proposal
- Quantify the greenhouse gas emissions associated with each greenhouse gas source

- Identify opportunities (mitigation measures) to reduce greenhouse gas emissions.

The calculation of greenhouse gas emissions for this assessment was facilitated using the Transport Authorities Greenhouse Group's (TAGG) Carbon Gauge greenhouse gas assessment tool which automates many of the calculations, assumptions and default greenhouse gas emissions factors. Carbon Gauge was used to determine the fuel combustion, material requirements and vegetation clearance associated with the proposal. The tool was also used to calculate the projected electrical energy as well as maintenance fuel and materials requirements of the proposal during operation (with emissions factors updated from other sources as required).

Emissions associated with the change in traffic resulting from the proposal have been calculated in using 'Tool for Roadside Air Quality' (TRAQ). The total annual greenhouse gas emissions (CO_2e) have been calculated for the following scenarios:

- Existing 2021 – Emissions resulting from the existing road layout, with existing traffic levels in the year 2021
- Without proposal 2026 – Emissions resulting from the existing road layout, with predicted traffic levels in the year 2026 (year of opening)
- With proposal 2026 – Emissions resulting from the traffic using the roads constructed as part of the proposal in the year 2026 (year of opening)
- Without proposal 2036 – Emissions resulting from the existing road layout, with predicted traffic levels in the year 2036 (ten years after opening)
- With proposal 2036 – Emissions resulting from the traffic using the roads constructed as part of the proposal in the year 2036 (ten years after opening).

Climate change

Projections

Climate change projections are derived using general circulation models (often referred to as global climate models or GCMs), which simulate the ocean, atmospheric and land surface processes which influence climate. The models are run under historical conditions and with scenarios representing long-term trajectories for greenhouse gas emissions or their effect on radiative forcing.

The projections adopted for the assessment were those developed by NARCliM (NSW and ACT Regional Climate Modelling), a partnership led by the NSW government alongside the ACT and SA Governments as well as the Climate Change Research Centre at the University of NSW. The NARCliM model covers a number of meteorological variables, including air temperature, precipitation, wind speed, surface evaporation and soil moisture.

Risk assessment

The methodology for conducting this climate change risk assessment is based on the Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach. The risk assessment is intended to form part of a risk management process which involves communication and consultation with the design team, relevant stakeholders such as transport departments as well as regular monitoring and review of the risk assessment plan.

Risk analysis and evaluation was carried out through desktop assessment, and in liaison with other specialist studies (such as hydrology). The risk assessment involved the following steps:

- Identify the hazard and receptor
- Assess the potential exposure
- Identify existing controls and their effectiveness

- Identify the consequence rating corresponding to the maximum credible impact across the consequence categories (may be more than one), given the existing controls and their effectiveness
- Identify the likelihood of occurrence of those consequences at that level, considering business as usual controls and their effectiveness
- Determine the level of risk based on the intersection of the consequence and likelihood rating
- Determine any action (e.g. risk treatment) and escalation based on the level of risk
- Recommend next steps for detailed design to carry out prior to reconsideration of the level of consequence and likelihood (and therefore residual risk).

6.16.2 Existing environment

Sustainability

An Environment and Sustainability Policy has been developed to articulate the proposals commitment to sustainable outcomes. This policy has been reproduced below in Table 6-128, and captures the social and environmental sustainability objectives of proposal.

Table 6-128 Great Western Highway Upgrade Environment and Sustainability Policy

Great Western Highway Upgrade Environment and Sustainability Policy
This policy reflects a commitment in the delivery of the Great Western Highway Upgrade program to: • Align with, and support, Transport Environment and Sustainability Policy • Optimise sustainability outcomes, transport service quality, and cost effectiveness • Develop effective and appropriate responses to the challenges of climate change, carbon management, resource and waste management, land use integration, customer and community expectation, and heritage and biodiversity conservation • Be environmentally responsible, by avoiding pollution, enhancing the natural environment and reducing the proposal ecological footprint, while complying with all applicable environmental laws, regulations and statutory obligations • Be socially responsible by delivering a workforce legacy which benefits individuals, communities, the proposal and industry, and is achieved through collaboration and partnerships. To deliver on these commitments, the Great Western Highway Upgrade team will provide: Industry leadership • Implement coordinated and transparent decision making, by engaging with stakeholders and suppliers, encouraging innovation and demonstrating sustainability leadership • Explore new benchmarks for the transport infrastructure sector by requiring high standards from our designers, contractors and suppliers, building on experience gained through development of the Great Western Highway Upgrade. Community • Provide accessible, safe, and convenient access to transport infrastructure for users and all members of the community • Establish positive relationships with community and stakeholders to maximise opportunities to add value to local communities.

Land use integration and place making

- Create desirable places, promote liveability and cultural heritage, and optimise both community and economic benefit
- Balance transit oriented development opportunities with stakeholder expectations.

Embedding environmental and social sustainability

- Establish robust sustainability objectives and targets
- Maintain an environmental management system that is integrated into all our proposal activities
- Ensure thorough and open environmental assessment processes are developed and maintained
- Develop and maintain an environmental management framework to embed best practice pollution management and sustainable outcomes during construction
- Apply effective assurance processes to monitor performance against the proposal environment and sustainability objectives and identify appropriate reward or corrective action, as required
- Apply environment and sustainability specific processes to the procurement of delivery activities.

Accountability

- Undertake public sustainability reporting
- Hold employees and contractors accountable for proactively meeting their environmental and social sustainability responsibilities
- Provide appropriate training and resources necessary to meet our responsibilities.

Transport for NSW Environment and Sustainability Policy

Under the Environment and Sustainability Policy Transport has the following interim sustainability targets:

Circular economy

- Maximise the use of recycled materials in accordance in accordance with existing specifications
- Look for opportunities for use of recycled materials
- Identify/estimate principle waste streams and identify re-use opportunities

Zero carbon

- Minimise energy use in operational assets
- Maximise use of lower emission materials in construction where appropriate

No net biodiversity loss

- Minimise construction footprints where appropriate and cost effective
- Maximise fauna connectivity opportunities
- Design cross-drainage structures for dual purpose fauna and drainage crossings where appropriate
- High quality revegetation and landscaping to reduce operational edge effects
- Provide biodiversity offsets for residual impacts

Future-proof for technology

- Design to allow for EV charging facilities at key points.

Sustainable procurement

- Include mandatory sustainability targets and strategy in procurement packages

Great Western Highway Upgrade Environment and Sustainability Policy
• Enhance existing tender assessment to include consideration of above in non-price criteria. Local employment and skills development • Adopt Infrastructure Skills Legacy Program or similar outcomes • Embrace Aboriginal Participation in Construction (APIC) Policy targets Community spaces with community • Where impacts to community spaces (e.g. parks, cycleways, footpaths), engage with the community to understand how the community perceives and uses these spaces, and to understand their future ambition. • Enhance these where appropriate in design – look beyond the road infrastructure. Aboriginal and local arts and cultural • Adopt smoking ceremonies or similar for all key milestones / announcements • Look for opportunities to embrace Aboriginal heritage and culture • Look for opportunities to public celebrate Aboriginal culture in design • Look for opportunities to incorporate local artists / art in community spaces and infrastructure spaces.

Climate change

The Central West and Orana Region, within which the proposal is located, has a highly variable climate. Annual and seasonal rainfall and temperatures vary over a wide range. The area is periodically subject to extreme weather and climatic events which may disrupt the community, threaten health and safety and damage infrastructure and the environment. The region's climate is also changing, with signs evident in records of temperature. Those and other changes are projected to continue as increasing atmospheric concentrations of greenhouse gases drive warming and other changes in the climate system.

Most of the seasonal patterns in rainfall are not projected to change significantly by 2030. Overall, summer, winter and spring will see some minor decreases, whilst Autumn is expected to increase by 14.7 per cent. Rainfall is expected to vary across summer with increases in the south west around Parkes and decreases around Coonabarabran. The greatest decreases in rainfall are found across the region during spring. Winter rainfall is primarily decreasing across the region. For 2070, the region is projecting increases in rainfall for summer, autumn and winter whilst spring is still maintaining a decrease of 5.8 per cent.

Table 6-129 Seasonal changes in rainfall (percentage change) for the Central West and Orana Region in response to projected climate change

Time period	2030 (2020 to 2039)	2070 (2060 to 2079)
Summer	-1.1 per cent	13.2 per cent
Autumn	14.7 per cent	13.5 per cent
Winter	-4.2 per cent	5.4 per cent
Spring	-7.6 per cent	-5.8 per cent

Source: Base data from BoM Station 063292. Projection data sourced from Climate Projects for NSW (NSW Government). Table includes projected changes in seasonal rainfalls for the 2030 and 2070 scenarios.

The increases are occurring across the region, with the greatest increase 0.95 degrees Celsius and 2.44 degrees Celsius during summer for the 2030 and 2070 scenario respectively. All models show there are no declines across the Central West and Orana Region.

Table 6-130 Seasonal changes in temperature (degrees Celsius) for the Central West and Orana Region in response to projected climate change

Time period	2030 (2020 to 2039)	2070 (2060 to 2079)
Summer	+0.95	+2.44
Autumn	+0.65	+2.04
Winter	+0.40	+1.65
Spring	+0.80	+2.30
Average	+0.70	+2.11

The Australian Rainfall & Runoff: A Guide to Flood Estimation 2019 (Geoscience Australia, 2019) provides guidance on estimating the increase in rainfall intensity with climate change. ARR 2019 details that an average temperature increase of 1 degree Celsius is in turn associated with a 5 per cent increase in the intensity of extreme rainfall events. Based on the projections in Table 6-130, the increase in rainfall intensity can be predicted. These are detailed in Table 6-131.

Table 6-131 Predicted increase in rainfall intensity in response to projected climate change

Time period	2030 (2020 to 2039)	2070 (2060 to 2079)
Increase in average temperature	+0.7 degrees Celsius	+2.11 degrees Celsius
Predicted Increase in Extreme Rainfall Intensity	3.5 per cent	10.6 per cent

Projections for days of extreme heat (i.e. days higher than 35 degrees Celsius) for the Central West and Orana Region are shown in Table 6-31. By 2030, it is expected the region will experience nearly 10 days a year over 35 degrees Celsius. By 2070, approximately 28 days will experience days of extreme heat.

Table 6-132 Average number of days exceeding 35 degrees Celsius for the Central West and Orana in response to projected climate change

Time period	1991 to 2021	2030 (2020 to 2039)	2070 (2060 to 2079)
Average number of days per year greater than 35 degrees Celsius	1.1	9.7	27.6

Over the course of the 21st century, the Central West and Orana Region is expected to become:

- Warmer: with increased average and extreme high temperatures, but fewer extreme cold temperatures.
- Wetter: rainfall is projected to increase. Increased annual rainfall is anticipated to result in wetter soil conditions, more run-off in water supply catchments and increased average river flows and groundwater recharge.
- Subject to more extreme weather conditions: hydrological cycles are projected to intensify with atmospheric warming, leading to more intense extreme rainfall events. Heatwaves would become more frequent, intense and prolonged. While extreme weather conditions may become more extreme, they may become less frequent.

6.16.3 Potential impacts

Sustainability

Six principles have been developed to govern environmental and socio-economic outcomes and performances for the proposal. The principles are designed to deliver on the Great Western Highway Environment and Sustainability Policy commitments and are set out in Figure 6-60.

Figure 6-60 Sustainability principles and objectives

Targets and initiatives have been developed to support the sustainability principles. These are outlined in Table 6-133. These initiatives and targets would be further refined as part of the design process.

Table 6-133 Sustainability initiatives and targets

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
Demonstrate leadership Deliver a world class road upgrade that is environmentally and socially conscious and	Embedding sustainability objectives into decision making	Integrate environmental and social principles into the proposal framework	●			●	●
		Establish collaborative working relationships with stakeholders	●	●	●	●	●
	Transparency and assurance	Develop performance targets across all sustainability focus areas	●	●	●	●	●

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
demonstrates innovation.		Develop a streamlined outcomes-focused approach to applying sustainability rating tools on the proposal	●				
		Obtain a high Infrastructure Sustainability rating for relevant infrastructure		●	●	●	
		Obtain a high Green Star rating for relevant infrastructure and precincts		●	●	●	
		Develop an assurance framework and reporting system to assist employees and contractors in reliably reporting against sustainability targets		●	●	●	
		Monitor sustainability performance and provide public sustainability reports			●	●	●
	Capture sustainability benefits	Document and evaluate environmental and social costs and benefits	●	●	●	●	●
		Adopt whole of life costing model to maximise benefits	●	●	●	●	●
	Encourage innovation that delivers sustainability benefits	Identify pathways to pilot new technology and approaches	●	●	●	●	●
		Identify opportunities to enable better sustainable approaches	●	●	●	●	●
		Engage with research organisations and look for opportunities to facilitate the uptake of new technologies and approaches	●	●	●	●	●
		Maximise the use of recycled materials in accordance in accordance with existing specifications (RAP / recycled		●	●	●	●

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
	Adopt circular economy principles	glass in asphalt pavement, fly-ash content / recycled glass in concrete)					
		Look for opportunities for use of recycled materials for construction		●	●	●	●
		Identify/estimate principle waste streams and identify re-use opportunities		●	●	●	●
	Emerging trends, approaches and priority areas for consideration	Prioritise blue (water related) and green (natural and designed greening such as landscaping/planting) infrastructure	●	●			
		Engage with local Aboriginal communities to develop integrate Aboriginal cultural values appropriately into design	●	●	●	●	
		Consider the future role of emerging technologies in relation to transport infrastructure and precinct development	●	●	●	●	
		Design to allow for EV charging facilities at key points	●	●			
Tackle climate change Integrate a comprehensive climate change response, and drive excellence in low carbon solutions	Infrastructure and operations will be resilient to the impacts of climate change	Identify all relevant climate change risks		●	●	●	
		Identify and implement adaptation measures to mitigate all very high, high and medium risks for the proposal	●	●	●	●	
		Identify sites vulnerable to flooding, and mitigate impacts where feasible	●	●	●	●	
		Ensure sensitivity testing is carried out on ventilation and air conditioning equipment		●	●	●	

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
		Ensure emergency procedures adequately address extreme weather events				●	
		Protect sensitive construction equipment from the effects of extreme climate and weather			●	●	
		Continued engagement with key stakeholders to develop and implement appropriate responses to interdependent risks		●	●	●	
	Reduce energy use and carbon emissions	Identify and prioritise areas where the greatest reductions in carbon and energy can be achieved	●	●	●	●	
		Use energy efficient equipment, methods, and practices			●		
		Maximise use of lower emission materials in construction where appropriate	●	●	●	●	
		Local sourcing of materials where feasible	●	●	●	●	
		Minimise energy use in operational assets		●		●	
		Adopt enabling technology where feasible	●	●	●		
Manage resources efficiently	Minimise potable water use	Set targets and monitor potable water use		●	●	●	
		Integrate current best-practice water-efficient features, equipment and	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
Achieve whole-of-life value through efficient use and management of resources		appliances at stations, stabling facility and construction sites					
		Avoid use of potable water for non-potable purposes if non-potable water is available	●	●	●	●	
		Set and implement targets for the use of non-potable water in concrete	●	●	●		
	Maximise non-potable water opportunities	Undertake a water balance to inform feasibility for reuse initiatives		●	●	●	
		Identify and implement opportunities for treatment and reuse on the proposal, including water from construction works, concrete batching, casting facilities		●	●		
		Connect to district recycled water networks where feasible	●	●	●	●	
		Harvest and reuse rainwater at permanent and temporary facilities where feasible	●	●	●	●	
	Minimise waste through the proposal lifecycle	Target 95 per cent construction and demolition waste recycling	●	●	●		
		Enable recycling of waste streams from site compounds	●	●	●		
		Plan for final disposal of operational assets		●	●		●
		Use modular, prefabricated and precast structural and finishing materials	●	●	●	●	
		Minimise the use of concrete and steel	●	●			

