6. Non-Indigenous and Indigenous Heritage

This Chapter outlines the potential non-Indigenous and Indigenous heritage impacts associated with the construction and operation of the Project. This Chapter provides a summary of the Capital Metro, Canberra Light Rail – Heritage Impact Assessment prepared by Godden Mackay Logan Heritage Pty Ltd (GML Heritage) contained as Technical Paper 2 in Volume 2 of this EIS.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential non-Indigenous and Indigenous heritage impacts risks presented in Table 6.1 below.

Table 6.1 Initial non-Indigenous and Indigenous heritage impacts risks associated with the Project

<table>
<thead>
<tr>
<th>ID</th>
<th>Potential impact</th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1</td>
<td>Potential to result in direct impacts to existing heritage buildings and/or curtilages as a result of establishing light rail infrastructure in the vicinity of heritage items.</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td>B.2</td>
<td>Potential to result in impacts to the proposed ‘Canberra the Planned National Capital’ National Heritage Listed area, which includes a portion of the southern end of Northbourne Avenue.</td>
<td>Likely</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>B.3</td>
<td>Potential to result in indirect impacts to existing heritage places and/or curtilages as a result of changes to the heritage and landscape character of the area, particularly along Northbourne Avenue.</td>
<td>Likely</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>B.4</td>
<td>Potential to result in Loss or damage to Aboriginal archaeological potential or places with Aboriginal cultural values, in particular within the northern portion of the study area as a result of land clearing and or excavation works. Particular areas for investigation include:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ the stabling depot and maintenance facility</td>
<td>Possible</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>■ part of the alignment on Flemington Road that crosses the end of the Gurbur Dhaura ridgeline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ part of the alignment between Well Station Drive and Lysaght Street</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ any areas outside the currently identified Project footprint.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.5</td>
<td>Impact to burial sites during construction including discovery of historic/European and/or Aboriginal burials.</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td>B.6</td>
<td>Potential for impacts on registered historical archaeology sites including:</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>■ the James Coopers Historic Site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ an existing culvert on Flemington Road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ Gubur Dhaura (Aboriginal Ochre Quarry and Historic Mining Area).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.1 Environmental conditions and values

6.1.1 Historical overview of the route

European colonisation of the area commenced in the 1820s with farming and grazing properties. There were both small and large estates, mainly used for grazing with some cropping near the Molonglo River. Following Federation in 1901, a long process began to establish a national capital for the newly federated Australia. In 1908, when the NSW District Surveyor Charles Scrivener was sent out to examine and survey potentially suitable sites for the federal capital he was directed by Hugh Mahon of the Commonwealth Parliament that:

The Federal Capital should be a beautiful city, occupying a commanding position with extensive views, and embracing distinctive features which lend themselves to the evolution of a design worthy of the object, not for the present but for all time.

This set the tone for the planned federal capital with a unique purpose, setting, character and symbolism. In 1911, land in the vicinity of what is now Canberra was chosen and repossessed by the Commonwealth Government for the federal capital.

Griffin planning for Canberra

The 1911 competition for the city design

An international competition to design the new city commenced in 1911. In May 1912, after considerable debate and 137 entries, two Chicago architects, Walter Burley Griffin and his wife Marion Mahony Griffin, won the competition. In their designs they aimed to draw references from the broader natural setting of a place. The 1911 international competition provided the Griffins with an opportunity to design a visionary ideal city set in an undeveloped, open, and largely pastoral site. The resulting design paid attention to the setting and the site’s natural features: hills, watercourses and views.

Griffin’s 1911 plan for the national capital was based on a geometry dictated by the landscape rather than the principal points of the compass. The city was laid out with vistas, axes aligned to the summits of four local mountains and a large central lake. Griffin planning for Canberra also provided for symmetry and geometry in response to the topography along the main approach road. Arterial roadways provided balance to the planned city design and linked the formal official ceremonial areas with local residential precincts. In this way, the main avenues were a means of ordering the city. Northbourne Avenue was part of this deliberate ordering of the new city landscape and the Griffins’ overall landscape design for Canberra included it as a major and symbolic approach to the central national area through the civic centre, which was the gateway to the political and administrative centre.

Griffin planning for Canberra also included rail and tram transport in the city—a main station was planned for Civic and a tram line (which Griffin termed ‘street car’) ran north-south parallel to Northbourne Avenue.

Planning for the Development of Canberra after Griffin

The development of Canberra after the Griffins maintained Northbourne Avenue as a main arterial road for Canberra and the main entrance avenue from the north. Planning and implementation for Canberra’s growth undertaken by the National Capital Development Commission between 1958 and 1989, confirmed the importance of Northbourne Avenue as the main entrance route to the city by developing the Y-Plan for Canberra and public housing along the avenue. Subsequent plans, including the Canberra Spatial Plan (2004b) and The National Capital Plan (2008) have also highlighted the importance of Northbourne Avenue as the main entrance route to the city, in addition to maintaining the vision of this route as a main transport corridor as initially envisaged by the Griffins.
6.1.2 Non-Indigenous heritage

A total of 26 heritage listed items were identified within the vicinity of the Project area. Table 6.2 sets out the listed and nominated non-Indigenous heritage places located within the Project study area. Appendix B of the Heritage Impact Assessment (Technical Paper 2) includes ACT Heritage listing documentation for all heritage items along the route and Australian Institute of Architect (AIA) citations for nominated places along the route. Appendix C of the Heritage Impact Assessment includes the National Heritage List (NHL) nominations for Canberra which encompass the route.

Table 6.2 Non-Indigenous heritage places and objects within the vicinity of the Project

<table>
<thead>
<tr>
<th>Item name</th>
<th>Location/Curtilage</th>
<th>Register</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canberra—Central National Area and Inner Hills</td>
<td>Includes Northbourne Avenue, Canberra</td>
<td>National Heritage List</td>
<td>Nominated</td>
</tr>
<tr>
<td>Canberra and Surrounding Areas</td>
<td>Includes Northbourne Avenue, Canberra</td>
<td>National Heritage List</td>
<td>Nominated</td>
</tr>
<tr>
<td>Canberra the Planned National Capital (Departmental amalgamation of other nominations)</td>
<td>Includes Northbourne Avenue, Canberra</td>
<td>National Heritage List</td>
<td>Nominated</td>
</tr>
<tr>
<td>City Hill</td>
<td>Section 34 and all the land enclosed by the outer perimeter of the Vernon Circle road reserve, City</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Melbourne and Sydney Buildings</td>
<td>27 and 28 Northbourne Avenue City Sections 1 and 48</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Havelock House</td>
<td>85 Northbourne Avenue Turner Block 1, Section 42</td>
<td>ACT Heritage Register</td>
<td>Nominated</td>
</tr>
<tr>
<td>Coggans Bakery</td>
<td>36 Mort Street, corner of Elouera Street Braddon Block 1 Section 28</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Former AAA Building (CSC Building)</td>
<td>212 Northbourne Avenue Braddon Block 3, Section 3</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>NRMA House</td>
<td>92-94 Northbourne Avenue Braddon, Block 8 &amp; 9 Section 18</td>
<td>ACT Heritage Register</td>
<td>Nominated</td>
</tr>
<tr>
<td>Haig Park</td>
<td>Braddon Blocks 3, 6, 7 Section 8 and Block 1 Section 14; Turner Blocks 4, 9–13, 18, 19, 22 Section 66 and Blocks 1–3, 9 Section 65</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Open Systems House (formerly Churchill House)</td>
<td>218 Northbourne Avenue Braddon Block 10 Section 7</td>
<td>ACT Heritage Register</td>
<td>Nominated</td>
</tr>
<tr>
<td>‘Expansion’ Mosaic Mural wall on Canberra Rex Hotel</td>
<td>150 Northbourne Avenue (Part) Braddon Block 9 Section 8</td>
<td>ACT Heritage Register</td>
<td>Registered object</td>
</tr>
<tr>
<td>Northbourne Housing Precinct</td>
<td>Dickson Block 4 Section 1, Block 1 Section 12, Block 41 Section 6, Lyneham Block 8 Section 51</td>
<td>ACT Heritage Register</td>
<td>Nominated</td>
</tr>
<tr>
<td>Trees of the Former CS&amp;IR Experiment Station</td>
<td>Swinden Street, Downer</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Well Station Homestead</td>
<td>Off Nullabor Avenue Section 5 Block 2 (Part), Harrison</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Gungaderra Homestead and part of Well Station Road</td>
<td>Otway Street/Sapling Street, Harrison Blocks 10 and 12, and Block 12 Section 2, Harrison</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Dickson Library</td>
<td>Dickson Place Dickson Block 13 Section 30</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
</tbody>
</table>
The location of each of the identified heritage items is shown on Figure 6.1a to Figure 6.1e. Details regarding the heritage significance of each of these sites are provided in Chapter 3 of the Heritage Impact Assessment (Technical Paper 2).