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
	Reduce materials consumption	Dematerialisation of components and finishes		●	●		
	Reduce embodied carbon and increase use of recycled materials	Undertake lifecycle assessments and minimise the embodied impacts of materials, through the selection of low carbon alternatives and considering durability and local sourcing	●	●	●		
		Minimise the embodied impacts of concrete through the adoption of proposal -wide supplementary cementitious materials use target and set targets for the use of alternate binder systems on non-structural elements		●	●		
		Minimise the embodied impacts of steel through maximising the use of recycled steel and steel produced using energy-reducing processes		●	●		
		Investigate and implement trials and pilot programs to demonstrate the viability of recycled alternatives		●	●		
		Engage with industry bodies to identify best practice low-impact alternative materials		●	●		
	Manage spoil effectively	Minimise volumes of excavation	●	●	●		
		Beneficial reuse of 100 per cent of usable spoil	●	●	●		
	Practice environmentally responsible sourcing	Source construction materials from environmentally responsibly sources where possible	●	●	●		

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
Drive supply chain best practice Collaborate with key stakeholders to drive a lasting legacy in workforce development, industry participation and sustainable procurement	Influence contractors, subcontractors and materials suppliers	Ensure procurement strategies are consistent with ISO:20400 Sustainable Procurement Guidelines	●	●	●	●	●
		Include mandatory sustainability targets and strategy in procurement packages	●				
		Enhance existing tender assessment to include consideration of mandatory sustainability targets and strategy in non-price criteria	●				
		Ensure supply chain sustainability objectives are adopted downstream	●	●	●	●	●
		Provide sustainability training to high impact suppliers		●	●		
	Increase supply chain transparency and responsibility	Adopt ethical governance principles and practices, including the use of Environmental Product Declarations and eco-labelling		●	●	●	●
		Conduct due diligence to ensure supply of materials and equipment align with human rights legislation and environmental standards	●	●	●	●	●
	Drive improvements in workforce development and industry participation	Increase diversity within the workforce and supply chain	●	●	●	●	
		Develop workforce skills which support skill shortages, transferable skills and new technologies	●	●	●	●	
		Increase local employment and participation of small and medium enterprises including Recognised Aboriginal Businesses	●	●	●	●	

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
		Inspire future talent and develop capacity in the sector	●	●	●	●	
		Provide opportunities for social enterprise		●	●	●	●
		Adopt Infrastructure Skills Legacy Program or similar outcomes	●	●	●		
		Embrace Aboriginal Participation in Construction (APIC) targets	●	●	●		
Value community and users Respond to community and user needs, promote heritage, liveable places and wellbeing for current and future generations	Protect and promote Aboriginal and non- Aboriginal heritage and culture	Avoid or minimise impacts to heritage	●	●	●		
		Identify and implement opportunities to enhance heritage and cultural values via design and interpretation	●	●	●		
		Develop partnerships with relevant stakeholders to identify heritage places and promote heritage values	●	●	●	●	
		Ensure key Aboriginal stakeholders are meaningfully engaged	●	●	●	●	
		Create opportunities for archaeological research and interpretation	●	●	●		
		Develop Aboriginal cultural design principles for the proposal and integrate into proposal outcomes	●	●	●	●	
		Adopt smoking ceremonies or similar for all key milestones / announcements			●	●	
		Design in accordance with best practice urban design principles	●	●			

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
	Prioritise community and user wellbeing	Incorporate Crime Prevention Through Environmental Design principles	●	●		●	
		Ensure efficiency and durability of built infrastructure that requires minimum expenditure in maintenance and upkeep	●	●	●	●	●
	Deliver community benefits	Ensure the community and local stakeholders are engaged and kept informed of proposal activities		●	●	●	●
		Where impacts to community spaces (eg parks, cycleways, footpaths), engage with the community to understand how the community perceives and use these spaces, and to understand their future ambition.	●	●			
		Provide information in ways that are easily accessible, taking into consideration dominate language groups	●	●	●	●	●
		Deliver initiatives that benefit local communities and provide positive social outcomes, enhance proposal design to incorporate community spaces		●	●	●	
		Look for opportunities to incorporate local artists / art in community spaces and infrastructure spaces	●	●	●	●	
Respect the environment Minimise impacts and take opportunities to provide	Minimise environmental impact	Target zero major pollution incidents			●	●	●
		Reduce sources of pollution through the development and implementation of a Construction Environmental Management Framework	●	●	●	●	
		Ensure environmental management plans and systems are in place		●	●	●	

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
environmental improvements		Avoid or minimise noise and vibration impacts	●	●	●	●	
		Early identification and management of soil and groundwater contamination issues	●	●	●	●	
		Design to minimise light spill in accordance with AS 4282-1997 Control of the obtrusive effects of oudoor lighting.	●	●	●	●	
		Develop an appropriate response to reduce air pollution	●	●	●	●	
		Develop appropriate responses to manage stormwater and groundwater contamination and runoff	●	●	●	●	
	Promote ecological functions and biodiversity	Avoid or minimise impacts to biodiversity, particularly with regard to endangered, vulnerable and threatened species, habitats and communities	●	●	●	●	
		Preserve ecological function through appropriate planning, management and financial controls	●	●	●	●	
		Contribute to the restoration and conservation of local ecological communities	●	●	●	●	
		Consider connectivity of existing ecosystems and impact on fauna movements	●	●	●	●	
	No net biodiversity loss	Minimise construction footprints where appropriate and cost effective	●	●	●		

Principle	Category	Sustainability initiatives and targets	Proposal life cycle phase				
			Planning	Design	Construction	Operation	End of life
		Maximise fauna connectivity opportunities	●	●	●		
		Design cross-drainage structures for dual purpose fauna and drainage crossings where appropriate	●	●			
		High quality revegetation and landscaping to reduce operational edge effects	●	●	●		
		Provide biodiversity offsets for residual impacts	●	●			
	Provide and promote green infrastructure	Use endemic species in landscaping and prioritise use of Aboriginal knowledge (six seasons) in asset management	●	●	●	●	

Greenhouse gas

Emissions associated with the construction and operation (over a 100 year design life) of the proposal are outlined in Table 6-33. Overall, the proposal is estimated to result in the generation of:

- 129,422 kilotonnes of carbon dioxide equivalent (CO_2e) during the construction of the proposal
- 98,264 kilotonnes of carbon dioxide equivalent (CO_2e) during the operation of the proposal

Greenhouse gas emissions during the construction phase of the proposal has been projected to be predominately sourced from the embedded emissions of the materials used to construct the proposal, accounting for just over 60 per cent of the emissions of the construction phase. Fuel combustion accounts for about 20 per cent of construction phase emissions and vegetation clearance accounts for the remainder.

Traffic emissions dominate the emissions of the maintenance and operation phase of the proposal. Traffic related emissions account for approximately 66 per cent of emissions over the 100-year design life of the proposal, with the remainder generated by maintenance activities and the electricity consumption associated with street lighting.

When divided by scope, the overall emissions of the proposal are dominated by Scope 3 emissions as a result of the significance of traffic and embedded emissions. Scope 3 emissions account for 72 per cent of all emissions of the proposal, with the majority of the remainder Scope 1 emissions.

Given how significant a contribution traffic makes to the overall projected emissions for the proposal, it should be noted that due to potential future changes in technology regarding road vehicles in Australia, emissions projected from traffic may significantly decrease in the future. The modelling method used

assumes improved fuel efficiency in new models of cars in when predicting future emissions, however it does not yet account for the growing adoption of lower emission electric vehicles. It is likely that the increased production and adoption of electric vehicles is anticipated to mean that by 2026 and 2036 there would be a much greater number of electric vehicles using the proposal roads, hence resulting in lower traffic emissions than estimated.

Table 6-134 Greenhouse gas emissions from construction and operation of the proposal

Category	Emission source	Emissions (t CO2e)			
		Scope 1	Scope 2	Scope 3	Total
Construction					
Fuel consumption	Site offices and site vehicles	846	-	43	889
	Construction works	9,772	-	501	10,273
	Demolition and earthworks	12,387	-	635	13,023
	Vegetation removal	350	-	18	368
Materials	Aggregate	-	-	2,038	2,038
	Asphalt and bitumen	-	-	3,146	3,146
	Cement and concrete	-	-	41,613	41,613
	Steel	-	-	33,389	33,389
Vegetation clearance	Class C (Open forest)	4,636	-	-	4,636
	Class D (Open Woodland)	20,047	-	-	20,047
Operation					
Electricity	Street lighting	-	976	108	1,084
Maintenance	Full depth asphalt	14,802	-	19,002	33,804
Traffic	Traffic emissions	-	-	63,376	63,376

Climate change risk assessment

Climate change is anticipated to have direct and indirect impacts on the proposal. The types of impacts are relatively well understood however their severity and extent are uncertain. As such, risks need to be identified and assessed and strategies to treat them developed.

The combined direct and indirect impacts of climate change may contribute to one or more of the following categories:

- Accelerated infrastructure deterioration and increased maintenance requirement
- Safety incidents
- Increased frequency and/or duration of road closures
- Infrastructure loss (total or partial loss as a result of a severe weather event).

Eight risks are identified in Table 6-135 as having a medium risk rating prior to the implementation of environmental management measures. With the implementation of environmental management measures, two of these risks were reduced to minor.

Table 6-135 Climate change risks with an inherent risk rating of medium or higher

Cause, trigger or issue	Risk, hazard or opportunity	Potential consequence	Inherent risk rating	Environmental management measure	Residual risk
Increase in the frequency and intensity of severe rainfall events.	Extreme flood events at Boxes Creek may be too powerful for existing and extended culverts, leading to a failure of the culverts at that area.	Failure of culverts, inability for floodwater to continue downstream, increase in flooding upstream, floodwaters cross over the road, damaging road infrastructure and delaying traffic.	C	Review design conditions to confirm the size and type of culverts are capable of withstanding more intense floods under predicted climate change.	C
Increase in the frequency and intensity of severe rainfall events.	Increased ponding and water accumulation due to the construction of paved surfaces during construction and operation phases	Construction areas are overtopped with flooding, and ponding on roads cause construction delays and traffic accidents and delays during operation.	C	Storm water modelling to review climate change projections and flooding for 10 per cent, 20 per cent and 30 per cent increases on standard 100 year ARI event.	C
Increase in the frequency and intensity of severe rainfall events.	Sections of the designed road alignment may worsen localised flooding (such as the Kelly Street Service Road), which may be compounded by flood events becoming more frequent and intense.	Flooding damages in the locality may become worsened beyond what was originally expected due to the compounded effects the road design and climate change, leading to impacts both in and out of the proposal alignment.	C	Review climate change projections for the locality where climate change may compound flooding and determine if any changes are required for design.	D
Increase in the frequency and intensity of severe rainfall events.	Sections of the designed road which formerly permitted overtop flow are heighted, leading to the potential for worse upstream flooding, further exasperated by increased flood intensities.	Flood waters increasing in height by metres, failure or damage to culverts and embankment under the worst circumstances.	C	Review the design of the embankments and climate change projections to determine if any changes are required for design.	D
Increased temperatures and the more	Maintenance activities have to be	Delay in maintenance	C	Accept risk and use standard procedures	C

Cause, trigger or issue	Risk, hazard or opportunity	Potential consequence	Inherent risk rating	Environmental management measure	Residual risk
frequent incidence and severity of heatwaves.	postponed due to extreme heat.	activities causes a backlog in work.		for working in extreme heat.	
More severe fire weather and elevated fire weather conditions.	Increased local bushfires cause decreased visibility due to smoke effects	Road users suffer reduced visibility due to smoke effects resulting in accidents.	C	Accept risk and actively manage through road closures as appropriate.	C
More severe fire weather and elevated fire weather conditions.	Increased local bushfires destroy road signage or equipment.	Bushfires in the proximity of the proposal cause direct damage to road signage and other road furniture.	C	Design consideration should be provided for potential impacts to structures, utilities and fauna connectivity structures in bushfire prone areas. Where feasible, access to fire trails will be maintained.	C
Increased concentration of carbon dioxide in the atmosphere.	Carbonation occurs to a greater depth in concrete structures, allowing exposure and degradation of reinforcement. Retaining walls, piers and bridge deck elements are degraded quicker than anticipated shortening their design life.	Shorter design life results in greater levels of inspection and maintenance needed, increase asset operational costs.	C	Review standards for concrete cover of reinforcement to provide additional coverage as required.	C

6.16.4 Safeguards and management measures

Table 6-136 Safeguards and management measures – sustainability and climate change

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
GH01	Greenhouse gas emissions	Undertaking detailed modelling to ensure that cut and fill balances are managed to minimise any unnecessary movements of material;	Contractor	Detailed design	Appendix Q	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
GH02	Greenhouse gas emissions	Review opportunities to specify biofuel use on construction plant and equipment based on site for long periods;	Contractor	Detailed design	Appendix Q	All
GH03	Greenhouse gas emissions	Review opportunities to use alternative materials in construction, such as fly ash as a supplementary cementitious material (to replace traditional Portland cement) and reclaimed aggregate;	Contractor	Detailed design and construction	Appendix Q	All
GH04	Greenhouse gas emissions	Specify high recycled content in steel use (where technically possible and cost effective).	Contractor	Detailed design	Appendix Q	All
GH05	Flooding	Findings of the CCRA will be used to inform further design considerations, mitigation measures and management plans regarding flooding in and around the proposal alignment.	Contractor	Detailed design	Appendix Q	All
GH06	Bushfire risk	Findings of the CCRA will be used to inform bushfire risk management measures and management plans.	Contractor	Detailed design	Appendix Q	All
GH07	Climate projections	Adopt consideration of climate projections, flooding and bushfire risks when developing the detailed design and material consideration	Contractor	Detailed design	Appendix Q	All

Other safeguards and management measures that would address sustainability and climate change impacts are identified in section 6.8 Hydrology and flooding.

6.17 Cumulative impacts

This section discusses the potential cumulative impacts that may arise as a result of the construction and operation of the proposal, and the interaction of these impacts with other identified major developments within the local area. The cumulative impacts relate to:

- The individual environmental impacts of the proposal
- The combined effects of this proposal and other proposals in the vicinity of the proposal that form part of the wider program to upgrade the Great Western Highway (refer to Section 3.1)
- The combined effects of this proposal and other projects beyond the Great Western Highway program (refer to Section 1.1).

While this REF focuses on the potential environmental impacts of this proposal, it is important these potential impacts are considered in their wider contextual surroundings. Cumulative impacts are those that may not be considered significant on their own but that may be more significant when considered in association with other impacts. Cumulative impacts may occur as the result of the interaction of impacts within a single project or due to the combined effects of a number of projects occurring simultaneously in a given area.

The consequences that may arise from the effects of incremental development are usually described as 'cumulative environmental impacts'. Cumulative impacts have the potential to arise from the following:

- The interaction of individual elements within the proposal and surrounds
- The additive effects of the proposal with other external projects
- The additive effects of the proposal with other road upgrade projects in the Blue Mountains.

In accordance with Clause 228(2) of the EP&A Regulation 2000, any cumulative environmental effects of the proposal with other existing and likely future activities must be taken into account in assessing the potential environmental impacts of the proposal. These can be viewed as either positive or negative cumulative impacts and are discussed below.

An assessment of cumulative environmental impacts has been undertaken based on the following criteria:

- Size of the proposed or existing project which was generally limited to major developments
- Type of project or proposal with emphasis being placed on other road upgrades being or proposed to be undertaken
- Location of the proposal or project with only those projects within the broader Blue Mountains region being considered
- Timeframe of the proposal or project with only those projects likely to be constructed concurrently with the proposal being considered for construction impacts in addition to other proposals that may occur subsequent to the Forty Bends upgrade (such as the future development of the Mount Victoria to Lithgow corridor) being considered for operational impacts.

6.17.1 Study area

The study area for the purpose of the cumulative impact assessment includes the following suburbs within the proposal corridor such as Little Hartley, Hartley, South Bowenfels and Hassans Walls and suburbs adjacent to the proposal corridor such as Bowenfels, Lithgow, Mt Victoria, Littleton, South Littleton, Sheedy's Gully and Kanimbla.

6.17.2 Broader program of work

The proposal forms part of the broader Great Western Highway Upgrade Program between Katoomba and Lithgow. The Great Western Highway Upgrade Program is an infrastructure program of national importance. It will make the Blue Mountains, the Central West and Orana more attractive places to live, and will unlock the potential of regional NSW.

The NSW Government has progressively upgraded sections of the Great Western Highway to make it safer and more reliable for all road users. The broader program will complete the final 34 km connection of a modern dual-carriageway link across the Blue Mountains.

The Great Western Highway Upgrade Program consists of:

- West Upgrade – Little Hartley to Lithgow (the proposal)
- Central Upgrade – Blackheath to Little Hartley
- Medlow Bath Upgrade
- East Upgrade - Katoomba to Medlow Bath and Medlow Bath to Blackheath.

These four proposals (described in Table 6-137) will be occurring both concurrently in timeframe and consecutively geographically and have the potential to result in cumulative impacts to local communities as well as road users throughout the Blue Mountains area.

Each proposal would be subject to a separate environmental assessment in accordance with the *Environmental Planning and Assessment Act 1979*.

6.17.3 Design proposals of the proposal

As described in Section 3.1, the proposal would be divided up into four separate design proposals. These include:

- Forty Bends to Lithgow
- River Lett to Forty Bends
- Little Hartley to River Lett
- Coxs River Road.

The impacts associated with these four design proposals have been considered individually and cumulatively.

6.17.4 Other projects and developments

The following sources were reviewed to identify potential projects within the cumulative impact assessment study area:

- Department of Planning, Industry and Environment Major Projects Register
- Transport for NSW website
- Infrastructure NSW website
- Lithgow City Council website
- Other government agencies and infrastructure providers websites.

Projects identified within the cumulative impact assessment study area were then considered against the screening criteria identified in Section 6.17. A description of projects that meet the screening criteria, along with their construction and operational impacts is provided in Table 6-137.

Table 6-137 Past, current and future projects

Project	Construction impacts	Operational impacts
Past projects		
New Intercity Fleet Springwood to Lithgow Rail Corridor Modifications The project involved modifications to stations and other rail corridor upgrades extending between Springwood Station and Lithgow Station to facilitate the introduction of the new trains which are marginally wider and longer than existing trains. Key features included extension of platforms at Lithgow Station and re-positioning of rail tracks along the length of the rail corridor. Construction of the project commenced in 2018 and was completed 2020.	Impacts to State heritage listed and locally listed heritage items included platform extensions, platform coping modifications and other upgrades.	Operational impacts associated with the project are minimal.
Mount Victoria Village Safety Upgrade Roads and Maritime Services has carried out work on safety upgrades and road improvements on the Great Western Highway through Mount Victoria village including: • Improvements along 1.6 kilometres of the existing highway, including changes and upgrades to intersections to make them safer • Widened road shoulders • Concrete footpaths for pedestrian access through the village. The project commenced in 2014 and was completed in 2018.	• The removal of about 0.55 hectares of 'Silvertop Ash – Narrow-leaved Peppermint open forest', which is a native vegetation community and removal of about 0.78 hectares of cleared and highly modified habitats. • Acquisition of a part of 18 properties.	• Minor reduction in traffic noise • An increase in impervious land which may impact upstream flood levels and downstream flow rates • Visual impacts due to the removal of trees and widening of the roadway • Improved road safety and traffic performance
Hartley Valley to Forty Bends road safety improvements Roads and Maritime carried out safety upgrades along the highway through Hartley Valley in the Blue Mountains. Improvements include road widening works, new culverts,	• The removal of about 3.2 hectares of remnant native vegetation in varying degrees of condition and about 1.2 hectares of cleared and highly modified habitats including 0.86 hectares of the ecological community 'Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in	• Improved road safety • Improved travel efficiency • Improved intersection performance • Improved and safer property access

Project	Construction impacts	Operational impacts
upgrades to nine intersections, and an improved road surface. The project commenced in 2014 and was completed in 2017.	the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions' • Acquisition of a portions of 18 properties.	• Increase in the impervious area of roadway. This would result in an increase in downstream peak flow rates during rainfall events at five locations including a relatively substantial increase in downstream peak flow rates, impacting on a farm dam downstream through scour and loss of capacity
Forty Bends upgrade Roads and Maritime Services upgraded and widened about 2.8 kilometres of the Great Western Highway at Forty Bends to three lanes with a central median along the majority of its length. The project included construction of a new twin bridge across Whites Creek. Construction of the project commenced in 2014 and was completed in 2017.	• Removal of 7.39 hectares of native vegetation and 15.27 hectares of cleared and modified habitat including 0.05 hectares of the endangered Ribbon Gum – Yellow Box grassy woodland on undulating terrain of the eastern tablelands, South Eastern Highland. • Destruction of an Aboriginal site of low significance • Permanent acquisition of about 17.7 hectares of land (including the full acquisition of three private properties).	• Reduction in operational traffic noise • Improved traffic performance and safety • Changes to local property access along Great Western Highway to improve safety
Current projects		
McKanes Bridge upgrade McKanes Bridge was built in 1893 and is one of only four remaining McDonald timber truss bridges in NSW. Its restoration would ensure one of the oldest examples of a McDonald timber truss bridge in NSW is conserved. The upgrade includes replacing old timber elements with new timber and new heritage sympathetic materials to strengthen the bridge, while still retaining the appearance and design of the original bridge. Work started in May 2020 and is expected to be complete by late 2021.	• Loss of non-Aboriginal heritage value through the replacement of some original fabric • The removal of several mature trees • Detour of traffic and increased travel times during construction due to the road closure • Altered visual amenity of the proposal area during construction • Water quality risks to Coxs River during construction.	• Improved access, reduced traffic disruption due to less frequent maintenance, and improved safety for all road users. • Improved heritage outcome through the preservation of one of the last remaining examples of a McDonald timber truss bridge.
Future projects		

Project	Construction impacts	Operational impacts
Medlow Bath Upgrade The proposal involves upgrading and duplicating the existing surface road corridor with intersection improvements and a new pedestrian bridge. The Review of Environmental Factors was exhibited for consultation in July and August 2021, with construction beginning late 2022	• Removal of 0.36 hectares of native vegetation including 0.34 hectares of Silvertop Ash – Narrow-leaved Peppermint open forest resulting in a minor impact on habitat of some threatened species • Risk of sedimentation due to earthworks and vehicle movements • Construction traffic impacts resulting in delays and detours • Changes to pedestrian, cyclist and public transport access • Noise and vibration impacts to some receivers including a small number of receivers being highly noise affected • Impacts to the curtilage of the state heritage listed Medlow Bath Railway Station • Impacts to five local heritage items • Landscape and visual impacts particularly near Bellevue Crescent	• Improvements to existing performance of the highway including accmodating future increases in traffic volumes • Improved traffic flows • Improved safety for vehicles with upgrade intersectsions • Reduced potential for pedestrian/vehicle collissions • A new shared path for pedestrians and cyclists • Operational noise impacts requiring additional noise mitigation at 13 receivers
Central Upgrade – Blackheath to Little Hartley The proposal involves the construction of a tunnel bypass of Blackheath and Mount Victoria, with connectivity between the two proposed tunnels currently under further investigation. The southern end of the proposal would connect to the northern end of this proposal. It is anticipated that the Environmental Impact Statement will be exhibited for consultation mid 2022. Impacts identified in this table are high level only.	• Transport and traffic, including road safety impacts • Air quality, including in-tunnel and ambient air quality impacts • Noise and vibration impacts • Socio-economic, land use and property impacts (including impacts on the Blue Mountains National Park) • Urban design, landscape character and visual amenity • Biodiversity impacts • Geology, groundwater and ground movement impacts	• Improvements to existing performance of the highway including accmodating future increases in traffic volumes • Improved traffic flows • Improved safety for vehicles
East Upgrade – Katoomba to Medlow Bath and Medlow Bath to Blackheath Katoomba to Medlow Bath and Medlow Bath to Blackheath – The proposal involves upgrading, duplicating and widening of the existing surface road corridor, with	• Transport and traffic, including road safety impacts • Air quality impacts • Noise and vibration impacts • Socio-economic, land use and property impacts • Urban design, landscape character and visual amenity	• Improvements to existing performance of the highway including accmodating future increases in traffic volumes • Improved traffic flows

Project	Construction impacts	Operational impacts
connections to a tunnel portal at Blackheath. It is anticipated that the Review of Environmental Factors will be exhibited for consultation in late 2021. Impacts identified in this table are high level only.	• Biodiversity impacts • Geology, groundwater and ground movement impacts	• Improved safety for vehicles

6.17.5 Potential impacts

Potential cumulative impacts associated with the proposal and the other projects identified in Table 6-137 are summarised in Table 6-138. The individual contributions of each project to the cumulative impacts described in Table 6-138. are summarised in Table 6-137. Where project impacts do not meet the screening criteria identified in Section 6.17 they have not been considered further. Impacts that haven't been considered further include temporary impacts, such as noise and vibration, that have occurred greater than one year prior to the project being constructed. Where there is limited information on the impacts of projects, these impacts have been considered at a high level.

Table 6-138 Potential cumulative impacts

Environmental factor	Construction	Operation
Biodiversity	The removal of about 86.69 hectares of native vegetation (of which the proposal accounts for 75.19 hectares) comprising a number of plant community types: • Ribbon Gum – Yellow Box grassy woodland on undulating terrain of the eastern tablelands, South Eastern Highland (0.05 hectares removed) • Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions (0.86 hectares removed) • Silvertop Ash – Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South (0.89 hectares removed) Eastern Highlands and South East Corner • Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion (17.59 hectares removed) listed as Endangered under the BC Act • White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern	Operational biodiversity impact associated with nearby projects identified in Section 6.17.4 were assessed as being minor and therefore cumulative impacts would be minimal.

Environmental factor	Construction	Operation
	Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (5.82 hectares removed) listed as critically endangered under the BC Act and the EPBC Act. This vegetation would provide habitat for threatened fauna species. The removal of about 232.57 hectares of cleared and modified habitat of which the proposal accounts for 215.32 hectares.	
Traffic and transport	Interaction between construction and highway traffic would occur along the proposal area. The most significant impact would be during the AM peak and PM peak periods when the use of the highway is at its highest. However, during off peak periods, construction traffic is not anticipated to adversely impact operational efficiency on the highway. Vehicles travelling along the Great Western Highway between Katoomba and Lithgow would experience concurrent cumulative traffic impacts due to congestion resulting in delays associated with the broader Great Western Highway Upgrade Program. Road users would also experience consecutive cumulative traffic impacts associated with several recent safety upgrades to the Great Western Highway in the project area. This could contribute to construction fatigue.	Traffic modelling of future year periods indicate that the proposed upgrade would provide a safer, reliable and more efficient road corridor on the Great Western Highway between Little Hartley and Lithgow.
Noise and vibration	Potential for concurrent cumulative construction noise impacts associated with the proposal and the Central Upgrade – Blackheath to Little Hartley proposal. Since the construction scenarios required for both proposals would likely require similar items of equipment, concurrent construction work being completed near to a particular area could theoretically increase worst-case noise levels by around three decibels. The various stages of the upgrade of the Great Western Highway would result in overlapping proposals in the wider area. When the impacts from various stages of the program are combined with the impacts generated by the previous projects, they may result in consecutive impacts (i.e 'construction fatigue') at surrounding receivers due to construction works occurring over an extended period.	Operational cumulative noise impacts would generally be associated with construction traffic noise. Due to the linear nature of the Great Western Highway upgrades, cumulative operational traffic Nosie impacts would not be expected at any one receiver.

Environmental factor	Construction	Operation
	Residential receivers in proximity to the proposal could also experience consecutive cumulative noise and vibration impacts associated with several recent safety upgrades to the Great Western Highway in the project area. This could contribute to construction fatigue.	
Aboriginal heritage	The proposal study area contains a total of 29 Aboriginal sites, of which four sites (AHIMS 45-1105, 45-4-1106, 45-4-1074, 45-4-1075) were not assessed during the test excavation phase. Of the assessable sites, potential direct impact would occur to 20 sites. These direct impacts range from negligible to major. In addition, two sites would be subject to minor indirect impacts associated with vibration and settlement, and one site subject to moderate indirect impacts also associated with vibration and settlement. The sites themselves, whilst being expected site types found within the project area (artefact scatters, isolated artefacts, rock shelters, engravings and one post-contact site), are of increased significance due to their rarity in an increasingly developed environment. Therefore, the regional Aboriginal cultural heritage values across the project would be reduced significantly by the cumulative impacts from the project if serious harm such as complete loss of a site was to occur. However, potential negligible or indirect impacts to a site are not considered to be a risk for cumulative impacts to the region's archaeology should the mitigation measures outlined be followed. With the implementation of the mitigation measures outlined in Section 6.4.4, the potential negligible or indirect impacts associated with the proposal are not considered to be a risk for cumulative impacts to the region's archaeology.	The operation of the proposal would not result in any cumulative impacts to Aboriginal heritage.
Non-Aboriginal heritage	Projects carried out within the vicinity of the proposal have had a minor impact on non-Aboriginal heritage in the region. The proposal would likely have a moderate impact on State and locally listed heritage items when considered individually however would only have a minor impact when considered cumulatively. Potential cumulative impacts would direct physical impacts to non-Aboriginal heritage items. Indirect visual impacts and vibration impacts would also be expected from nearby heritage items.	Operational non-Aboriginal heritage impact associated with nearby projects identified in Section 6.17.4 were assessed as being minor and therefore cumulative impacts would be minimal.
Soils and surface water	Cumulative construction soil and surface water quality impacts would be minimal. Key risks would include increased risk of erosion and	Cumulative operation soils and surface water quality impacts would relate to risk of runoff,

Environmental factor	Construction	Operation
	sedimentation, transport of materials to and from site and accidental spillages however these could be managed with the implementation of mitigation measures.	accidental leaks or spills and erosion from areas that have not been stabilised adequately. These risks would be managed through the implementation of mitigation measures.
Groundwater	Cumulative groundwater impacts associated with the construction of the proposal interacting with other major projects in the area are assessed as unlikely to occur. This is because no material impacts to groundwater due to the proposal are likely provided appropriate management measures are implemented.	Cumulative groundwater impacts associated with the operation of the proposal interacting with other major projects in the area are assessed as unlikely to occur. This is because no material impacts to groundwater due to the proposal are likely provided appropriate management measures are implemented.
Flooding	In a flooding context (stormwater generated outside the proposal) the cumulative impacts of the proposal are negligible. Floodwater would be conveyed across the proposed alignment without significant change in all but the most extreme floods.	The proposal would not result in any cumulative operational flooding impacts.
Social impacts	Cumulative construction social impacts would include: • Cumulative delays for people accessing community services and facilities in Lithgow and the wider Blue Mountains and Sydney regions. Extended delays and disruptions for motorists using the Great Western Highway may discourage some people from making trips to access some services and facilities • Extended periods of traffic disruptions for motorists and commercial vehicle movements • Extended periods of impacts on communities in the study area associated with construction noise, dust and traffic • Increased construction traffic on local and regional roads associated with such things as the haulage of materials, plant and equipment and movement of construction workers for the various projects, increasing possible community concerns about road safety risks • Increased demand for construction workers, providing benefits for local workers and potentially affecting the availability of local workers for non-construction related jobs • Potential increase in the number of construction workers within the study area from	Cumulative operational social impacts would include: • Improved travel times, travel reliability and safety for motorists making trips using the Great Western Highway would contribute to improved access and connectivity to community services and facilities such as education uses, major medical and health care facilities, and community support facilities located in regional centres such as Lithgow and Katoomba, and in the western Sydney region • Improved access to facilities within the study area and surrounding areas for people travelling from Sydney and surrounding regions.