### 6.1.3 Historical archaeology

A total of three register historical archaeological features have also been identified in close proximity to the Project. These features are shown in Table 6.3.

#### Table 6.3 Historical Archaeological features registered within the study area

<table>
<thead>
<tr>
<th>Item name</th>
<th>Location/Curtilage</th>
<th>Register</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2/H5 ‘Culvert’</td>
<td>Flemington Road between Manning Clarke Crescent and Kate Crace Street</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>CDHS NC41 ‘James Cooper Historic Site’</td>
<td>Approximately 200m to the south of the proposed depot area</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
<tr>
<td>Gubur Dhaura (Aboriginal Ochre Quarry and Historic Mining Area)</td>
<td>Franklin Block 1 Section 106</td>
<td>ACT Heritage Register</td>
<td>Registered</td>
</tr>
</tbody>
</table>

All three of these features are located within the Flemington Corridor (refer to Figure 6.1a to Figure 6.1c). No registered archaeological features were noted within the Northbourne Corridor. Details regarding the heritage significance of each of these sites are provided in Chapter 5 of the Heritage Impact Assessment (Technical Paper 2).
Figure 6.1c: Heritage places and objects

Legend
- Project Alignment
- Stop platform
- Heritage places and objects

Note – this map does not show the NHL nomination boundary or Aboriginal heritage.
6.1.4 National Heritage Listed areas

Northbourne Avenue

The only historic heritage place that would be directly affected by the proposal would be the draft NHL-nominated area of ‘Canberra the Planned National Capital’ which would have the potential to be impacted by the portion of the Project located along Northbourne Avenue. Northbourne Avenue is currently included in two nominations of Canberra to the NHL including the following:

- **Canberra – Central National Area and Inner Hills**
- **Canberra and Surrounding Areas**.

The *Canberra – Central National Area and Inner Hills* NHL nomination is identified as reflecting ‘the foundational elements of the Griffin plan and later changes’ (of which Northbourne Avenue is a part).

The *Canberra and Surrounding Areas* NHL nomination is identified as referring to Northbourne Avenue as one of the ‘significant features of Canberra’s fabric’.

In addition to the above nominations, Northbourne Avenue is also included on the draft boundary map for the *Canberra, the Planned National Capital* assessment released by the Australian Heritage Council. Only the portion from City to the Anthill Street/Mouat Street intersection is identified (refer to Figure 6.2). The southern section of the Federal Highway which is part of the Project route is not included on the map. At this time, no determination regarding the Canberra, the Planned National Capital nomination has been made. Therefore, for the purpose of assessing the potential impacts of the Project, it is has been assumed that Canberra, the Planned National Capital will proceed to listing and has been included as part of the consideration of potential impacts.

Source: GML Heritage, Technical Paper 2

Figure 6.2 Detail from the draft NHL boundary map provided as part of the ‘Canberra, the Planned National Capital’ nomination showing Northbourne Avenue and city streets
The key components of Northbourne Avenue’s heritage values as part of the NHL-nominated area relate to its qualities as a grand processional tree and building-lined entry to Canberra; its size (wider than a normal road); and the linear views it affords to City Hill. These characteristics reflect the intent of the original Griffin plan for Canberra and later updates and provide for a suitably ceremonial approach into central Canberra from the north. The treed landscape of Northbourne Avenue contributes to the heritage values of the nominated Canberra, the Planned National Capital area in defining the avenue as a processional entry route and a symbol of Canberra’s planned relationship to nature – this is part of the early concept for Canberra.

Gungahlin

The Gungahlin town centre is included in the draft NHL boundary map provided as part of the Canberra, the Planned National Capital discussion paper. The discussion paper notes the following:

One of the proposed values relates to the adoption of the ‘Y-Plan’ for Canberra and the resultant establishment (but not the form) of decentralised town centres.

6.1.5 Aboriginal land

Before European settlement, Aboriginal people occupied the hills and plains of the Molonglo Valley. They lived a nomadic hunter-gatherer lifestyle, setting up shelter and camps as they travelled in response to availability of natural resources. A total of over 200 campsites have been located in the ACT and many artefacts recovered within the immediate area of Lake Burley Griffin.

Aboriginal people were displaced from their land following European settlement of the area and their numbers reduced dramatically, possibly associated with a smallpox epidemic in 1830, influenza, and a measles epidemic in the 1860s. There are few records of Aboriginal people on the Limestone Plains (the original colonial name for the Canberra city centre and national area), after it was settled by pastoralists, perhaps because of the seasonal migratory lifestyles of Aboriginal people, or because they retreated in the face of colonial settlement, moving to the hills.

Search information for the Project study area has indicated that the landscapes around Gungahlin, Franklin, Harrison and Mitchell were well-occupied by Aboriginal people prior to the arrival of European settlers. This suggests that any land that is undeveloped in this area has the potential to have Aboriginal artefacts present on it. Typically in and around many areas of Canberra, lower slopes near watercourses are areas where Aboriginal occupation sites occur in greater frequency.

The presence of a small watercourse in near vicinity to the proposed stabling depot and maintenance facility suggests that this area may have some archaeological potential. It is also apparent that undeveloped land in the Gungahlin area is likely to have some archaeological potential. Gubur Dhaura, a very significant cultural place with a large artefact scatter, is located in relatively close proximity to Gungahlin Creek, a consistent water source that would have facilitated the use of this landscape by Aboriginal people in the past.

During the site visit with the Registered Aboriginal Organisations (RAO), a potential cultural scar tree was identified within the proposed compound site along Flemington Road at Gungahlin. The southern side of the west end of the stabling depot and maintenance facility site was also considered to have some potential as a potential archaeological deposit (PAD).

On the basis of this environmental setting and the presence of previously recorded sites in the near vicinity, the general landscape from Gubur Dhaura to the Gungahlin Creek may have the potential to contain archaeological sites and artefacts.
6.2 Investigations

Non-Indigenous heritage and historical archaeology items

As part of the Heritage Impact Assessment (Technical Paper 2), a review of the following statutory heritage lists was undertaken to determine the presence of historic heritage items, conservation areas and archaeological sites which may be impacted by the Project:

- the ACT Heritage Register
- the Commonwealth Heritage List
- National Heritage List (NHL)
- National Trust ACT Heritage Register
- Australian Institute of Architects (ACT Branch) Register of Significant Twentieth Century Architecture
- Register of the National Estate (a non-statutory archive).

Database searches of the ACT Heritage Unit were also undertaken to identify historical archaeological features. The ACT Heritage Unit also holds information on Indigenous places and objects in the ACT. A database search was undertaken for an area covering Gungahlin, Harrison and Franklin suburban development areas as well as along the Project study area. A meeting with the DA Taskforce of the ACT Heritage Council was also undertaken.

Aboriginal land

Background research

A database search of the ACT Heritage Unit for an area covering Gungahlin, Harrison and Franklin suburban development areas as well as along the Project alignment into the city was undertaken. The database search area was significantly wider than the immediately proposed Project impact footprint, including areas of undeveloped land between Gungahlin Drive Horse Park Drive, Well Station Drive and approximately 800 metres to the east of Flemington Road. This wider search area was undertaken to assist in understanding the broader context of Aboriginal sites in the landscape surrounding the Project alignment.

Consultation with Registered Aboriginal Organisations

To assess the Indigenous heritage values of the route, consultation was also undertaken with four recognised RAOs in the ACT to afford them an opportunity to participate in the assessment and management of their own cultural heritage. The four RAOs consulted for this Project are:

- the Buru Ngunnawal Aboriginal Corporation
- King Brown’s Tribal Group (formerly known as the Consultative Body Aboriginal Corporation on Indigenous Land and Artefacts in the Ngunnawal Area)
- the Little Gudgenby River Tribal Council
- the Ngarigu Currawong Clan.

A site inspection with the RAOs was also undertaken on 3 February 2015.
6.3 Potential impacts

Overview of potential heritage impacts

The Project has been assessed against the potential and official heritage values identified along the Project alignment. The key potential heritage impacts of the Project include:

- the compatibility of the light rail with the potential National Heritage values of Canberra
- temporary impacts on potential National Heritage values of Northbourne Avenue and Canberra, the Planned Capital NHL nomination areas during construction through the temporary loss of trees and placement of construction hoardings along its length and construction compounds near City Hill
- potential permanent impacts on the potential National Heritage values of Northbourne Avenue and Canberra, the Planned Capital through the placement of new structures in the avenue’s landscaped median where previously there were none, and the implementation of the proposed new planting scheme along the median
- temporary impacts on the setting of heritage places along the Project route during construction through changes to the landscape setting of Northbourne Avenue (particularly the loss of trees), the erection of construction site hoardings, and construction dust and vibration
- permanent impacts on the setting of heritage places along the Project alignment through changes to the landscape character of Northbourne Avenue, new structures such as stops, overhead wires and poles, and substations, and the potential to obstruct significant views from the avenue to these heritage places
- noise and vibration from the Project are not anticipated to impact on heritage items along the Project route (refer to section 7.3.2 below).

Further discussion of the potential impacts of the Project on heritage along the Project alignment is provided in the following sections.

6.3.1 Direct and indirect impacts on existing heritage places

The Project, including the light rail tracks, overhead wiring, stops and shelters, and associated infrastructure such as substations and temporary construction compounds, has the potential to have an impact on the setting of nominated and registered heritage places and objects along the Project alignment, in particular along Northbourne Avenue. The Project also has the potential, however minor, to have an impact on all heritage buildings along the route via construction and operation vibration.

A summary of the potential impacts of the Project on heritage places and objects adjacent which may be impacted by the Project is provided below.

Gungaderra Homestead, the Old Well Station Road and Well Station Homestead Precinct

The Project is unlikely to impact on the heritage significance or features intrinsic of Gungaderra Homestead or the Old Well Station Road and Well Station Homestead Precinct due to the existing urban development between them and the proposed Project alignment. The Project may generate vibration and dust which may have a minor effect on these places.

Trees of the Former CS & IR Experiment Station

The Project design would retain the two trees (subject to indirect impacts from the construction works). Any direct impact on the trees would be avoided through appropriate mitigation measures such as exclusion fencing to protect root zones (refer to section 8.4 of this EIS).
Northbourne Housing Precinct

The construction of the Project along Northbourne Avenue between the two sides of the Northbourne Housing Precinct, including the Macarthur Avenue stop, would not impact on the precinct’s historic and architectural values. Some views to the buildings from Northbourne Avenue would be partially obscured by hoardings during construction works; however, these views would be reinstated following completion of the works and would not constitute a permanent impact on their heritage significance. The creation of a construction compound at the present location of the Canberra Tourist Office carpark has the potential to cause some damage to the buildings from increased vibration and dust; however this impact is minor.

Former AAA Building and Churchill House (Open Systems House)

The proposed construction works in the Northbourne Avenue median and the new light rail infrastructure and median plantings would not impact on the features intrinsic to the AAA building and the significant elements noted in the nomination for Churchill House. Some views to the buildings from Northbourne Avenue would be partially obscured by hoardings during construction works; however, these views would be reinstated following completion of the works and would not constitute a permanent impact on their heritage significance.

Expansion Mosaic Mural Wall

The Project is unlikely to have an impact on the heritage values of the mosaic. Vibration from construction and operation would be limited and monitored to avoid any detrimental impact on its fabric.

Haig Park

Two trees are proposed to be removed at the intersection of Masson Street and Northbourne Avenue adjacent to Haig Park. These trees are general street trees and not part of the Haig Park historic plantings. The erection of construction hoardings within Northbourne Avenue would obstruct views across the avenue from one side of the park to the other and would have a moderate temporary impact on the heritage significance of the park. The permanent infrastructure for the light rail would be present in these views, but would not obstruct them. The impact of removing the Northbourne Avenue trees would be substantially mitigated by the planting of new trees in this area (refer to Chapter 8 of this EIS).

Havelock House

The potential impact of the Project on Havelock House by light rail infrastructure substantially blocking views of the building from Northbourne Avenue is unlikely as the proposed Elouera Street stop is located north the Gould Street junction with Northbourne Avenue. The impact of other Project infrastructure on these views would be minor to none.

Coggans Bakery, Elouera Street

Coggans Bakery is located to the east at 36 Elouera Street, Braddon, around the corner from the proposed substation. The location of a light rail substation at this location would not impact on the features intrinsic to Coggans Bakery.

NRMA House

The proposed Elouera Street stop on Northbourne Avenue is aligned with the NRMA House building. Given the proposed design of the stop, it is unlikely to impact on the likely features intrinsic to significance of NRMA House, if it is entered in the ACT Heritage Register. The proposed construction works in the Northbourne Avenue median and the new light rail infrastructure and median plantings would not have an impact on the significant elements noted in the nomination for NRMA House.
Some views to the buildings from Northbourne Avenue would be partially obscured by hoardings during construction works; however, these views would be reinstated following completion of the works and would not constitute a permanent impact on their heritage significance.

Melbourne and Sydney buildings

The proposed Alinga Street stop would be located on the northern side of Alinga Street, to the north of the Melbourne and Sydney buildings. The stop would be a terminus, with the split platforms directly opposite each other. The proposed location of the stop would not have an impact on the significant visual relationship between the Melbourne and Sydney buildings. The stop would partially obscure diagonal views from the north towards the buildings. This would have a minor impact on their setting.

The proposed construction compound on London Circuit immediately to the south of the Melbourne building, although temporary for the duration of the construction phase, may impact on the building from the increase in dust and vibration generated. The compound would also impede on views to the building from the roadway around City Hill to the south. This would have a minor, temporary impact on the setting of the Melbourne building, which would be mitigated when hoardings are removed.

City Hill

Infrastructure associated with the Project, especially the two construction compounds on London Circuit, have the potential to have an impact on views to City Hill south along Northbourne Avenue. The Alinga Street stop has the potential to partially obstruct distant views of City Hill from Northbourne Avenue. However, as views would still be available from the traffic lanes of Northbourne Avenue on either side of the median, these impacts would be minor.

6.3.2 Impacts to the Federal Highway and Northbourne Avenue heritage values

Federal Highway

The portion of the Federal Highway included in the light rail project area has no identified heritage values or structures apart from the trees of the former CS & IR Experiment Station, most of which are located at the eastern end of Swinden Street outside the alignment of the Project. Two trees remaining from the original tree plantings at the western end of Swinden Street are on the boundary of the Project impact footprint (refer to section 6.3.1 of this EIS).