Environmental factor	Construction	Operation
	outside of local and regional communities, resulting in potential impacts associated with increased demand for local accommodation and impacts on community values • Where construction timeframes for proposals occur sequentially, there is potential for disturbance and disruptions for local communities (for example, construction noise, dust, traffic delays and disruptions) to occur over extended periods, potentially resulting in construction fatigue particularly communities at Mount Victoria and Little Hartley due to concurrent works for the Mount Victoria tunnel and Little Hartley to River Lett Hill stage of the proposal.	
Contamination	Other projects near to the proposal alignment have not been identified that would compound any impacts during construction or operation. Any new projects to be undertaken within the vicinity of the proposal would need to undertake contamination investigations to assess the suitability of the site for the proposed land use. Where contamination is identified, it would need to be remediated to remove or suitably reduce the exposure to human and/or environmental receptors in accordance with the legislative requirements of the *Contaminated Lands Management Act 1997*. Both the management of contamination sources during construction and operation of these projects and remediation works to render the potential project sites suitable for use is unlikely to increase potential cumulative impacts from contamination exposure to common receptors (i.e. unlikely that cumulative impacts would arise).	The proposal would not result in cumulative operational contamination impacts.
Air quality	Although there several projects within the vicinity of the proposal, none are expected to result in any cumulative air quality impacts with the proposal. The only potential for cumulative impacts which may arise is if construction of adjacent segments of the proposal are completed at the same time such that receiver(s) may be affected by emissions from multiple work areas. These impacts would be minimised through construction planning.	The proposal would not result in cumulative operational air quality impacts.

6.17.6 Safeguards and management measures

Table 6-139 Safeguards and management measures – Cumulative impacts

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
CU01	Cumulative impacts	Ongoing coordination and consultation will be undertaken with nearby projects as required.	Transport/ Contractor	Prior to and during construction	N/A	All
CU02	Cumulative impacts	The CEMP will be revised to consider potential cumulative impacts from surrounding development activities as they become known.	Contractor	Construction	N/A	All
CU03	Cumulative impacts	Opportunities for further design refinements would be considered during detailed design to reduce potential impacts where feasible.	Contractor	Detailed design	N/A	All
CU04	Dust, exhaust and other emissions during construction	To the extent practical, plan the construction of the various segments of the proposal to avoid situations where sensitive receivers may be affected by emissions to air from multiple work areas.	Contractor	Prior to construction and construction	Appendix O	All

Other safeguards and management measures that would address cumulative impacts are identified in sections 6.13 Air quality.

7. Environmental management

This Section describes how the proposal will be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Construction Environmental Management Plan (CEMP) will be prepared to describe the safeguards and management measures identified. The CEMP will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

The CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Transport Environment Officer, Western Region, prior to the commencement of any on-site works. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP would be developed in accordance with the specifications set out in the QA Specification *G36 – Environmental Protection (Management System)*, QA Specification *G38 – Soil and Water Management (Soil and Water Plan)*, QA Specification *G40 – Clearing and Grubbing*, QA Specification *G10 – Traffic Management.*

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-1.

Table 7-1 Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
General					
GEN01	General - minimise environmental impacts during construction	A CEMP will be prepared and submitted for review and endorsement of the Transport Environment Manager prior to commencement of the activity. As a minimum, the CEMP will address the following: • any requirements associated with statutory approvals • details of how the proposal will implement the identified safeguards outlined in the REF • issue-specific environmental management plans • roles and responsibilities • communication requirements • induction and training requirements • procedures for monitoring and evaluating environmental performance, and for corrective action • reporting requirements and record-keeping • procedures for emergency and incident management • procedures for audit and review. The endorsed CEMP will be implemented during the undertaking of the activity.	Contractor / Transport project manager	Prior to construction / detailed design	N/A

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GEN02	General - notification	All businesses, residential properties and other key stakeholders (eg schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.	Contractor / Transport project manager	Prior to construction	N/A
GEN03	General – environmental awareness	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the proposal. This will include up-front site induction and regular "toolbox" style briefings. Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include: • Areas of Aboriginal heritage sensitivity • Threatened species habitat • Adjoining residential areas requiring particular noise management measures	Contractor / Transport project manager	Prior to construction / detailed design	N/A
Biodiversity					
BI01	Biodiversity	A Flora and Fauna Management Plan will be prepared in accordance with Transport's *Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects* (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • Requirements set out in the *Landscape Guideline* (RMS, 2008) • Pre-clearing survey requirements • Procedures for unexpected threatened species finds and fauna handling • Procedures addressing relevant matters specified in the *Policy and guidelines for fish habitat conservation and management* (DPI Fisheries, 2013) • Protocols to manage weeds and pathogens.	Transport/ Contractor	Detailed design Prior to construction	Section 4.8 of QA G36 Environment Protection

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
BI02	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Native vegetation and habitat removal will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI03	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Further consideration for the placement of ancillary facilities (including drainage and sediment basins) currently positioned in native vegetation and high value areas will be considered during the detailed design stage.	Transport/ Contractor	Detailed design	Appendix D
BI04	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Pre-clearing surveys will be undertaken in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI05	Removal of native	Vegetation and habitat removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity	Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	vegetation, threatened species habitat, habitat features and threatened plants	Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).			
BI06	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Native vegetation will be re-established in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI07	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site.	Contractor	Construction	Appendix D
BI08	Removal of native vegetation, threatened	Habitat removal will be minimised through detailed design.	Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	species habitat, habitat features and threatened plants				
BI09	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI10	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). Modified limbs salvaged from removed vegetation in the subject land would be preferenced over nest boxes for artificial hollow construction.	Contractor	Construction	Appendix D
BI11	Removal of native vegetation, threatened species habitat,	Vegetation removal will be minimised around mapped Purple Copper Butterfly habitat.	Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	habitat features and threatened plants				
BI12	Removal of native vegetation, threatened species habitat, habitat features and threatened plants	A Purple Copper Butterfly management plan will be developed within the Flora and Fauna Management Sub-plan which will include measures to minimise impacts to the species including consideration of construction activity timing/scheduling to minimise mortality in areas of mapped habitat and a monitoring strategy to detect efficacy of management measures.	Transport/ Contractor	Construction	Appendix D
BI13	Aquatic impacts	Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) and Section 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	Contractor	Construction	Appendix D
BI14	Aquatic impacts	Creek works and bridges would be designed in accordance with the *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI, 2003)	Contractor	Construction	Appendix D
BI15	Aquatic impacts	Instream works would be undertaken during periods of low flow where possible. Where not possible, any creek diversions would require a permit from DPI (Fisheries).	Contractor	Construction	Appendix D
BI16	Aquatic impacts	A Construction Soil and Water Management Plan (CSWMP) would be developed as a subplan to the CEMP and will outline measures to manage water quality impacts associated with construction work.	Transport/ Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
BI17	Aquatic impacts	A surface water quality monitoring program will be developed in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA, 2003) as part of the Soil and Water management Sub-plan of the CEMP. The program will monitor surface water prior to construction, during construction and during operation.	Transport/ Contractor	Construction Operation	Appendix D
BI18	Groundwater dependent ecosystems	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI19	Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI20	Fragmentation of identified habitat corridors	Connectivity measures will be implemented in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RTA, 2011). This will include retrofitting culverts with fauna friendly design features suitable for target species.	Contractor	Construction	Appendix D
BI21	Fragmentation of identified habitat corridors	Any connectivity measures implemented will be installed under the supervision of an experienced ecologist and maintained during proposal operation.	Transport	Operation	Appendix D
BI22	Fragmentation of identified habitat corridors	Revegetation of unused pavement beneath the bridge at Jenolan Caves Road would be investigated as a potential option to increase fauna connectivity in this area. This would need to consider risk of road strike and feasibility of fauna fencing at this intersection.	Contractor	Detailed design	Appendix D
BI23	Fragmentation of identified habitat corridors	Riparian zone under the twin bridges at River Lett would be revegetated, where feasible, to ensure habitat connectivity is retained.	Contractor	Detailed design	Appendix D
BI24	Indirect impacts on native	Exclusion zones will be set up at the limit of clearing in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	vegetation and habitat				
BI25	Invasion and spread of weeds	Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI26	Invasion and spread of pests	Pest species will be managed within the construction footprint.	Contractor	Construction	Appendix D
BI27	Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI28	Noise, light and vibration	Works in proximity to cuvert 2 and 3 would be undertaken at night to minimise impacts to roosting microbats	Contractor	Construction	Appendix D
BI29	Noise, light and vibration	Permanent shading and artificial light impacts will be minimised through detailed design.	Contractor	Detailed design Construction	Appendix D
BI30	Noise, light and vibration	Construction lighting impacts would be minimised as follows: • Lighting would only be used as necessary to conduct construction activities at night. Lights would be turned off when not needed • Adaptive light controls to manage light timing, intensity and colour would be installed • Only the object or area intended would be lit where feasible • Lights would be kept close to the ground, directed and shielded to avoid light spill • The lowest intensity lighting appropriate for the task would be used	Contractor	Construction	Appendix D

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Use non-reflective, dark-coloured surfaces where possible • Use lights with reduced or filtered blue, violet and ultra-violet wavelengths where possible.			
BI31	Impacts to habitat in human made structures	A Microbat Management Plan would be prepared as a part of the Fauna and Flora Management Sub-Plan to manage impacts to microbats. It would include pre-clearance checks of culverts, monitoring of microbats during noisy works and stop works procedures.	Contractor	Construction	Appendix D
BI32	Impacts to habitat in human made structures	Permanent roost habitat for cave-dwelling microbats should be considered for inclusion in the design of new bridges and culvert structures. This may include pre-casting roosting chambers on the underside of bridges or in the roof of culverts, and/or retrofitting/modifying standard structures to make them more suitable for microbats i.e. leaving grab holes and section joins unsealed, scabbling of concrete surfaces to make structures more suitable, particularly in recesses and potential roosting sites.	Transport/ Contractor	Detailed design Construction	Appendix D
BI33	Impacts to habitat in human made structures	Access to Culvert 2 and 3 would be restricted during construction to minimise impacts to roosting microbats. If access to either culvert is required, consultation with an ecologist would be undertaken and/or an ecologist would supervise activities/access.	Contractor	Construction	Appendix D
BI34	Vehicle strike	Fauna fencing would be installed at targeted locations along the highway to minimise vehicle strike where reasonable and feasible. Fauna fencing would be designed to minimise impacts to threatened fauna species and species subject to vehicle strike. Locations selected would consider connectivity requirements of fauna and proposed structures. A monitoring strategy would be developed to detect efficacy of fauna fencing and maintenance requirements would be detailed as part of the Flora and Fauna Management Sub-plan of the CEMP.	Transport/ Contractor	Detailed design Construction Operation	Appendix D
Traffic and transport					

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
TT01	Construction traffic	A Traffic Management Plan (TMP) will be preparedfor the construction phase of the proposal. This will adhere to Traffic Control at Worksites, Technical Manual, Issue No. 6, Transport, September 2020 and QA Specification G10 Traffic Management (Transport, August 2020). This will include details on: • Measures to maintain access to properties and local roads • Site specific traffic control measures to manage and regulate traffic movement • Requirement and methods to consult and inform the local community of impacts on the local road network • Measures to maintain pedestrian and cyclist access • Access to ancillary sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • A response plan for any construction road traffic incident • Consideration of other developments which may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • Monitoring, review and amendment mechanisms.	Contractor	Prior to and during construction	Appendix E
TT02	Construction traffic staging	Traffic management plans would be prepared for the construction area and progressively updated as the works progress. The plans would be prepared and implemented by suitably qualified personnel	Contractor	Prior to and during construction	Appendix E
TT03	Construction traffic staging	Schedule partial road closures to maintain 2 lanes at all times except for blasting periods. Full road closures would be required for short periods of time (approximately 15 minutes) however this would be conducted at non-peak times.	Contractor	Prior to and during construction	Appendix E
TT04	Consultation	Undertake consultation with local and regional bus companies prior to and during construction	Contractor	Prior to and during construction	Appendix E

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
TT05	Consultation	Undertake consultation with emergency services prior to and during construction to confirm any diversions during construction and any operational road network changes	Contractor	Prior to and during construction	Appendix E
TT06	Consultation	Undertake consultation with property owners and occupiers regarding changes to access arrangements	Contractor	Prior to and during construction	Appendix E
TT07	Consultation	Undertake consultation with local councils regarding potential impacts to parking during the construction period.	Contractor	Prior to and during construction	Appendix E
TT08	Operational traffic management	Review incident management plan in the event the highway may be temporarily closed due to scheduled maintenance or accident	Transport	Operation	Appendix E
TT09	Operational traffic management	Consult with residents who may be affected by the temporary closure of the highway closed due to scheduled maintenance or accident.	Transport	Operation	Appendix E
Noise and vibration					
NV01	Construction noise and vibration management plan	A Construction Noise and Vibration Management Plan should be prepared before any work begins which would include: • Identification of nearby sensitive receivers • Description of works, construction equipment and hours work would be completed in • Criteria for the proposal and relevant licence and approval conditions • Requirements for noise and vibration monitoring • Details of how community consultation would be completed • Procedures for handling complaints • Details on how respite would be applied where ongoing high impacts are seen at certain receivers.	Contractor	Prior to construction	Appendix F

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NV02	Construction noise and vibration assessments	Location and activity specific noise and vibration impact assessments should be carried out prior to (as a minimum) activities: • With the potential to result in noise levels above 75 dBA at any receiver • Required outside Standard Construction Hours likely to result in noise levels in greater than the relevant Noise Management Levels • With the potential to exceed relevant criteria for vibration. The assessments should confirm the predicted impacts at the relevant receivers in the vicinity of the activities to aid the selection of appropriate management measures, consistent with the requirements of the CNVG.	Contractor	Prior to construction	Appendix F
NV03	Construction noise exceedances	The assessment has identified that 'highly intrusive' impacts are likely at the nearest receivers when noise intensive equipment such as concrete saws or rockbreakers are in use, especially during evening and night-time periods. Where noise intensive equipment is to be used near sensitive receivers, the work should be scheduled for Standard Construction Hours, where possible. If it is not possible to restrict the work to the daytime then they should be completed as early as possible in each work shift. Appropriate respite should also be provided to affected receivers in accordance with the CNVG and/or the proposal's conditions of approval.	Contractor	Construction	Appendix F
NV04	Compounds noise	Hoarding, or other shielding structures, should be used where receivers are impacted near compounds or fixed work areas with long durations. To provide effective noise mitigation, the barriers should break line-of-sight from the nearest receivers to the work and be of solid construction with minimal gaps.	Contractor	Construction	Appendix F
NV05	Vibration – monitoring	Monitoring should be carried out at the start of noise and/or vibration intensive activities to confirm that actual levels are consistent with the predictions and that appropriate mitigation measures from the CNVG have been implemented.	Contractor	Construction	Appendix F
NV06	Construction traffic	The potential impacts from construction traffic should be reviewed at a later stage when more information is available.	Contractor	Prior to construction	Appendix F
NV07	Vibration work within	Where work is within the minimum working distances and considered likely to exceed the cosmetic damage criteria:	Contractor	Construction	Appendix F