The landscape structure of the Federal Highway between the Flemington Road intersection and the start of Northbourne Avenue consist of dense plantings of exotic species on either side of the road, and some scattered median plantings of eucalypts between the Flemington Road and Barton Highway intersections. There are no median plantings along Northbourne Avenue between the Barton Highway intersection and the Antill Street/Mouat Street intersection. There are no identified Remembrance Driveway plantings in this area.

While the plantings, especially the screening plantings of ornamental exotic species, indicate that the route is approaching a planned urban centre, none of these plantings have potential or listed heritage values. The Project would remove the scattered median plantings between Flemington Road and the Barton Highway, but the dense plantings on either side of Federal Highway south of Flemington Road would be retained. The median grass would be replaced with mass planting of low vegetation.
Northbourne Avenue

The fabric and spatial composition of the Northbourne Avenue road reserve has changed over time as different planting regimes have been instated and as the urban area has extended north from Civic. The original spatial composition of Northbourne Avenue comprised a wide road with a planted median and built form set back within landscaped grounds on either side. The plantings have been replaced twice, but the essential spatial composition of the avenue remains. This spatial composition contributes to the sense of arrival and procession that part of Northbourne Avenue’s heritage values.

To date there have been no substantial built elements within the median, although the side road reserves have had bus stops and traffic signs erected along them over time, all of which reinforce the entrance avenue function of the route.

The proposed light rail tracks, poles, overhead wires and stops in the Northbourne Avenue median would represent a continuation of the road reserve’s adaptation over time to fulfil its function as the ceremonial entrance route to Canberra from the north. The introduction of built form for the light rail will alter the spatial composition of the median to some extent; however the proposed reinstatement of plantings along on either side of the light rail line would ensure that landscape elements continue to dominate the median and that significant impacts to the potential heritage values of the route will be avoided.

The new spatial composition of replacement trees, light rail infrastructure and stops along the median would reinforce the linear nature of the route in its intended purpose as the entrance route to Central Canberra from the north, and would not constitute a significant impact.

6.3.3 Impacts to National Heritage Listed areas

Northbourne Avenue

Northbourne Avenue is one of the major avenues identified in the combined NHL nomination as discussed in section 6.1 of this EIS. Other roads in Canberra affected by the Project are also identified in the combined NHL nomination. These are roads having a junction with Northbourne Avenue and include: Macarthur Avenue and Wakefield Avenue; Masson Street and Girrawheen Street; Gould Street and Elouera Street; Mort Street; Barry Drive and Cooyong Street; Rudd Street and Bunda Street; Alinga Street and London Circuit (refer to Figure 6.2).

The potential heritage impacts to Northbourne Avenue and the potential NHL values and attributes, sensitivity to change as a result of the Project are summarised in Table 6.4.
### Table 6.4 Northbourne Avenue potential NHL values and attributes, sensitivity to change and potential heritage impacts

<table>
<thead>
<tr>
<th>Heritage values and attributes</th>
<th>Sensitivity to change</th>
<th>Heritage Impact Assessment</th>
</tr>
</thead>
</table>
| The association with early Griffin planning for Canberra which is still evident in the avenue’s:  
  - width  
  - route  
  - location adjoining the Federal Highway and leading to the city  
  - function as a grand processional and ceremonial entry to Canberra. | High Sensitivity to Change  
  The Project alignment has high integrity. Its location and alignment has not been altered and it still performs its intended function as a processional entry to Canberra City. Northbourne Avenue has been ‘a work in progress’ over many decades and the concept of its design intent can still be developed.  
  Northbourne Avenue’s position as the processional entrance to Canberra from the north should be retained by maintaining its alignment, direction, generous width and aesthetic character. | The Project would retain Northbourne Avenue’s existing alignment and width. It has the potential to reinforce the road’s processional character through proposed light rail lines and plantings which would provide further directional strength to the route despite the construction of new elements within the road’s wide median.  
  The Project would not have an adverse impact on this aspect of Northbourne Avenue’s heritage values. |
| The route treatment as a grand wide processional entrance to the federal capital with progression along the route marked with large trees that significantly contribute to Canberra’s urban forest. | High Sensitivity to Change  
  The generous planting of the median and verges with consistent species choice throughout the route provides a strong sense of direction and processional entry along Northbourne Avenue and focus attention on the vista to City Hill.  
  Planting in offset double rows gives the impression of denser planting when viewed from the side. This planting pattern is also found elsewhere in Canberra, particularly within the Central National Area.  
  The width of the road reserve and the generous planting of its median and verges are both essential heritage attributes of the avenue, but a change in species would be acceptable given previous replanting of the Project alignment. | The trees along Northbourne Avenue are not entered on the ACT Heritage Register. The present trees are the third set of plantings and can be replaced.  
  The Project proposes the use of a consistent single species along the median, which is essential for the processional qualities of Northbourne Avenue (refer to Chapter 8).  
  In the short term, while the light rail is being constructed and all trees have been removed, the heritage impact of the Project would be considered to be severe.  
  This impact would be mitigated by the proposed replacement plantings along the median and verges. The permanent impact of the Project on this aspect of Northbourne Avenue’s heritage values (in the long term) would be minor. |
| A route with landscaping responding to historic ideas and ideals of the Garden City with open landscaped boundaries. | High Sensitivity to Change  
  The garden setting for several of the listed heritage places along the route is clearly discernible and also noted in their heritage listings. Landscaped boundaries to the route are an important part of its heritage values.  
  The open aspect to Northbourne Avenue verges/nature strip adjacent to residential areas should be maintained by sensitive complementary development incorporating landscaping. | Verge trees that are to be removed by the Project would be replaced as part of the planting scheme. The landscaped settings for heritage places beyond the verge will not be affected by the Project.  
  The Project would not have an impact on this aspect of Northbourne Avenue’s heritage values. |
| A route which provides views to important landscape features and the hills surrounding the city. | High Sensitivity to Change  
  The route has high integrity in this respect. Views to Mt Ainslie and Black Mountain would be retained wherever possible and to City Hill in particular. | The construction works would inhibit views along Northbourne Avenue towards City Hill. This would be a temporary, minor impact on this aspect of Northbourne Avenue’s heritage values.  
  The proposed Alinga Street stop may partially obstruct views to City Hill, which would be a permanent minor impact on the heritage values of Northbourne Avenue. |
Heritage values and attributes | Sensitivity to change | Heritage Impact Assessment
--- | --- | ---
A route providing a sense of arrival through a variety of ‘gateways’ or monumental progression points resulting from the urban built form or landscaping at important junctions or landmarks. | **High Sensitivity to Change**<br>The Project alignment was deliberately planned with a variety of ‘gateways’ to provide a sense of arrival and progression, but urban renewal and the historical process have reduced their impact over the years.<br>The Haig Park green belt is an important progression point, as is the clear visibility of the Melbourne and Sydney buildings framing views to City Hill. | The removal of trees and erection of construction hoardings would have a moderate impact during the construction phase of the Project.<br>This impact would be mitigated in the long term by the proposed replacement plantings. The light rail would also emphasise the sense of progression along Northbourne Avenue.<br><br>A route with quality architectural development as recognised from several heritage listings of the best examples of particular styles from a variety of eras. | **High Sensitivity to Change**<br>The importance of the route as one of the premier roads of Canberra attracted high-quality design for a particular era in both commercial and residential developments.<br>Quality design should continue to mark Northbourne Avenue as a premier road and important entrance route with likely National Heritage values. | No development is proposed by the Project on either side of Northbourne Avenue. No buildings are proposed to be demolished.<br>The proposed new stops within Northbourne Avenue are of a high quality would employ high-quality materials.<br>The Project would not have an impact on this aspect of Northbourne Avenue’s heritage values.

Further details regarding the potential NHL values and attributes of Northbourne Avenue, the sensitivity to change and potential heritage impacts that may occur as a result of the Project are detailed in section 7.4.2 of the **Heritage Impact Assessment** (Technical Paper 2).

**Gungahlin**

The contribution of Gungahlin to the potential heritage values of Canberra, the Planned National Capital, arises from its establishment as part of the ‘Y-Plan’ for future development of the city planned by the National Capital Development Commission (now NCA). The Project would reinforce Gungahlin’s role as a town centre and follows the existing connecting route from the City.

Further detail regarding the heritage significance of Northbourne Avenue and the Federal Highway, is provided in Chapter 6 and Chapter 7 of the **Heritage Impact Assessment** (Technical Paper 2).

**6.3.4 Potential impacts to Aboriginal heritage**

Predictive modelling and previously recorded sites in the landscape around the project area indicate there are areas of unknown Aboriginal archaeological sites. These areas are discussed below.

**Southwest part of the proposed stabling depot and maintenance facility site**

The proposed stabling depot and maintenance facility site has the potential for archaeological deposits in the south-western part of the site and therefore any works in or around the remaining stands of trees and along the southern half of the western end of the site have the potential to have an impact on archaeological deposits. This zone of archaeological potential is shown on Figure 6.3.
Proposed construction compound on Flemington Road at Gungahlin

As the nature and extent of the works for the construction compound are unknown at this stage, it is assumed the impacts would cover the whole construction site. This site has a potential scarred tree at the eastern end and the potential for unknown archaeological deposits. Any works within this area may have an impact on unknown archaeological deposits.

Federal Highway and Northbourne Avenue

There are no predicted Aboriginal archaeological risks associated with the alignment along the Federal Highway or Northbourne Avenue.

6.3.5 Potential impacts to burial sites

No burials or graves sites have been recorded on the ACT Heritage Register within the Project area. Previous research on rural graves in the ACT indicates that the territory contained many ‘dispersed cemeteries and graves sites which date from the nineteenth and early twentieth centuries prior to the passing of the Public Cemeteries Act in 1936’. Many formal and informal burials were recorded and are known, although ‘bush burials’ (low key burials that were not in church land and often not recorded) were common in the early to mid-nineteenth century. Many such bush burials were close to the family home or rural homestead.

A range of public and private cemeteries, church graveyards, and private individual/family graves have all been historically recorded around the ACT including some in the north at Ginninderra, Glenburn, Amaroo within the Majura Valley). Only one of these many known locations is within moderately close proximity to the study area — a private and unmarked burial plot at Gungaderra Homestead (formerly Red Hill Station). This burial site is recorded as containing the graves of three babies, although there do not appear to be any records of confirmation.
While the Flemington corridor section of the Project traverses the former property of the Gungaderra station, it is far enough from the homestead that it would seem unlikely that there would be additional grave sites that would be impacted by the Project.

Despite the historically rural nature of the study area, the recent intensive development for the northern suburbs of Canberra is most likely to have already exposed any unknown burial sites that may have occurred near the alignment. Therefore it is anticipated that the potential for unknown burials to be inadvertently unearthed during construction works would be low.

6.3.6 Potential impacts to registered historical archaeology sites

As noted in section 6.1, three registered historical archaeological features have been identified in close proximity to the Project. The potential impact of the Project on these sites is discussed below.

C2/H5 culvert

C2/H5 is listed as a culvert on Flemington Road between Manning Clarke Crescent and Kate Crace Street. The ACT Heritage Unit has no additional data regarding this item and it is believed that it was destroyed during the construction of Flemington Road. However, as its condition had not been determined, its registered location was inspected during the site inspection undertaken for the preparation of the Heritage Impact Assessment.

No evidence was found of the item. The Project is therefore unlikely to impact this heritage item.

James Cooper historic site

The James Cooper Historic Site (listed as item CDHS NC41) is located approximately 200 metres to the south of the proposed stabling depot and maintenance facility area (refer to Figure 6.1a). The listing information includes the following description: ‘Mature exotic trees and early excavation pits, may have potential archaeological deposits, to be further investigated’. During the inspection of the proposed stabling depot site, attention was paid to the possibility that ‘excavation pits’ relating to this feature or any other historic remains relating to it might exist.

No historic or historical archaeological features within the proposed stabling depot and maintenance facility area were found during the inspection. Furthermore, no historic or historical archaeological features were visible through the fence line to the south of the property, in the direction of the supposed location of this feature. In the absence of any further detailed information, there is no evidence of the James Cooper historic site within the Project impact footprint, and would therefore not be impacted by the Project.

Gubur Dhaura

The Gubur Dhaura site is not only an Aboriginal ochre quarry but also a historic mining area. The site retains evidence of late nineteenth and early twentieth century surface exploration and mining activity mainly for pipeclay (kaolin) as well as for iron ore and ironstone gravels. Evidence of these activities remains in landscape modifications including extraction pits and shafts. At its closest point, the boundary of this site is approximately 90 metres from the road easement of Flemington Road. The historic heritage values of this feature would not be impacted by the Project. This known listed area would be avoided for all works staging and construction activities.
Other historic remains

The Flemington Road portion of the Project passes through land dominated by pastoral holdings from the late 19th century well into the twentieth century. Parts of the Gungahlin area were occupied by pastoral properties such as Well Station and Gungaderra; both of which are in approximately 300 metres east of Project alignment on Flemington Road. These areas were predominantly sheep grazing and cultivation — activities that would have left little or no substantial evidence in the archaeological record. Therefore the archaeological potential of this part of the Project impact footprint would be low.

The Northbourne Avenue portion has been subject to a range of suburban developments over the last century. The main focus of the Project along the central corridor of Northbourne Avenue is unlikely to have an effect on any archaeological remains as the roadway has been maintained along the same alignment and configuration since its creation. Its establishment would have destroyed any archaeological evidence of earlier land use.

6.4 Proposed mitigation measures and offsets

General measures

The following mitigation measures would be applicable to mitigating impacts on historic heritage values across the Project:

Detailed design

- Heritage specialists would be involved in the detailed design and documentation phase of the Project. They would also liaise with the teams selected to carry out the construction works to ensure that the recommended mitigation measures are implemented and impacts on heritage items and sites minimised.

- A landscape and planting scheme would be developed for Northbourne Avenue and Federal Highway would be implemented and its long-term viability ensured through the preparation of a landscape maintenance plan and sufficient funding allocated for ongoing maintenance. This plan is detailed in the Landscape Character and Visual Impact Assessment (Technical Paper 4) which forms part of the overall environmental impact statement for this Project.

- Detailed design of the light rail stops would aim to minimise impacts on heritage items in terms of form, scale and materials. The open, lightweight and low profile structures of contemporary design proposed would minimise visual impacts on key views to heritage buildings. The balance of glazing to opaque materials would be maximised. The use of highly reflective materials would be avoided to ensure the stops are recessive in the landscape.

- Where above-ground substations are proposed, they would be designed to minimise impacts on heritage items in the vicinity by minimising their scale and careful design of form and materials. Landscaping would be used to screen the substations where appropriate. In principle, low-profile structures of contemporary design, utilising complementary materials and details that minimise visual impacts on key views to heritage items, would be appropriate.

- An interpretation strategy would be developed for the Project and implemented during construction and prior to operation of the light rail. It would provide strategies for providing permanent interpretation along the Project route and for mitigating the temporary impacts on the Northbourne Avenue landscape during construction.