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	minimum working distance	• Different construction methods with lower source vibration levels should be investigated and implemented, where feasible • Attended vibration measurements should be undertaken at the start of the work to determine actual vibration levels at the item. Work should be ceased if the monitoring indicates vibration levels are likely to, or do, exceed the relevant criteria.			
NV08	Vibration work within minimum working distance	Certain receivers in the study area are within the human comfort minimum working distance and occupants of affected buildings may be able to perceive vibration impacts when vibration intensive equipment is in use. The potential human comfort impacts and requirement for vibration intensive work should be reviewed as the proposal progresses.	Contractor	Prior to construction	Appendix F
NV09	Vibration impacts on structures	Building condition surveys should be completed before and after the work where buildings or structures are within the minimum working distances and considered likely to exceed the cosmetic damage criteria during the use of vibration intensive equipment and/or blasting activities.	Contractor	Prior to construction	Appendix F
NV10	Blasting	The following is recommended to be considered to manage impacts during blasting: • A blast management plan should be prepared prior to the start of blasting • Trial blasts should be undertaken when blasting is proposed to occur within the minimum working distances • Monitoring of overpressure and vibration levels should be undertaken at the potentially most affected receivers for each blast • Notification of all potential affected receivers should occur at least 24 hours prior to blasting.	Contractor	Prior to construction	Appendix F
NV11	Blasting	A Flyrock Management Plan would be developed to manage the potential impacts of flyrock during blasting. This would be developed in consultation with technical specialists. Management measures to be considered would include:	Contractor	Prior to construction	Appendix F

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Implementing a minimum clearance distance of 500 metres to non-construction personnel • Temporary evacuation of residents within a 150 metre radius of each planned blast • Timing of blasting to minimise disruption to local residents • Use of blast mats and soil cover.			
NV12	Operational road traffic noise mitigation measures	As proposals progress through the early design stages, road design features will be evaluated to minimise road traffic noise where necessary. This would include: • Adjustments to vertical and horizontal alignments • Road gradient modifications • Traffic management • Cost effective use of won proposal spoil to provide landscape mounds where there is suitable site footprint.	Contractor	Detailed design	Appendix F
NV13	Operational road traffic noise mitigation measures	Where it is determined that receivers would still have residual exceedances of the Noise Criteria Guideline criteria, site specific 'additional noise mitigation measures would be required. For receivers that qualify for consideration of additional noise mitigation, potential noise mitigation measures are to be considered in the following order of preference: • At-source mitigation such as quieter road pavement surfaces • In-corridor mitigation such as noise mounds and noise barriers • At-receiver mitigation including at-property treatments.	Contractor	Prior to construction	Appendix F
Aboriginal heritage					
AH01	Aboriginal heritage management	An Aboriginal Heritage Management Plan (AHMP) will be developed in consultation with the RAPs to document standard procedures for:	Contractor / Transport	Prior to construction	Section 4.9 of QA G36 Environment Protection

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Unexpected finds procedure for the discovery of Aboriginal ancestral remains, Aboriginal objects or new Aboriginal sites consistent with RMS (2015) Standard Management Procedures Unexpected Heritage Items • Detailed site salvage strategy • Management and curation of salvaged Aboriginal objects • Detailed locations and installations procedures for fencing and protective coverings • Details of permissible activities and permissible vehicle access inside protected Aboriginal areas • Heritage components of induction package for construction workers and supervisors • Any other heritage matters addressed in the Conditions of Approval for the proposal			
AH02	Minimise impacts to Aboriginal heritage sites	Detailed design will investigate opportunities to minimise impacts to: • Forty Bends contact site • 45-4-1111 (GWH 42) • GWH RS01	Contractor	Detailed design	Appendix G
AH03	Retention of sites located under elevated structures	The feasibility of retaining portions of sites that are located under elevated structures (bridges) over River Lett and on River Lett Hill will be investigated as part of the detailed design process, including the following sites: • 45-4-1097 (GWH 07) • 45-4-1072 (GWH 09) • [redacted] Site • GWH 20-2	Contractor	Detailed design	Appendix G
AH04	Aboriginal cultural	Across the proposal, the following interpretation elements have been considered for design integration: • Public works of art	Contractor	Detailed design	Appendix G

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	values interpretation	• Interpretive signage • Bridges • Earthworks • Plantings • Noise walls.			
AH05	Impacts to Aboriginal heritage during construction	Construction works will be closely confined to the minimum possible area required for construction activities. Haulage and other access roads will be designed and located to minimise potential disturbance of soils. Maximising the protection is particularly important in the zone within 100 m of creeks and may require covering the original cultural deposits in temporary protective barriers such as geotextile fabric and a layer of clean fill.	Contractor	Detailed design	Appendix G
AH06	Impacts to Aboriginal heritage during construction	Temporary fencing will be placed on the boundary of the following Aboriginal heritage sites: • GWHAS01 • GWH 20-3 • GWH 20-2 • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1072 (GWH 9) • 45-4-1071 (GWH 8) • [redacted] Site • South Bowenfels Rural Fire Brigade Site • Magpie Hollow Road site • 45-4-1111 (GWH 42)	Contractor	Prior to construction	Appendix G
AH07	Community collection	Salvage collection is warranted at those Aboriginal sites in the construction footprint where stone artefacts have been recorded on the surface. Salvage collection is to record MGA coordinates of each artefact by GPS and relevant	Contractor	Prior to construction	Appendix G

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		artefact attributes consistent with the broader archaeological salvage analysis. The results of salvage collection should be collated in an Aboriginal Site Salvage Report (ASSR). Salvage collection will be undertaken by a suitably qualified archaeologist. Sites requiring salvage collection include: • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1075 (GWH 12) • 45-4-1074 (GWH 11) • GWH 20-3			
AH08	Salvage excavation	Salvage excavation will be carried out by a suitably qualified archaeologist (refer to Section 1.6 of the Code of Practice) to define the western limit of artefact distribution in accordance with the requirements outlined in Section 10.2 of Appendix G for the following sites: • GWH 20-2 • 45-4-1103 (GWH 31) • 45-4-1097 (GWH 7) • 45-4-1072 (GWH 9) • 45-4-1071 (GWH 8) • [redacted] Site • South Bowenfels Rural Fire Brigade Site • Magpie Hollow Road site.	Contractor	Pre-construction	Appendix G
AH09	Aboriginal heritage sites	An Aboriginal Heritage Impact Permit (AHIP) will be required under Section 90 of the NP&W Act before any known Aboriginal heritage sites are impacted.	Transport	Prior to construction	Section 4.9 of QA G36 Environment Protection
AH09	Aboriginal heritage sites	Aboriginal site information recording forms (ASIRF) are to be completed for each site and submitted to OEH to be updates on AHIMS.	Transport	Prior to construction	Appendix G

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
AH10	Unexpected finds	*The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Prior to construction Construction	Appendix G
Non-Aboriginal heritage					
NH01	Discovery of historical heritage materials features or deposits	If at any time during the construction of the proposal, historical heritage materials, features and/or deposits are located, the Transport Standard Management Procedure: Unexpected Heritage Items (unexpected finds protocol) (Transport for NSW 2019) will be implemented The works will not re-commence until the requirements of the procedure have been satisfied	Contractor	Construction	Appendix H
NH02	Discovery of human remains	In the event that construction activities reveal possible human skeletal material (human remains), the Transport Standard Management Procedure Unexpected Heritage Items (unexpected finds protocol) (Transport for NSW 2019) will be implemented. These guidelines have been developed in consultation with Heritage NSW and are consistent with the requirements of the Skeletal Remains: Guidelines for Management of Human Skeletal Remains under the Heritage Act (NSW Heritage Office 1998)	Contractor	Construction	Appendix H
NH03	Inadvertent impacts by contractors during construction	Historical heritage awareness training will be provided for contractors prior to the commencement of construction works to ensure understanding of known and potential heritage items that may be impacted or otherwise encountered during the proposed works This training will include specific mention of the procedure required in the event unexpected heritage finds or human remains are encountered	Contractor	Construction	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NH04	Direct impacts to heritage fabric/within an item's heritage curtilage	Design consideration should be given to the heritage item and proposed works with critical assessment of the necessity of the proposed impacts: • Road culvert and retaining wall at Emoh (LEP A027) • Bowenfels Presbyterian Cemetery (LEP A030) If the impacts cannot be mitigated through design, additional justification will be required to inform the item's Statement of Heritage Impact	Contractor	Detailed design	Appendix H
NH05	Direct impacts to heritage fabric	An archival recording of the heritage item would be carried out, in accordance with the guidelines Photographic Recording of Heritage Items Using Film or Digital Capture (Heritage Council of NSW 2006) at the following sites: • Billesdene Grange (LEP I023) • Section of Coxs River Road (unlisted) • Lyndoch Orchard (LEP I019) • Bridge over the River Lett (unlisted) • Historical bullock track and creek crossing (unlisted) • Road culvert and retaining wall at Emoh (LEP A027) Dependant on the nature and complexity of the heritage item and the potential impact of the proposed works, the archival recording may also include additional primary or archival research, and additional digital data capture methods such as 3D scanning	Contractor	Prior to construction	Appendix H
NH06	Proposed works within the curtilage of an SHR listed heritage item	Options to reduce the construction footprint within the SHR curtilage should be considered at the following items: • Hartley Historic Village (SHR 00992/LEP I043) • Fernhill (SHR 00225/LEP I043) An archival recording of the heritage item would be carried out, in accordance with the guidelines Photographic Recording of Heritage Items Using Film or Digital Capture (Heritage Council of NSW, 2006). The appropriate heritage permits must be obtained prior to construction This will be an approval under either Section 60 or subsection 57(2) of the Heritage Act	Contractor	Detailed design	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Either application will require the approval of the NSW Heritage Council or its delegate			
NH07	Changes to, or exacerbation of existing, water runoff and drainage in proximity to a heritage item	An assessment of existing drainage and water runoff on the item should be completed for the following items: • House (LEP I021) • Meads Farm (LEP I020) Options to mitigate drainage or runoff issues through the installation of drainage infrastructure or other modifications should be explored prior to or during detailed design.	Contractor	Detailed design	Appendix H
NH08	Direct impact to heritage fabric with unknown impacts	Structural assessment by a heritage structural engineer in order to determine the structural capability of the causeway, the probable impacts from the road construction and required compaction, and any additional management or mitigation measures at Billesdene Grange (LEP I023). Archaeological investigation of the area of impact should be completed in order to fully understand the structure and enable a comprehensive archival recording to be produced.	Contractor	Prior to construction	Appendix H
NH09	Removal of old, rare, or otherwise significant trees or vegetation	The remnant orchard trees at Lyndoch Orchard (LEP I019) should be examined by a qualified arborist and assessed for significance and horticultural value Any rare, old, or otherwise significant examples or varieties should have potential for propagation or preservation considered	Transport	Prior to construction	Appendix H
NH10	Construction (cut or fill) of large road cuttings, embankments or batter slopes	Attempts should be made, where possible, to blend new batter slopes and embankments with existing topography near: • Rosedale (LEP I024) • Meads Farm (LEP I020) • Old Roman Catholic Cemetery (LEP A015) • Hartley Historic Village (SHR 00992/LEP I043)	Contractor	Prior to construction and construction	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Fernhill (SHR 00225/LEP I043) Where the construction requires vegetation removal, embankment design should aim to be of an obtuse angle such that revegetation or new landscape planting is possible			
NH11	Removal of visually significant vegetation or areas of existing mature trees	Wherever possible, areas where vegetation removal is required should attempt to revegetate or landscape the area, with plantings to match the existing landscape (trees replacing trees, grasses replacing grasses) at the following items: • Rosedale (LEP I024) • Billesdene Grange (LEP I023) • Harp of Erin (LEP I028) • Meads Farm (LEP I020) • Old Roman Catholic Cemetery (LEP A015) • Fernhill (SHR 00225/LEP I043) • Old Catholic Cemetery (LEP A029) Landscaping of new works elements should not introduce plantings of tall height species if they did not previously exist in that location. This should aid in maintaining an open landscape where suitable and screening vegetation where it currently exists	Contractor	Construction	Appendix H
NH12	Structures not expected to be sensitive to vibration impacts, but need this to be confirmed prior to construction	A dilapidation survey should be confirmed for the following items, with consideration to the proposed works and expected construction plant to be used in their proximity, in order to confirm whether they would be sensitive to vibration impacts during construction: • Billesdene Grange (LEP I023) • Log Cabin Farmhouse Village Shop (unlisted) • House (LEP I021) • Lyndoch Orchard (LEP I019) • Old Roman Catholic Cemetery (LEP A015)	Contractor	Prior to construction	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• St John the Evangelist's Anglican Church (LEP I029) • Stone and Timber Cottage (LEP I045) • Bowenfels National School Site (SHR 00761/LEPI054)			
NH13	Structures considered to be sensitive to vibration impacts during construction	A dilapidation report should be prepared for each of the following sensitive heritage item to assess, on a case-by-case basis, whether the fabric would be sensitive to vibration impacts during construction or operation: • Rosedale (LEP I024) • Nioka (LEP I025) • Harp of Erin (LEP I028) • House (LEP I021) • Meads Farm (LEP I020) • Hartley Historic Village (SHR 00992/LEP I043) • Bridge over the River Lett (unlisted) • Fernhill (SHR 00225/LEP I043) • Emoh (Emu Store/Corderoy's Store) (LEP I051) • Road culvert and retaining wall at Emoh (LEP A027) • Umera (Bowenfels Inn, Tricks House) (LEP I052) • Ben Avon (former Royal Hotel) (LEP I053) • Old Catholic Cemetery (LEP A029) • Somerset House (LEP I057) • Parsonage Farm (LEP I058) • Presbyterian Church and Sessions Hall (LEP I059) • Bowenfels Presbyterian Cemetery (LEP A030) • Caldwells House (LEP I061) Vibration monitoring would be carried out on sensitive heritage items for at least the period of construction	Contractor	Prior to construction	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Monitoring should continue at least 12 months after the completion of works to determine if ongoing impacts are occurring i.e. identify any operational damage attributable to the proposal Surfacing and construction methods in proximity to sensitive heritage items should be in accordance with the Transport criteria for construction adjacent to sensitive heritage buildings The dilapidation report for each cemetery should involve archival recording/photographs showing the present state of monuments, followed by an assessment of any tilting of headstones or cracking of slabs that may be attributable to roadworks			
NH14	Vibration impacts during construction	Where a heritage item is deemed sensitive to vibration impacts, the more stringent German Standard guideline values (DIN 4150) should be followed when assessing minimum safe distances and determining allowable plant and its maximum vibration level This may require a greater safety buffer to be maintained between the heritage item a particular vibration-intensive construction equipment	Contractor	Construction	Appendix H
NH15	Ground disturbance in an area of low archaeological potential	Application for a s139 exception and test excavation or monitoring of ground disturbance works by an appropriately qualified archaeologist are required at the following locations: • Harp of Erin (LEP I028) • Hartley Historic Village (SHR 00992/LEP I043) • Archaeological potential on unidentified Lot (unlisted) Test excavation prior to, or monitoring during ground disturbance works in this area under a s139 exception.	Contractor	Prior to construction	Appendix H
NH16	Ground disturbance in an area of moderate archaeological potential	Test excavation under a s140 permit - an Excavation Permit under Section 139(4) of the Heritage Act is required at the following sites: • Hartley Historic Site (SHR 00992/LEP I043) • Ben Avon (LEP I053) • Former Bowenfels Lockup (unlisted) • Bowenfels Presbyterian Cemetery (LEP A030)	Contractor	Prior to construction	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		For works within the SHR curtilage, the excavations would require approval under s60 of the Heritage Act instead Where test excavations are proposed, an archaeological research design and methodology must be prepared in accordance with Archaeological Assessments: Archaeological Assessment Guidelines (NSW Heritage Office 1996a)			
NH17	Disturbance of an area of high archaeological potential	As the causeway at Billesdene Grange (LEP I023) is considered to be an archaeological 'work' it does not trigger the requirement for a s140 permit Archaeological investigation should be completed under appropriately qualified supervision to expose, investigate and record the causeway fabric A detailed archival recording of the causeway and Billesdene Grange frontage to the Great Western Highway should be completed prior to works	Contractor	Prior to construction	Appendix H
NH18	Disturbance of an area with the potential for human remains	An archaeological assessment should be completed of the site Archaeological potential on unidentified Lot, including a detailed survey of the lot and area of potential in order to assess the landform and identify any surface features, and remote sensing of an appropriate method Based on the results of the survey and remote sensing, an archaeological research design should be prepared for management of the site and. It should include further research to try and ascertain the potential identity of the deceased and may subsequently include genealogical research to locate any of their descendants If the archaeological assessment identifies potential features, complete a test excavation. If the results are inconclusive then the area to be impacted should be monitored during the removal of topsoil by an appropriately qualified archaeologist. This work would require a s139 exception and should be completed with the support of a physical anthropologist in case potential human remains are identified.	Contractor	Prior to construction	Appendix H
NH19	Properties unable to be accessed	Further assessment in the detailed design phase will be completed at the following locations in order to physically inspect these items and amend the desktop assessment of the items presented in this report: • Billesdene Grange (LEP I023) • House (LEP I021)	Contractor	Detailed design	Appendix H