- Opportunities to interpret the history and significance of heritage items along the Project route during and following construction would also be investigated in the development of the interpretation strategy.
Construction

- Construction compounds would be rationalised (where possible) and associated services would be grouped to reduce the amount of excavation and new structures required, to minimise impacts on Aboriginal archaeological resources in the stabling depot and maintenance facility and the Gungahlin construction compound. Where possible, services (permanent and temporary) would be installed in existing service trenches to minimise disturbance to areas of Aboriginal archaeological potential.

- All contractors working on the Project would receive a heritage induction that identifies potential Aboriginal archaeological issues and minimises construction risk impacts to built and landscape heritage items.

- Photographic recording of any heritage items/areas affected by the Project would be undertaken in accordance with the relevant NSW Heritage Council guidelines.

Historic heritage

Canberra, the Planned National Capital

- The proposed landscape design, particularly the Northbourne Avenue trees, grass and urban meadows, would be implemented to reinstate the avenue’s significant processional landscape character.

- The landscape’s long-term viability would be ensured through preparation of a landscape maintenance plan and allocation of sufficient funding for maintenance.

- The history and heritage values of Canberra would be interpreted along Northbourne Avenue in the construction and operation phases of the Project, through the integration of interpretive signage into temporary construction hoardings and in permanent infrastructure.

Northbourne Avenue

- The proposed landscape design, particularly the Northbourne Avenue trees, grass and urban meadows, would be implemented to reinstate the avenue’s significant processional landscape character.

- The history and heritage values of Northbourne Avenue and its contribution to the Canberra plan would be interpreted in the construction and operation phases of the Project through the integration of interpretive signage into temporary construction hoardings and in permanent infrastructure.

- A general photographic archival recording of Northbourne Avenue from City Hill to Anthill/Mouat Street would be undertaken to record the current landscape of the avenue prior to works commencing.

Trees of the Former CS & IR Experiment Station

- Arborist’s advice would be sought for the protection of the two listed trees on the edge of the Swinden Street construction site. Arborist’s advice would be sought in relation to a buffer zone near the trees in the Project construction and operation stages to safeguard their survival as original plantings and historic markers.

- If any above-ground works are required in the vicinity of the trees, tree trunks would be protected.

- Opportunities for interpretation of the history and heritage values of the CS & IR Experiment Station would be explored.

Expansion Mosaic Mural Wall

- The condition of the Expansion Mosaic Mural Wall would be monitored during construction works.
Haig Park

- Arborist’s advice would be sought for the protection of trees and their root zones in Haig Park during construction. Arborist’s advice would be sought in relation to a buffer zone near the trees in the Project construction and operation stages to safeguard their survival as historic plantings. If any above-ground works are required in the vicinity of the trees, tree trunks would be protected.

Melbourne and Sydney buildings

- Opportunities for interpretation of the history and heritage values of Melbourne and Sydney Buildings and their contribution to the significance of Canberra would be explored.

City Hill

- All permanent Project infrastructure would be designed to avoid any substantial impacts on the view to City Hill from Northbourne Avenue.

- Interpretation of the history and heritage values of City Hill as part of the Griffin Plan for Canberra would be included in the interpretation strategy. Permanent interpretation at the Alinga Street stop and temporary interpretation on and temporary interpretation on the construction hoardings around the London Circuit compounds during the construction phase would be explored.

Historical Archaeology

- Construction personnel would be informed during site induction of the possibility of encountering of unexpected archaeological remains and the existence of an unexpected finds protocol.

- The following protocols would be adopted following unexpected finds:
  - If archaeological relics or remains are found during construction work, all work in the immediate area of the find would cease.
  - The site area would be secured by the construction site manager and an archaeologist must be called to the site to assess the nature and significance of the find.
  - The archaeologist will assess the required management of the find based on its significance and in conjunction with the construction site manager.
  - Construction work would resume after the implementation of appropriate mitigation measures.

Aboriginal Heritage

General

- CMA would provide an update to the RAOs on any proposed measures to establish a sustainable plan for ongoing training and employment opportunities for members of the Aboriginal community including options for operations phase work opportunities and maintenance works for the system.

- CMA/Project Co would explore opportunities for design and graphic input from the Aboriginal community for other themes and motifs for external LRV paint and design as well as interior fabrics and other elements of the project including paving, stops, substations, etc.

- All construction personnel would be provided with a cultural awareness induction from the RAOs. This cultural awareness induction would serve to outline the significance of areas of the route to Aboriginal people and to alert construction personnel to the possibility of unexpected finds during the work, and the nature of those potential finds.
The Project would adopt the following unexpected finds protocol:

- If Aboriginal archaeological artefacts, sites or remains are found during construction work all work in the immediate area of the find would cease.
- The site area would be secured by the construction site manager and the RAOs and an archaeologist must be called to the site to assess the nature and significance of the find.
- The RAOs and the archaeologist will assess the required management of the find based on its significance and in conjunction with the construction site manager.
- Construction work would resume after the implementation of appropriate mitigation measures.

Where human skeletal remains are unexpectedly found during the construction work the following protocol would be adopted:

- The site area would be secured by the construction site manager and the police would be informed along with the RAOs, ACT Heritage and an archaeologist.
- Further action would depend upon the nature of police investigation. Where the remains are deemed to be or historic in nature and not from a recently deceased person, the RAOs and archaeologist will assess the required management of the find based on its significance and in conjunction with the construction site manager.
- This protocol would apply for either suspected Aboriginal or non-Aboriginal skeletal remains. All remains would be assumed to be potentially Aboriginal in nature unless there are other immediately clear circumstances to suggest otherwise. Further assessment of any cultural characteristics of the remains would be conducted as part of the assessment process.

Stabling depot and maintenance facility site

The southern side of the west end of the Depot Facility site is considered to have some potential as a Potential Archaeological Deposit (PAD). Therefore, the following measures would be implemented:

- Archaeological test pitting would precede any proposed impacts to the PAD area.
- The RAOs would be invited to participate in any archaeological test pitting program.

Proposed construction staging site, Flemington Road, Gungahlin

- All trees on the site would be retained and fenced during construction.
- A specific development plan for the construction compound would be forwarded to the RAOs for their understanding of the proposed impacts to the area.
- Any proposed impact areas would be subject to further archaeological investigation including surface scraping with a grader (for widespread areas) and artefact collection, or a specific program of test pitting.

6.5 Expected conditions

The Project would be sensitively and carefully designed to ensure the landscape character of Northbourne Avenue would be reinstated as part of the Project and the potential National Heritage values of Canberra, the Planned National Capital are conserved. When fully implemented and mature, the proposed landscaping works would be an improvement on the current landscape of the corridor and would enhance the heritage values of Northbourne Avenue.
The Project would be compatible with the potential National Heritage values of Canberra through its enhancement of Northbourne Avenue as the main processional entry to Canberra, which was part of the Griffin plan, and the connection to Gungahlin town centre, which would affirm the Y-plan phase of Canberra’s planning. The Project would not have any permanent moderate or severe impacts on historic heritage along its alignment.

6.6 Residual risks

Based on the mitigation measures identified in section 6.4, an assessment of the residual non-Indigenous and Indigenous heritage risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 6.5.