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Meads Farm (LEP I020) • Lyndoch Orchard (LEP I019) • Archaeological potential on unidentified Lot (unlisted) • Fernhill (SHR 00225/LEP I043) • Emoh (I051) • Umera (LEP I052)			
Soils and surface water					
SW01	Erosion and sedimentation of soils / Surface water quality	A Construction Soil and Water Management Plan (CSWMP) would be developed as a subplan to the CEMP and will outline measures to manage water quality impacts associated with construction work. The CWSMP will provide: • An Erosion and Sediment Control Plan (ESCP) including measures to mitigate erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans for all progressive stages of construction and the implementation of erosion and sediment control measures including the use of sediment basins. • Erosion and sediment control measures which would be implemented and maintained in accordance with *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom, 2004) and *Volume 2D* (DECC, 2008). • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation. • Measures to manage waste including classification and handling of spoil. • Measures to manage tannin leachates. • Measures to manage accidental spills including requirement to maintain materials such as spill kits, an emergency response procedures and regular visual water quality checks when working near waterways.	Contractor	Prior to construction Construction	Appendix I

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Controls for sensitive receiving environments which may include but not be limited to designation of 'no go' zone for construction plant and equipment (where application).			
SW02	Erosion and sedimentation of soils / Surface water quality	A soil conservation specialist will be engaged for the duration of construction of the proposal to provide advice on the planning an implementation of erosion and sediment control including review of the Construction Soil and Water Management Plan and Erosion and Sediment Control Plan.	Transport Contractor	Prior to construction Construction	Appendix I
SW03	Neutral or Beneficial Effect (NorBE) assessment for water quality	A further NorBE assessment will be undertaken during detailed design.	Contractor	Detailed design	Appendix I
SW04	Water reuse	A water reuse strategy will be developed as part of the CEMP for both construction and operation to reduce reliance on potable water. Any water from sediment basins will be checked to ensure compliance with *ANZG (2018) Water Quality Guidelines* for proper reuse.	Contractor	Detailed design Prior to construction Construction	Appendix I
SW05	Water balance	A water balance assessment may need to be undertaken at the design stages to determine if there is any impact on the quantity of surface runoff that is currently received at various private farm dams located at the downstream end (within approximately 500 meters) of the proposed road corridor. Any increases or decreases would need to be quantified based on an average yearly runoff yield assessment at each of the affected farm dams.	Transport	Detailed design	Appendix I
SW06	Surface water quality impacts	A surface water quality monitoring program will be developed in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA, 2003). The program will monitor surface water prior to construction, during construction and during operation.	Transport Contractor	Prior to construction Construction Operation	Appendix I

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
SW07	Surface water quality impacts	An Acid Sulfate Rock Management Plan (ASRMP) would be prepared to provide information on the mitigation and management of acid sulfate rock disturbed as part of the construction works.	Contractor	Detailed design Prior to Construction Construction	Appendix I
Groundwater					
GW01	Evaluation of hydraulic conductivity test data	Once groundwater monitoring bores associated with the current geotechnical drilling program have been installed and slug tested, the hydraulic conductivity assumptions adopted for the Groundwater report (Appendix J) will be reviewed in light of the test data. If test data shows hydraulic conductivity to deviate significantly from the assumed values in this report, then re-assessment of potential groundwater impacts and groundwater inflow rates will be required. A hydrogeologist will review the hydraulic conductivity test data once available and determine whether re-assessment of potential groundwater impacts/groundwater inflow rates with revised hydraulic conductivity assumptions is required.	Transport	Prior to construction	Appendix J
GW02	Groundwater monitoring program	Groundwater monitoring will be undertaken to acquire appropriate baseline data and to provide a basis by which the proposal impact on groundwater can be monitored. This would include: • Reviewing groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores (currently in process of being installed as part of geotechnical investigations) • Prior to commencement of construction, a groundwater quality sampling round should be undertaken at the 26 scheduled proposal groundwater monitoring bores. The analytes should comprise field parameters, major ions (chloride, sulphate, sodium, potassium, magnesium, calcium, carbonate and bicarbonate) and dissolved heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and manganese).	Transport	Prior to construction	Appendix J

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GW03	Construction groundwater monitoring	During the construction phase, the following groundwater monitoring should occur: • Continuation of groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores. The data should be downloaded and reviewed quarterly. • Quarterly groundwater quality sampling rounds at select (locations and quantity to be confirmed at end of baseline period, prior to construction) proposal monitoring bores. The tested analytes should be the same as those outlined in Section 6.3.1 of Appendix J. The data should be reviewed after each sampling round.	Contractor	Construction	Appendix J
GW04	Operational groundwater monitoring	During the operational phase the following groundwater monitoring should occur: • Continuation of groundwater level measurement by data logger at all 26 scheduled proposal monitoring bores. The data should be downloaded and reviewed quarterly. • Quarterly groundwater quality sampling rounds as per the construction period monitoring regime. The data should be reviewed after each sampling round. After one a year the data should be reviewed, and a decision made as to whether monitoring should continue.	Transport	Construction	Appendix J
Hydrology and flooding					
HF01	Operational flooding impacts	All cross-drainage structures including culverts and bridges would be constructed to cater for the 100 year ARI local and regional storm events to minimise upstream afflux.	Contractor	Detailed design	Appendix K
HF02	Operational flooding impacts	During detailed design, the height of the proposed road embankment adjacent to Boxes Creek would be reviewed or alternative designs considered to eliminate or reduce potential PMF impact.	Contractor	Detailed design	Appendix K
HF03	Operational flooding impacts	Additional flood modelling would be undertaken during detailed design. If residual risk of embankment stress remains adjacent to Boxes Creek, a dam	Contractor	Detailed design	Appendix K

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		safety check would be undertaken and further mitigation such as a debris catch upstream would be considered.			
HF04	Operational flooding impacts	An eastwards shift of the Kelly Street service road will be considered during detailed design to mitigate potential flooding impacts at this location.	Contractor	Detailed design	Appendix K
Landscape character and visual impact					
LV01	Landscape character and visual impact	An Urban Design Plan will be prepared to support the final detailed proposal design and implemented as part of the CEMP. The Urban Design Plan will present an integrated urban design for the proposal, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for: • location and identification of existing vegetation and proposed landscaped areas, including species to be used • built elements including retaining walls and bridges • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. The Urban Design Plan will be prepared in accordance with relevant guidelines, including: • Beyond the Pavement (Transport for NSW, 2020b) • Landscape and design guideline (Roads and Maritime Services, 2018) • Bridge Aesthetics (Transport for NSW, 2019).	Transport / Contactor	Detailed design Prior to construction	Appendix L

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
LV02	Landscape character and visual impact	Detailed design of the proposal will consider, where feasible and reasonable: • Opportunities to reduce the construction footprint • Minimising the number of ancillary facilities required • Using visually recessive materials to minimise the visual dominance of the road • Investigating opportunities to reduce the bulk of structures • Minimising vegetation clearing and maximising revegetation and planting opportunities, particularly in high sensitivity areas where screening is required • Ensuring residual land is developed to complement the existing landform • Opportunities to incorporate pedestrian and cycle connections.	Transport/ Contractor	Detailed design	Appendix L
LV03	Landscape character and visual impact	Landscape planting and maintenance will be in accordance with the Lithgow City Council Weed List and include indigenous species endemic to the area. Locally collected seeds or bioregionally-sourced indigenous seeds and plants will be used where feasible.	Transport/ Contractor	Detailed design Construction	Appendix L
LV04	Lighting	The design of temporary and permanent lighting will be carried out in accordance with AS 1158.1-1986 and will avoid unnecessary light spill on adjacent residents or sensitive receivers.	Transport/ Contractor	Detailed design Construction	Appendix L
LV05	Landscape character and visual impact	During construction, the following measures will be implemented: • Provide suitable barriers to screen views from adjacent areas during construction • Return temporary works areas, such as ancillary facilities, to at least their pre-construction condition progressively throughout the works, where feasible, or once construction is complete • Identify, protect and retain existing trees located within the ancillary facility areas	Transport/ Contractor	Construction	Appendix L

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Temporary lighting should be screened or diverted to reduce unnecessary light spill.			
Socio-economic					
SE01	Community consultation	A Community Communication Strategy (CCS) will be prepared for the proposal to facilitate communication with the local and regional communities including relevant Government agencies, Councils, adjoining landowners and businesses, residents, motorists and other relevant stakeholders that may be affected by the proposal. The strategy will: • Identify people or organisations to be consulted during the delivery of the proposal • Set out procedures and mechanisms for the regular distribution of information about the proposal • Outline mechanisms to keep relevant stakeholders updated on construction activities, schedules and milestones • Outline avenues for the community to provide feedback (including a 24-hour, toll free proposal information and complaints line) or to register complaints and through which Transport will respond to community feedback • Outline a process to resolve complaints and issues raised.	Transport/ Contractor	Prior to construction and construction	Appendix M
SE02	Business impacts	Access will be maintained to local businesses near to construction works. Where temporary access changes are proposed, these will be agreed with the affected business owner.	Contractor	During construction	Appendix M
SE03	Business impacts	Signage would be provided to key business locations such as Little Hartley and Hartley Historic Village during construction.	Contractor	During construction	Appendix M
SE04	Business impacts	Ongoing consultation will be undertaken with local business owners at Little Hartley, Hartley Historic Village, Hartley and South Bowenfels that may be impacted during construction in accordance with Community Communication Strategy.	Contractor	During construction	Appendix M

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
SE05	Emergency vehicle access	Access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency (e.g. for South Bowenfels Rural Fire Brigade and Lithgow Hospital).	Contractor	During construction	Appendix M
SE06	Local access changes	Local communities and road users will be notified about access changes prior to implementation.	Contractor	During construction	Appendix M
Property and land use					
PL01	Leased land	Areas of land leased for the purposes of construction will be reinstated at the end of the lease to at least equivalent standard in consultation with the landowner.	Contractor	Construction	N/A
PL02	Property	All partial and full acquisitions and associated property adjustments will be carried out in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* and the *Transport for NSW Land Acquisition Information Guide* in consultation with landowners. This will include the provision of monetary compensation determined in accordance with the provisions of the Act.	Transport	Prior to construction	Appendix M
PL03	Property	Property adjustments for the proposal will be completed in consultation with property owners.	Transport/ Contractor	Prior to construction / during construction	Appendix M
PL04	Property	Existing property access will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided following consultation with the affected property owners.	Transport/ Contractor	During construction	Appendix M
Contamination					
CN01	Detailed site investigation	A Detailed Site Investigation (DSI) is being undertaken prior to construction to better understand the nature and extent of contamination in accordance with the NEPM (2013) and other guidelines made or endorsed by the NSW EPA.	Contractor	Prior to construction	Appendix N

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
CN02	Management of low risk contamination	Where site investigation data confirms that contamination is likely to have a very low, low or moderate impact potential, the site would then be managed in accordance with Construction Environmental Management Framework.	Contractor	Prior to construction	Appendix N
CN03	Remediation Action Plan	If identified as required following detailed site investigations, a Remedial Action Plan (RAP) would be developed for identified risk areas within the construction footprint. Each RAP would detail the remediation works required to mitigate risks from contamination throughout and following completion of construction. The RAP would be prepared in accordance with relevant NSW EPA guidelines and where applicable, detail remediation methodologies in accordance with Australian Standards and other relevant government guidelines and codes of practice.	Contractor	Prior to construction	Appendix N
CN04	Site audit statement	If identified as required following detailed site investigations, an accredited Site Auditor would review and approve the RAP and remediation activities and will develop a Site Audit Statement (SAS) and Site Audit Report (SAR) upon completion of remediation.	Contractor	Prior to construction	Appendix N
CN05	Residual contamination following construction	Ongoing management and monitoring measures would be documented in an appropriate form, for example an environmental management plan, and implemented for any areas where minor, residual contamination remains following construction.	Contractor	Construction	Appendix N
Air quality					
AQ01	Air quality management	Develop and implement an Air Quality Management Plan (AQMP) as part of the Construction Environmental management Plan (CEMP). In addition to detailing how the measures above should be implemented, the AQMP should also identify: • Potential sources of air pollution (including odours and dust) during construction. • Air quality management objectives consistent with any relevant published guidelines.	Construction contractor	Prior to and during construction	Appendix O

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		• Methods to manage works during strong winds or other adverse weather conditions. • A progressive rehabilitation strategy for exposed surfaces. • When the air quality, suppression and management measures need to be applied, who is responsible, and how effectiveness will be assessed. • A monitoring program to record whether the air quality mitigation, suppression and management measures have been applied; and assess the effectiveness of the applied measures.			
AQ02	Dust emissions during construction	Minimise the extent of disturbed and exposed areas, and revegetate finished areas as soon as possible	Construction contractor	During construction	Appendix O
AQ03	Dust emissions during construction	Minimise the drop heights of materials	Construction contractor	During construction	Appendix O
AQ04	Dust emissions during construction	Review and where necessary modify or suspend activities during dry and windy weather and background air quality conditions.	Construction contractor	During construction	Appendix O
AQ05	Dust emissions during construction	Cover or otherwise regularly stabilise (with water sprays or binders) stockpiles	Construction contractor	During construction	Appendix O
AQ06	Dust emissions during construction	Regularly water haul routes and ensure that all loads are covered	Construction contractor	During construction	Appendix O

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
AQ07	Dust emissions during construction	Regularly inspect and remove debris from plant and equipment to avoid the tracking of materials on to the adjacent road network	Construction contractor	During construction	Appendix O
AQ08	Dust emissions during construction	To the extent practical, position ancillary sites and stockpiles away from nearby sensitive receivers	Construction contractor	Prior to construction	Appendix O
AQ09	Exhaust emissions from plant and equipment used during construction	Inspect all plant and equipment before it is used on-site	Construction contractor	Prior to and during construction	Appendix O
AQ10	Exhaust emissions from plant and equipment used during construction	Ensure all vehicles, plant, and equipment operate in a proper and efficient manner.	Construction contractor	During construction	Appendix O
AQ11	Exhaust emissions from plant and equipment used during construction	Switch off all vehicles, plant and equipment when not in-use	Construction contractor	During construction	Appendix O
AQ12	Exhaust emissions	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable.	Construction contractor	During construction	Appendix O

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
	from plant and equipment used during construction				
AQ13	Odours and airborne hazardous substances from uncovered contaminated materials	Apply odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works	Construction contractor	During construction	Appendix O
AQ14	Odours and airborne hazardous substances from uncovered contaminated materials	Adhere to relevant requirements for removal and disposal listed in the Work Health and Safety Act 2011, and Work Health and Safety Regulation 2017.	Construction contractor	During construction	Appendix O
AQ15	Emissions to air and visual impacts from blasting activities	Prior to firing, review and confirm that the blast would not likely result in any dust or fume-related impacts. This should include a review of whether meteorological conditions (ie inversions, wind speeds and directions, stability, time of day, cloud cover, temperature and humidity are suitable	Construction contractor	During construction	Appendix O
AQ16	Emissions to air and visual impacts from blasting activities	Where possible, avoid blasting during early morning and late afternoon when meteorological conditions are typically least favourable in terms of the potential for blast-related impacts	Construction contractor	During construction	Appendix O

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
Bushfire					
BF01	Emergency access during construction	In the event of a fire, emergency services will be able to gain access via existing Great Western Highway or tracks used for construction activities. Access and egress to/from private properties in bushfire prone areas adjoining the construction corridor will be maintained, with advice on any access changes provided to RFS in advance of the bushfire season.	Construction contractor	Construction	Appendix P
BF02	Hot works	Works that have potential to generate sparks or heat and ignite fires will be subject to the contractor's hot works safety management procedures. Hot works will not be undertaken on total fire ban days except where permission has been given by the RFS. Construction equipment and contractor's vehicles will carry fire extinguishers or knap sacks to help extinguish any small fires that may be ignited by construction activities.	Construction contractor	Construction	Appendix P
BF03	Hazardous materials storage	Storage of hazardous and flammable materials should follow environmental protection guidance and be located in areas with low radiant heat exposure in the event of a bushfire. Any hazardous fuel storage areas should be free of vegetation or any other combustible materials that could contribute to a fire ignition.	Construction contractor	Construction	Appendix P
BF04	Emergency management	On site bushfire emergency management arrangements will be addressed through the construction contractor's site emergency management plan. This plan will specify notifications to emergency services in case of fire, emergency assembly areas and evacuation procedures. If a fire is ignited and cannot be safely contained using fire extinguishers or other materials at hand, construction crews will dial 000 and seek emergency service assistance.	Construction contractor	Construction	Appendix P
BF05	Operational bushfire risks	Grass within the highway corridor should be inspected and maintained at the commencement of the fire season (and through the fire season, if required) to reduce fuel loading and the potential for fire ignition and to create a low bushfire fuel zone in the immediate vicinity of the road. Woody vegetation in the vicinity of the road should also be actively managed to remove dead plants. Roadside trees should be inspected for stability and safety following any fire event to minimise the risk posed to road users.	Transport	Operation	Appendix P

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
BF06	Operational access	Design would incorporate the need for safe emergency vehicle access at all times.	Transport	Operation	Appendix P
BF07	Fire weather signage	Roadside signage should be erected at either end of the proposal that informs road users of the daily fire weather forecast (i.e. the daily Fire Danger Rating). On days of highly elevated fire danger (extreme or catastrophic fire danger), additional advice should be posted that advises road users to reconsider the need for travel.	Transport	Operation	Appendix P
BF08	Road closures	During active fire events in the landscape surrounding the proposal, emergency services should consider temporary road closures to all but emergency service vehicles.	Transport	Operation	Appendix P
Waste					
WM01	Waste management	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (reuse, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Transport for NSW Land (Roads and Maritime Services, 2014) and relevant Transport for NSW Waste Fact Sheets.	Contractor	Prior to construction	Environmental Procedure - Management of Wastes on Transport Land (Roads and Maritime Services, 2014)
WM02	Waste management	All wastes will be managed and disposed of in accordance with the Protection of the Environment Operations Act 1997 and the Protection of the Contractor Construction Environment Operations (Waste) Regulation 2014	Contractor	Construction	N/A
WM03	Waste disposal	Excavated material would be assessed for reuse as backfill material as part of the proposal. If material is unable to be used as backfill material it would be	Contractor	Construction	Appendix N

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		appropriately tested and classified against the NSW EPA Waste Classification Guidelines Part 1: Classifying Waste (NSW EPA, 2014) and Addendum 1 (NSW EPA, 2016) prior to being disposed of off-site.			
WM04	Green waste	Where possible and suitable for use, cleared vegetation will be used as mulch or coarse woody debris for site erosion and sedimentation controls or rehabilitation.	Contractor	Construction	N/A
WM05	Fill material	Any required additional fill material will be sourced from appropriately licensed facilities and/or other construction projects wherever possible. Additional fill material will be sourced and verified as suitable for use in accordance with relevant EPA and Transport guidelines.	Contractor	Construction	N/A
Sustainability, greenhouse gas and climate change					
GH01	Greenhouse gas emissions	Undertaking detailed modelling to ensure that cut and fill balances are managed to minimise any unnecessary movements of material;	Contractor	Detailed design	Appendix Q
GH02	Greenhouse gas emissions	Review opportunities to specify biofuel use on construction plant and equipment based on site for long periods;	Contractor	Detailed design	Appendix Q
GH03	Greenhouse gas emissions	Review opportunities to use alternative materials in construction, such as fly ash as a supplementary cementitious material (to replace traditional Portland cement) and reclaimed aggregate;	Contractor	Detailed design and construction	Appendix Q
GH04	Greenhouse gas emissions	Specify high recycled content in steel use (where technically possible and cost effective).	Contractor	Detailed design	Appendix Q
GH05	Flooding	Findings of the CCRA will be used to inform further design considerations, mitigation measures and management plans regarding flooding in and around the proposal alignment.	Contractor	Detailed design	Appendix Q
GH06	Bushfire risk	Findings of the CCRA will be used to inform bushfire risk management measures and management plans.	Contractor	Detailed design	Appendix Q

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GH07	Climate projections	Adopt consideration of climate projections, flooding and bushfire risks when developing the detailed design and material consideration	Contractor	Detailed design	Appendix Q
Cumulative					
CU01	Cumulative impacts	Ongoing coordination and consultation will be undertaken with nearby projects as required.	Transport/ Contractor	Prior to and during construction	N/A
CU02	Cumulative impacts	The CEMP will be revised to consider potential cumulative impacts from surrounding development activities as they become known.	Contractor	Construction	N/A
CU03	Cumulative impacts	Opportunities for further design refinements would be considered during detailed design to reduce potential impacts where feasible.	Contractor	Detailed design	N/A
CU04	Dust, exhaust and other emissions during construction	To the extent practical, plan the construction of the various segments of the proposal to avoid situations where sensitive receivers may be affected by emissions to air from multiple work areas.	Contractor	Prior to construction and construction	Appendix O

7.3 Licensing and approvals

Table 7-2 provides a summary of the licensing and approvals required for the proposal.

Table 7-2 Summary of licensing and approvals required

Instrument	Requirement	Timing
Protection of the Environment Operations Act 1997 (s43)	Environment protection licence (EPL) for scheduled activities [if known describe the applicable scheduled activities eg road construction / extractive activities / crushing, grinding or separating etc] from the EPA.	Prior to start of the activity.
Fisheries Management Act 1994 (s199)	Written notice of the proposed dredging and reclamation work must be given to the Minister for Agriculture and Western NSW, with consideration given to any comments provided within 21 days.	Prior to start of the activity.
Fisheries Management Act 1994 (s220)	Permit to obstruct the free passage of fish (temporary or permanent) from the Minister for Agriculture and Western NSW.	Prior to start of the activity.
National Parks and Wildlife Act 1974 (s90)	Aboriginal heritage impact permit from the Chief Executive of OEH.	Prior to start of the activity.
National Parks and Wildlife Act 1974	Revocation of land reserved as a National Park to occur via an Act of Parliament.	Prior to the determination of any land reserved under the National Parks and Wildlife Act 1974
Water Management Act 2000	A water supply works approval to construct a work	Prior to start of the activity
Water Management Act 2000	A water use approval to use the water.	Prior to start of the activity
Heritage Act 1977	A section 60 permit or subsection 57(2) permit for works that have (or have the potential to have) a minor impact on the heritage significance of a State Heritage item.	Prior to start of the activity
Heritage Act 1977	A section 140 excavation permit to disturb or excavate any land in NSW that is likely to contain archaeological relics.	Prior to start of the activity
Heritage Act 1977	A section 139(4) excavation permit exemption.	Prior to start of the activity

A detailed summary of the heritage approvals required for specific heritage items is provided in Table 7-3.

Table 7-3 Summary of heritage approvals required

Proposal section	Heritage item (Register and ID)	Approval requirement
Little Hartley to River Lett	Billesdene Grange	• Under the ISEPP, impacts to a local heritage item which are more than negligible or minor, will require consultation with Lithgow City

Proposal section	Heritage item (Register and ID)	Approval requirement
		Council. Any response received within 21 days must be taken into consideration in the REF • As the causeway would be considered a work the proposal would not require an excavation permit, however best practice requires that its archaeological investigation by managed appropriately
Coxs River Road	Harp of Erin (LEP I028)	• The area of archaeological sensitivity behind the Harp of Erin within the construction footprint is assessed as having low potential. Test excavation in this area to determine the presence or absence of archaeological material within the construction footprint would require an Excavation Permit Exception under section 139 of the Heritage Act
	Lyndoch Orchard (LEP I019)	• Under the ISEPP, impacts to a local heritage item which are more than negligible or minor, will require consultation with Lithgow City Council. Any response received within 21 days must be taken into consideration in the REF
River Lett to Forty Bends	Hartley Historic Site (SHR 00992/LEP I043)	• Works within the SHR curtilage will require approval from the Heritage Council prior to construction under Section 60 or subsection 57(2) of the Heritage Act • Archaeological investigations or monitoring will also require an excavation permit under Section 60 of the Heritage Act
	Bridge over the River Lett (unlisted)	• Although not currently listed, best practice requires that the heritage values of the item should be managed appropriately • Information regarding the proposed impacts to the heritage item should be submitted with this assessment to Transport for their internal comment and approval as the determining authority
	Archaeological potential on unidentified Lot (unlisted)	• As an area of identified archaeological potential, the archaeological investigation would require a permit exception under Section 139 of the Heritage Act and the proposed works would require approval under Section 140 of the Heritage Act prior to construction
	Fernhill (SHR 00225/LEP I043)	• Works within the SHR curtilage will require approval from the Heritage Council prior to construction under Section 60 or subsection 57(2) of the Heritage Act
	Historic bullock track and creek crossing (unlisted)	• Although not currently listed, best practice requires that the heritage values of the item should be managed appropriately • Information regarding the proposed impacts to the heritage item should be submitted with this assessment to Transport for their internal comment and approval as the determining authority
Forty Bends to Lithgow	Ben Avon (LEP I053)	• As an area of identified archaeological potential, archaeological test excavations would require approval under Section 140 of the Heritage Act, or a permit exception under Section 139 of the Heritage Act prior to construction

Proposal section	Heritage item (Register and ID)	Approval requirement
	Former Bowenfels Lockup (unlisted)	• As an area of identified archaeological potential, archaeological test excavations would require approval under Section 140 of the Heritage Act, or a permit exception under Section 139 of the Heritage Act prior to construction
	Bowenfels Presbyterian Cemetery (LEP A030)	• Located within the curtilage of an archaeological item, the proposed works would require approval under Section 140 of the Heritage Act, or a permit exception under Section 139 of the Heritage Act prior to construction

8. Conclusion

This section provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

8.1 Justification

8.1.1 Social factors

As outlined in Section 6.10, the proposal would have some negative social impacts during the construction phase of the proposal. These would include:

- Disruptions for motorists and road users during construction due to temporary changes to road conditions, reductions in speed limits, temporary traffic lane closures and temporary diversions and access changes. These changes have potential to result in longer traffic delays and disruptions, and increased road safety risks for motorists using the Great Western Highway, including freight operators.
- The intensification of road infrastructure and the clearing of vegetation from bushland areas, rural properties and the road reserve impacting on the rural character and visual amenity from locations within the proposal area
- Some rural and rural residential properties at Hartley are likely to experience impacts on residential amenity due to the construction of multiple proposal stages. This would mainly affect occupants of properties at the eastern end of the River Lett to Forty Bends phase of the proposal, which may experience noise, dust and traffic impacts from construction activities for both the Little Hartley to River Lett and River Lett to Forty Bends stages of the proposal.
- Temporary changes to local amenity for occupants of residential and commercial properties, and users of community facilities near to construction works. These temporary changes would possibly impact on individuals' use and enjoyment of these properties, particularly within outdoor areas
- Temporary noise and light spill from night works, potentially impacting night-time amenity at residential properties closest to these works and impacts on health and wellbeing due to sleep disturbance or disruptions to sleeping patterns
- Dust from construction activities, resulting in possible effects on the health and wellbeing of some people near to construction works who may be more sensitive to changes in air quality.

It is also likely that some residents, business owners and employees in the study area facing changes associated with property acquisition may experience a level of stress and anxiety about these changes, potentially affecting the health and wellbeing of some individuals. These impacts are likely to already be occurring in the study area given the investigations for the proposal and delivery of safety upgrades have been occurring over several years. Transport has commenced consulting with affected property owners and has already purchased numerous properties directly impacted by the proposal. It is expected that this has provided a level of certainty about the proposal for some property owners.

Further, mitigation measures as detailed in Section 6 and Section 7 of this REF would be implemented to minimise adverse impacts due to the proposal.

Once operational, the proposal would have long term positive impacts on access and connectivity for local and regional communities, business, and industry. Specifically, the proposal would support quicker, more reliable and safer regional connections and links to and from destinations within the study area,

surrounding Blue Mountains, Lithgow and Central West and Orana regions, and greater Sydney. Access changes during operation to properties and local destinations such as Little Hartley village and Hartley Historic village would generally be localised to individual stages of the proposal. Locally, changes to the alignment of the highway, new access roads and widening of the existing highway has potential to intensify road infrastructure at some locations and move the alignment closer to residential uses. Traffic noise from the proposal has potential to impact on amenity for residents, including during the evening and night-time given the relatively low existing noise environment.

Reduction of through traffic, including heavy vehicles within the Little Hartley village would support safer access and enhanced amenity for residents and businesses within the village. The separation of local traffic and through traffic would also support safer access to properties and destinations in the study area, although this may require increased travel for motorists accessing some locations.

8.1.2 Biophysical factors

Throughout the options development process for the proposal, an important consideration has been to minimise potential impacts on biodiversity and particularly the removal of native vegetation. The result of the optioneering process means that only 75.19 hectares of the 267 hectares impacted by the proposal comprises native vegetation. Impacts to this native vegetation would further be reduced through the implementation of mitigation measures including minimising vegetation clearing where feasible and reasonable.

The proposal would result in the removal of approximately 75.19 hectares of native vegetation including the following protected plant community types:

- Around 17.59 hectares of Tablelands Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as Endangered under the BC Act
- Around 5.82 hectares of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as Critically Endangered under the BC Act
- 3.6 hectares is consistent with White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as Critically Endangered under the EPBC Act.

These plant community types could potentially serve as habitat for threatened fauna species.

Mortality and injury of terrestrial fauna species could potentially occur, including potential mortality and injury of threatened fauna species. This occurrence would be minimised through pre-clearing procedures during construction and installation of fauna fencing during operation.

Construction of the proposal would require the removal of a series of culvert structures. These structures have the potential to be used for roosting by cave roosting threatened microbat species. Potential impacts are considered to be minor and not likely to reduce the persistence of local or bioregional populations as habitat to be impacted is unlikely to be important to any of the species for breeding

The realignment and upgrade of the Great Western Highway would increase habitat fragmentation (ie would widen an existing gap in otherwise continuous fauna habitat), which could create a further barrier to fauna movement between habitat to the north and south of the Great Western Highway.