<table>
<thead>
<tr>
<th>ID</th>
<th>Potential impact</th>
<th>Original residual risk rating</th>
<th>Residual likelihood</th>
<th>Residual consequence</th>
<th>Residual risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1</td>
<td>Potential to result in direct impacts to existing heritage buildings and/or curtilages as a result of establishing light rail infrastructure in the vicinity of heritage items.</td>
<td>Medium</td>
<td>Remote</td>
<td>Major</td>
<td>Low</td>
</tr>
<tr>
<td>B.2</td>
<td>Potential to result in impacts to the proposed ‘Canberra the Planned National Capital’ National Heritage Listed area, which includes a portion of the southern end of Northbourne Avenue.</td>
<td>High</td>
<td>Likely</td>
<td>Positive</td>
<td>Beneficial</td>
</tr>
<tr>
<td>B.3</td>
<td>Potential to result in indirect impacts to existing heritage places and/or curtilages as a result of changes to the heritage and landscape character of the area, particularly along Northbourne Avenue.</td>
<td>High</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>
| B.4 | Potential to result in Loss or damage to Aboriginal archaeological potential or places with Aboriginal cultural values, in particular within the northern portion of the study area as a result of land clearing and or excavation works. Particular areas for investigation include:  
  - the stabling depot and maintenance facility  
  - part of the alignment on Flemington Road that crosses the end of the Gurbur Dhaura ridgeline  
  - part of the alignment between Well Station Drive and Lysaght Street  
  - any areas outside the currently identified Project footprint. | Medium | Unlikely | Moderate | Low |
| B.5 | Impact to burial sites during construction including discovery of historic/European and/or Aboriginal burials. | Medium | Remote | Major | Low |
| B.6 | Potential for impacts on registered historical archaeology sites including:  
  - the James Cooper’s Historic Site  
  - an existing culvert on Flemington Road  
  - Gurbur Dhaura (Aboriginal Ochre Quarry and Historic Mining Area. | Medium | Remote | Major | Low |

Note for residual risk ID B.2: The consequence of this risk has been reduced as the proposed tree planting strategy that would be implemented by the Project (including planting of more appropriate tree species) would provide long term overall benefits.
7. Noise and vibration

This Chapter outlines the potential noise and vibration impacts associated with the construction and operation of the Project. This Chapter provides a summary of the *Noise and Vibration Impact Assessment* prepared by SLR Consulting and contained as Technical Paper 3 in Volume 2 of this EIS.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential noise and vibration risks presented in Table 7.1 below.

<table>
<thead>
<tr>
<th>ID</th>
<th>Potential impact</th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1</td>
<td>Increased noise and vibration from construction plant, equipment, trucks and vehicles</td>
<td>Almost Certain</td>
<td>Moderate</td>
<td>Very high</td>
</tr>
<tr>
<td>C.2</td>
<td>Construction vibration that exceeds adopted criteria for human comfort and adopted criteria for cosmetic damage to buildings.</td>
<td>Possible</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>C.3</td>
<td>Increase in noise for noise sensitive receivers including:</td>
<td>Almost Certain</td>
<td>Moderate</td>
<td>Very high</td>
</tr>
<tr>
<td></td>
<td>• increased noise due to operation of light rail vehicles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• including elements such as warning bells</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• increase in noise around the proposed depot location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• noise from fixed project elements such as substations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.4</td>
<td>Potential for increased levels of vibration due to operation of light rail vehicles.</td>
<td>Possible</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>C.5</td>
<td>Operational vibration affecting vibration sensitive equipment.</td>
<td>Possible</td>
<td>Major</td>
<td>High</td>
</tr>
</tbody>
</table>

7.1 Environmental conditions and values

7.1.1 Existing noise environment

The Project is located in urban and suburban environments and within an established road corridor. The Project alignment would pass through, or adjacent to, the following areas:

- Gungahlin Town Centre
- Harrison
- Franklin
- Kenny (possible future suburb)
- Mitchell
- Watson
- Downer
- Lyneham
- Turner
- Braddon
- Canberra Civic Centre.
The existing ambient noise environment is variable. Within the city, it is influenced by a general urban hum from mechanical plant and pedestrian activities, with existing noise levels generally higher than in the surrounding suburbs. In the suburban areas, the ambient noise decreases during the evening and night-time in locations where road traffic decreases from daytime volumes. The primary noise influence surrounding the Project alignment is road traffic noise.

For the purpose of the noise and vibration impact assessment (NVIA) discussed in section 7.2 below, the Project area has been divided into three main precinct areas (Canberra Civic Centre, Inner North Canberra and Gungahlin District) which reflect the land uses adjacent to the Project together with corresponding Noise Catchments (NCs) that have been used to represent each of the three precincts (refer to Table 7.2).

The locations of the various NCs are shown on Figure 7.1a to Figure 7.1g.

### Table 7.2 Precincts and noise catchment areas

<table>
<thead>
<tr>
<th>Precinct/Locality</th>
<th>NC</th>
<th>Description of Suburbs/Areas Included in NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canberra Civic Centre</td>
<td>NC01</td>
<td>Civic</td>
</tr>
<tr>
<td>Inner North Canberra</td>
<td>NC02.1</td>
<td>Braddon and Turner</td>
</tr>
<tr>
<td></td>
<td>NC02.2</td>
<td>Dickson and Lyneham (South of Mouat Street)</td>
</tr>
<tr>
<td></td>
<td>NC02.3</td>
<td>Lyneham (North of Mouat Street)</td>
</tr>
<tr>
<td></td>
<td>NC02.4</td>
<td>Downer and Watson</td>
</tr>
<tr>
<td>Gungahlin District</td>
<td>NC03.1</td>
<td>Mitchell (and possible future suburb of Kenny)</td>
</tr>
<tr>
<td></td>
<td>NC03.2</td>
<td>Franklin and Harrison</td>
</tr>
<tr>
<td></td>
<td>NC03.3</td>
<td>Gungahlin town centre and residential suburb</td>
</tr>
</tbody>
</table>

#### 7.1.2 Noise sensitive receivers

 Receivers that are potentially sensitive to noise and vibration have been categorised into the following:

- residential (including hotels, motels etc.)
- education Institutions (including schools, child-care centres)
- commercial
- places of worship
- industrial
- outdoor recreation areas
- other (TV/radio studios, conference centres).

Table 7.3 summarises the potential noise and vibration-sensitive receivers located along the Project alignment. Residential premises are likely to be the most sensitive receivers on this route. The minimum distances between the preliminary alignment and the nearest residential receivers are summarised for each NC.

The locations of the identified sensitive receivers along the Project alignment are shown on Figure 7.1a to Figure 7.1g.
Source: SLR Consulting, Technical Paper 3

**Figure 7.1a** Noise catchment areas and sensitive receivers along the Project alignment
Source: SLR Consulting, Technical Paper 3

Figure 7.1b  Noise catchment areas and sensitive receivers along the Project alignment
Figure 7.1bc  Noise catchment areas and sensitive receivers along the Project alignment
Figure 7.1d  Noise catchment areas and sensitive receivers along the Project alignment
Source: SLR Consulting, Technical Paper 3

**Figure 7.1e** Noise catchment areas and sensitive receivers along the Project alignment
Source: SLR Consulting, Technical Paper 3

Figure 7.1f Noise catchment areas and sensitive receivers along the Project alignment
Figure 7.1g  Noise catchment areas and sensitive receivers along the Project alignment

Source: SLR Consulting, Technical Paper 3
## Table 7.3 Existing noise and vibration sensitive receivers