The proposal is expected to result in only localised changes to flood behaviour at River Lett within the banks of the river with no flood impacts outside of the creek banks and impacts dissipating within a short distance downstream. Flood impacts at Rosedale Creek are expected to affect some previously flood-affected pastureland. Flood levels would increase by approximately 100 millimetres at the upstream end of

the main culvert which is proposed to be extended at its downstream end. The flood extent would not be increased in practical terms because the terrain is relatively steep.

The proposal would require excavation, removal of vegetation, disturbance of soil and the construction of road surfaces and drains, which may lead to exposed soils, sediment entering waterways and the degradation of water quality.

The proposal has some long-term negative biophysical impacts that would be managed through implementation of the mitigation measures proposed in Section 7.1. However, these impacts of the proposal would be outweighed by the long-term benefits once the proposal is operational through improvements to the transport network in and around the proposal area.

8.1.3 Economic factors

Locally, the proposal would improve road safety and accessibility, including through reduced congestion, travel time savings and improved travel reliability for staff, customers and deliveries. This would impact positively on businesses, supporting general improvements to local business and industry within the study area and surrounding suburbs.

The proposal will contribute to the NSW Future Transport Strategy 2056 state-wide outcome for a strong economy. The proposal supports this outcome by enabling growth in economic activity, including the movement of freight

As outlined in Section 3.2.1 the proposal will require a workforce of up to 200 people over a 3-year period. The Great Western Highway Upgrade Environment and Sustainability Policy presented in Section 6.15 summarises that local employment and skills development are a key point of the policy. This includes increasing local employment, adopting Infrastructure Skills Legacy Program or similar outcomes and embracing Aboriginal Participation in Construction (APIC) Policy targets.

8.1.4 Public interest

The public interest is best served through the equitable distribution of resources, and investment in public infrastructure that fulfils the need of the majority. The proposal represents a cost-efficient investment in public infrastructure that would maximise the long-term social and economic benefits, while minimising the long-term negative impacts on communities and the environment. By improving local and regional transport facilities, the proposal would better enable movement of people, goods and services.

The proposal would result in some short-term impacts on amenity, accessibility and transport efficiency during construction. In addition, the clearing of approximately 75.19 hectares of native vegetation would be required to construct the proposal. Mitigation measures would be implemented to manage and reduce these impacts.

There are a number of Commonwealth and State strategic plans that specifically aim to improve safety and efficiency of the road network. The proposal is consistent with these plans including the State Infrastructure Strategy and the Future Transport Strategy among others.

8.2 Objects of the EP&A Act

Object	Comment
1.3(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	Development of the proposal has considered potential impacts to all environmental resources, including air, water, land and biodiversity, that may be affected by the development of the proposal. Wherever possible, the design of the proposal has avoided and minimised impacts and safeguards have been developed to further reduce and mitigate impacts on the environment. The proposal will contribute to a broader program of works on the Great Wester Highway thereby continuing traffic safety and efficiency improvements which are promoting social and economic welfare of the community.
1.3(b) To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	The principles of ecologically sustainable development, being the precautionary principle, intergenerational equity, conservation of biological diversity and ecological integrity and improved valuation, pricing and incentive mechanisms have been considered for the proposal in Section 8.2.1. The consideration of these principles has found that ecologically sustainable development had been facilitated throughout the design of the proposal and the safeguards developed in this REF.
1.3(c) To promote the orderly and economic use and development of land.	The proposal would form an important element in the upgrade of the Great Western Highway throughout the Blue Mountains in NSW. It would assist in the coordination of the orderly economic use and development of land for the region and along this significant freight transport corridor.
1.3(d) To promote the delivery and maintenance of affordable housing.	Not relevant to the proposal.
1.3(e) To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	The proposal would result in the removal of approximately 75.19 hectares of native vegetation including the following protected plant community types: • Around 17.59 hectares of Tablelands Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as Endangered under the BC Act • Around 5.82 hectares of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as Critically Endangered under the BC Act

Object	Comment
	• 3.6 hectares is consistent with White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as Critically Endangered under the EPBC Act. These plant community types could potentially serve as habitat for threatened fauna species. Mortality and injury of terrestrial fauna species could potentially occur, including potential mortality and injury of threatened fauna species. This occurrence would be minimised through pre-clearing procedures during construction and installation of fauna fencing during operation. Construction of the proposal would require the removal of a series of culvert structures. These structures have the potential to be used for roosting by cave roosting threatened microbat species. Potential impacts are considered to be minor and not likely to reduce the persistence of local or bioregional populations as habitat to be impacted is unlikely to be important to any of the species for breeding The realignment and upgrade of the Great Western Highway would increase habitat fragmentation (ie would widen an existing gap in otherwise continuous fauna habitat), which could create a further barrier to fauna movement between habitat to the north and south of the Great Western Highway.
1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	An assessment of potential impacts to Aboriginal heritage and non-Aboriginal heritage is provided in Section 6.4 and Section 6.5 respectively. The assessment includes measures to avoid or mitigate impacts due to the proposal to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).
1.3(g) To promote good design and amenity of the built environment.	An urban design, landscape character and visual impact assessment has been prepared for the proposal which outlines the urban design and landscape strategy for the proposal. The strategy aims to facilitate an integrated urban design and engineering design outcome for the proposal.
1.3(h) To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	Not relevant to this proposal
1.3(i) To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Not relevant to the proposal.

Object	Comment
1.3(j) To provide increased opportunity for community participation in environmental planning and assessment.	Consultation with the community and relevant government agencies was carried out during the development of the proposal. There would be further opportunities for the public to comment on the proposal during the exhibition of the REF. Details on this consultation can be found in Section 5.

8.2.1 Ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD have been an integral consideration throughout the development of the proposal.

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are discussed below.

The precautionary principle

This principle states: "*if there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation*".

Evaluation and assessment of alternatives and options have aimed to reduce the risk of serious and irreversible impacts on the environment. Stakeholder consultation considered issues raised by stakeholders and a range of specialist studies were carried out for key issues to provide accurate and impartial information to assist in the evaluation of options.

The concept design has sought to minimise impacts on the amenity of the study area while maintaining engineering feasibility and safety for all road users. A number of safeguards are proposed to minimise potential impacts. These safeguards would be implemented during construction and operation of the proposal. No safeguards have been postponed out of any lack of scientific certainty.

A CEMP would be prepared before construction starts. This requirement would ensure the proposal achieves a high level of environmental performance. No mitigation measures or management mechanisms would be postponed because of a lack of information.

Intergenerational equity

The principle states: "*the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations*".

The proposal would not result in any impacts that are likely to adversely impact on the health, diversity or productivity of the environment for future generations.

The proposal would cater for future population and traffic growth in the region. The proposal would benefit future generations by improving safety and helping to address the future increases in traffic volumes and traffic congestion associated with movement of traffic along Great Western Highway. While the proposal would have some adverse impacts, they are not considered to be of a nature or extent that would result in disadvantage to any specific section of the community or to future generations.

Should the proposal not proceed, the principle of intergenerational equity may be compromised, as future generations would experience an increase in travel time on Great Western Highway by about four per cent in 2036. Without the proposal, travel times and intersection level of service would deteriorate to unacceptable levels. Traffic modelling of future year periods indicate that the proposed upgrade would

provide a safer, reliable and more efficient road corridor on the Great Western Highway between Little Hartley and Lithgow.

Conservation of biological diversity and ecological integrity

This principle states: "*the diversity of genes, species, populations and communities, as well as the ecosystems and habitats to which they belong, must be maintained and improved to ensure their survival*".

The principle of conservation of biological diversity and ecological integrity requires the maintenance and improvement of genes, specie, populations and communities, as well as the ecosystems and habitats to which they belong, to ensure their survival. A thorough assessment of the existing local environment was undertaken to identify and manage any potential impacts of the proposal on local biodiversity (refer to Section 6.1 Biodiversity).

The proposal would result in the removal of approximately 75.19 hectares of native vegetation including the following protected plant community types:

- Around 17.59 hectares of Tablelands Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as Endangered under the BC Act
- Around 5.82 hectares of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as Critically Endangered under the BC Act
- 3.6 hectares is consistent with White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as Critically Endangered under the EPBC Act.

These plant community types could potentially serve as habitat for threatened fauna species including the Large-eared Pied Bat (*Chalinolobus dwyeri*), Purple Copper Butterfly (*Paralucia spinifera*), Greater Glider (*Petauroides volans*) and Squirrel Glider (*Petaurus norfolkensis*).

As the proposal would require the removal of native vegetation and potential fauna habitat from the subject land, Transport are required to offset these impacts on biodiversity. The offsets required for the proposal were calculated using the BAM calculator. A total of 2,195 ecosystem credits and 3,227* species credits are required to offset the direct impacts of the proposal. An additional number* of ecosystem credits may be required to offset indirect impacts; these would be in addition to BAM credit obligations and are at the discretion of the Minister for Planning and Public Spaces.

The proposed culvert extension works and scour protection would potentially impact instream habitat of several creeks mapped as Key Fish Habitat. Under the 'Policy and guidelines for fish habitat conservation and management' (NSW DPI, 2013) this would require offsetting. Final offset calculations will be carried out following further design development.

The species credit offset requirement and credits to offset indirect impacts from the proposal will be updated upon completion of remaining surveys.

Improved valuation, pricing and incentive mechanisms

This principle is defined as:

improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as:

(i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

This REF has examined the environmental consequences of the proposal and identified mitigation measures to manage the potential for adverse impacts. The requirement to implement these mitigation measures would result in an economic cost to Transport and would increase the capital and operating costs of the proposal. The costs of the generation and management of waste and pollution would be captured in any waste disposal charges for construction activities. This signifies that environmental resources have been given appropriate valuation.

The concept design has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the proposal is being developed with an environmental objective in mind.

8.3 Conclusion

The proposed upgrade of the Great Western Highway between Little Hartley and Lithgow is subject to assessment under Division 5.1 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, biodiversity stewardship sites under the BC Act, wilderness areas, areas of outstanding value, impacts on threatened species and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

Transport has commenced the revocation process with National Parks and Wildlife Service for a portion of land reserved as National Park. Transport intends to exclude from its determination any works requiring revocation until such time that a decision has occurred, via an Act of Parliament.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the proposal objectives but would still result in some impacts including construction noise and vibration, changes to access and traffic delays during construction, land acquisition and property adjustments, visual and landscape changes, loss of around 75.19 hectares of native vegetation and non-Aboriginal heritage impacts. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would form part of the broader Greater Western Highway Upgrade program that aims to reduce congestion and deliver safer, more efficient and reliable journeys for those travelling in, around and through the Blue Mountains, while also better connecting communities in the Central West. Provision of dual carriageway would provide travel time savings in 2036 of around 10 minutes between Katoomba and Lithgow. In addition, the proposal is predicted to reduce the number of crashes on the Great Western Highway from 89 to 39 over a six year period. On balance the proposal is considered justified and the following conclusions are made.

Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act. A Biodiversity Development

Assessment Report is required and has been prepared for the proposal. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.

The NorBE assessment for the proposal shows that the proposal is likely to have a positive effect on surface water quality and a neutral impact on groundwater quality. The annual average pollutant loads for the upgraded road conditions with the proposed water quality controls are anticipated to provide between 6 and 68 per cent improvement on existing surface water conditions. These results demonstrate compliance with the NorBE requirements.

Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of Agriculture, Water and the Environment is not required.

This REF has been prepared to meet the requirements of the EPBC Act strategic assessment approval for Transport Division 5.1 road activities. A referral to the Australian Department of Agriculture, Water and the Environment is not required.

9. Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Kate Wiggins

Environment Manager, Jacobs Arcadis Joint Venture

Date: 26 October 2021

I have examined this review of environmental factors and accept it on behalf of Transport for NSW.

Paul Peters

Senior Project Development Manager

Date: 27/10/2021

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Terms and acronyms used in this REF

Term / Acronym	Description
AAAC	Association of Australasian Acoustical Consultants
ACHAR	Aboriginal Cultural Heritage Assessment Report
AEI	Area of Environmental Interest
AEP	Annual Exceedance Probability
AFG	Aboriginal Focus Group
AHIMS	Aboriginal Heritage Information Management Systems
AHIP	Aboriginal Heritage Impact Permit
AOBV	Areas of Outstanding Biodiversity Value
AQMP	Air Quality Management Plan
ASIRF	Aboriginal Site Information Recording Forms
ASRMP	Acid Sulfate Rock Management Plan
AusLink	Mechanism to facilitate cooperative transport planning and funding by Commonwealth and state and territory jurisdictions
AWS	Automatic Weather Station
BAL	Bushfire Attack Level
BAM	Biodiversity Assessment Method
BC Act	*Biodiversity Conservation Act 2016* (NSW).
BDAR	Biodiversity Development Assessment Report
BFMC	Bush Fire Management Committee
BOS	Biodiversity Offset Strategy
CCRA	Climate Change Risk Assessment
CCS	Community Communication Strategy
CEMP	Construction Environmental Management Plan
CHL	Commonwealth Heritage List
CM SEPP	*State Environmental Planning Policy* (Coastal Management) 2018
CNVG	Construction Noise and Vibration Guideline
CSWMP	Construction Soil and Water Management Plan
DECCW	Department of Environment, Climate Change and Water
DSI	Detailed Site Investigation
ECRTN	Environmental Criteria for Road and Traffic Noise

Term / Acronym	Description
EIA	Environmental impact assessment
ENMM	Environmental Noise Management Manual
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased
FM Act	*Fisheries Management Act 1994* (NSW)
GCCCAA	Guideline for Child Care Centre Acoustic Assessment Version 2.0
GDEs	Groundwater Dependent Ecosystems
GMA	Greater Metropolitan Area
Heritage Act	*Heritage Act 1977* (NSW)
HNA	Highly Noise Affected
IBRA	Interim Biogeographic Regionalisation of Australia
ICNG	Interim Construction Noise Guideline
ISEPP	*State Environmental Planning Policy* (Infrastructure) 2007
ITS	Intelligent Transport Systems
KFH	Key Fish Habitat
LALC	Local Aboriginal Land Council
LCZs	Landscape Character Zones
LEP	Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.
LGA	Local Government Area
LoS	Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
MIC	Maximum Instantaneous Charge

Term / Acronym	Description
MNES	Matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
NCAs	Noise Catchment Areas
NCG	Noise Criteria Guideline
NEPM	*National Environment Protection Measures* (2013)
NHL	National Heritage List
NMG	Noise Mitigation Guideline
NMLs	Noise Management Levels
NorBE	Neutral or Beneficial Effect
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NPWS	National Parks and Wildlife Services
OEH	Office of Environment and Heritage
PACHI	Procedure for Cultural Heritage Consultation and Investigation
PAD	Potential Archaeological Deposit
PCT	Plant Community Type
PMF	Probable Maximum Flood
POEO Act	*The Protection of the Environment Operations Act* 1997
QA Specifications	Specifications developed by Transport for NSW for use with road work and bridge work contracts let by Transport for NSW.
RAPs	Registered Aboriginal Parties
RBL	Rating Background Level
REF	Review of Environmental Factors
RFS	Rural Fire Service
RNE	Register of the National Estate
RNP	Road Noise Policy
Roads and Maritime	NSW Roads and Maritime Services, now known as Transport for NSW
SAII	Serious and Irreversible Impact
SAR	Site Audit Report
SAS	Site Audit Statement
SAT	Spot Assessment Technique
SCA	Sydney Catchment Authority
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.

Term / Acronym	Description
SES	State Emergency Services
SHI	State Heritage Inventory
SHR	State Heritage Register
SPRAT	Species Profile and Threats
TAGG	Transport Authorities Greenhouse Group's
TBDC	Threatened Biodiversity Data Collection
TECs	Threatened Ecological Communities
TMP	Traffic Management Plan
TRAQ	Tool for Roadside Air Quality
VDV	Vibration Dose Value
WHL	World Heritage List
WoNS	Weeds of National Significance

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