<table>
<thead>
<tr>
<th>Noise catchment area precinct/ Locality</th>
<th>Description</th>
<th>Address</th>
<th>Receiver type</th>
<th>Minimum horizontal distance from the alignment (m)¹,²</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC01 Civic</td>
<td>Novotel</td>
<td>65 Northbourne Avenue, Civic</td>
<td>Residential</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Canberra City Uniting Church</td>
<td>69 Northbourne Avenue, Civic</td>
<td>Place of Worship</td>
<td>30</td>
</tr>
<tr>
<td>NC02.1 – Braddon and Turner</td>
<td>Closest units at Northbourne Flats</td>
<td>Various at 3 Forbes Street/ 65 Henty Street</td>
<td>Residential</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Various multi-unit/ mixed use residential</td>
<td>Various</td>
<td>Residential</td>
<td>30</td>
</tr>
<tr>
<td>NC02.2 Dickson/Lyneham (South of Mouat Street)</td>
<td>Various residential</td>
<td>Various</td>
<td>Residential</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>ABC Canberra</td>
<td>Corner Northbourne &amp; Wakefield Avenue, Dickson</td>
<td>TV/Radio Studio</td>
<td>75</td>
</tr>
<tr>
<td>NC02.3 Lyneham (North of Mouat Street)</td>
<td>Southwell Park Rugby League club</td>
<td>Northbourne Avenue, Lyneham</td>
<td>Open space – active use (sports field, golf course)</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Netball ACT</td>
<td>Northbourne Avenue, Lyneham</td>
<td>Open space – active use (sports field, golf course)</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Yowani Country Club Golf Course</td>
<td>Northbourne Avenue, Lyneham</td>
<td>Open space – active use (sports field, golf course)</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Yowani Country Club Motel</td>
<td>Northbourne Avenue, Lyneham</td>
<td>Residential</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>EPIC Conference Centre</td>
<td>Corner Flemington Road and Northbourne Avenue, Lyneham</td>
<td>Conference Centre</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>EPIC Horse Stabling Blocks</td>
<td>Off Flemington Road, Lyneham</td>
<td>Horse stables</td>
<td>65</td>
</tr>
<tr>
<td>NC02.4 Downer and Watson</td>
<td>Closest houses in Downer</td>
<td>Approx. 570–582 Northbourne Avenue</td>
<td>Residential</td>
<td>45</td>
</tr>
<tr>
<td>NC03.1 Mitchell</td>
<td>National Archives of Australia</td>
<td>Corner Flemington Road and Sandford Street</td>
<td>Other</td>
<td>20</td>
</tr>
<tr>
<td>NC03.2 Franklin and Harrison</td>
<td>Various multi-unit residential</td>
<td>Typical closest receivers</td>
<td>Residential</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Urban Open Space</td>
<td>Block 4 Section 47, Franklin</td>
<td>Open space – passive use (parkland, bush, reserves)</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Harrison School</td>
<td>Wimmera Street, Harrison</td>
<td>Educational institution</td>
<td>135</td>
</tr>
</tbody>
</table>
7.2 Investigations

A Noise and Vibration Impact Assessment (NVIA) was prepared by SLR Consulting Australia to assess the Project (Technical Paper 3). The NVIA was prepared to address potential noise and vibration impacts associated with the construction and operation of the Project.

7.2.1 Assessment approach

The Project would be the first light rail development in the ACT, and as such, there is no preceding noise and vibration assessment methodology in ACT legislation or guidance. Section 8 of the ACT Environment Protection Act (the EPA Act) (ACT Parliamentary Counsel 1997) lists a number of sources to which the EPA Act does not apply. Noise from ‘a train’ is listed as exempt. A statement from the ACT EPA and CMA (18 February 2015) confirmed that this exemption extends to operational noise from light rail vehicles.

CMA, in consultation with the EPD, has proposed that, as the Project has no precedent for such a Project in the ACT, and that ‘major road’ is the closest analogous construction project discussed in the Regulation, construction work for the Project will be assessed as though it were a major road. As such, construction work for the Project would be assessed as though it were a major road, and therefore not be subject to numerical noise limits.

The following assumptions for assessment requirements have been made following consultation with the ACT EPA, CMA and other stakeholders.

- Noise and vibration from operation of the Project has been assessed in accordance with guidance provided by the NSW EPA in the Rail Infrastructure Noise Guideline (RING). This means that, although not covered by ACT legislation, the potential noise impact to the community would be assessed and mitigation measures would be considered, where feasible and reasonable.

- As required by the RING, vibration from operation and construction of the light rail line has been assessed in accordance with Assessing Vibration: A Technical Guideline, DEC, 2006 (the NSW Assessing Vibration guideline).
Noise from stabling depot and maintenance facility site, stops and electrical substation has been assessed in accordance with the requirements of the Regulation, as clarified by the ACT EPA Noise Environment Protection Policy (the Policy), as for other fixed noise sources in the ACT.

The assessment of noise and vibration has included:

- ambient noise surveys to determine the existing noise environment within the surrounding environment of the Project
- identification of receivers along the alignment potentially sensitive to noise and vibration
- prediction of noise and vibration from the construction and operation of the light rail line, including stabling yard and maintenance depot, stops and ancillary infrastructure
- assessment of potential noise and vibration impacts in accordance with relevant legislation and guidelines
- identification of potential improvement to existing noise environments as a result of the Project
- the recommendation of management and mitigation measures to reduce and control potential impacts where noise and vibration levels are predicted to be above the assessment criteria.

### 7.2.2 Identification of noise sensitive receivers

The sensitivity of receivers to noise and vibration is dependent upon the purpose of the occupancy and the nature of the activities performed within the affected premises. Sensitivity to noise is a subjective response varying for different individuals and can depend on the existing noise environment.

The identification of noise sensitive receivers was undertaken as part of the NVIA and the nearest of these receivers are identified in Table 7.3 above.

### 7.2.3 Ambient noise surveys and monitoring locations

A baseline noise survey was undertaken for the Project in March/April 2014 and was supplemented by noise measurements taken in 2010 and 2011. The baseline noise survey was undertaken to quantify and characterise the existing ambient noise environment across the Project area.

Noise monitoring locations were selected to be representative of receivers and communities potentially affected by the construction and operation of the Project and are identified in Table 7.4. Locations of the noise survey monitoring locations are shown in Figure 7.1a to Figure 7.1g.

#### Table 7.4 Ambient noise survey locations

<table>
<thead>
<tr>
<th>Ref</th>
<th>NC</th>
<th>Suburb</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG1</td>
<td>NC03.3</td>
<td>Gungahlin</td>
<td>Gungahlin Village shopping centre, 46–50 Hibberson Street</td>
</tr>
<tr>
<td>BG2</td>
<td>NC 03.3</td>
<td>Gungahlin</td>
<td>5 Farran Street</td>
</tr>
<tr>
<td>BG2a</td>
<td>NC 03.2</td>
<td>Franklin</td>
<td>Block 3 Section 32</td>
</tr>
<tr>
<td>BG3</td>
<td>NC 03.2</td>
<td>Harrison</td>
<td>Harrison School, Wimmera Street</td>
</tr>
<tr>
<td>BG4</td>
<td>NC 03.2</td>
<td>Harrison</td>
<td>Unit 39, 144 Flemington Road</td>
</tr>
<tr>
<td>BG5</td>
<td>NC 02.4</td>
<td>Watson</td>
<td>51 McCawley Street</td>
</tr>
<tr>
<td>BG6</td>
<td>NC 02.4</td>
<td>Downer</td>
<td>540 Northbourne Avenue</td>
</tr>
<tr>
<td>BG7</td>
<td>NC 02.2</td>
<td>Lyneham</td>
<td>65/12 Oliver Street</td>
</tr>
</tbody>
</table>
Noise monitoring equipment was deployed with consideration of other noise sources that may influence the measurements, accessibility and security, and with the consent of relevant land owners.

### Light rail noise within the existing environment

On the basis of the existing noise survey (as summarised in Table 5 of the NVIA, Technical Paper 3) and the current road transport adjacent to the route, noise conditions at most locations are already above the light rail $L_{Aeq}$ noise goals at most of the measurement locations.

Whilst the Project would introduce a new noise source to the receiver environments the potential noise impacts would be limited to whether the light rail noise would be audible above road traffic noise and other localised noise sources. The maximum noise levels from light rail are likely to be audible, but at a level that is similar to or less than the maximum noise levels from road traffic, particularly from heavy vehicles.

#### 7.2.4 Unattended noise monitoring

Unattended noise monitoring was undertaken between 24 March 2014 and 2 April 2014. Noise loggers were deployed adjacent to sensitive receivers to measure noise levels in contiguous 15-minute sampling periods. This would determine the existing statistical noise levels during the daytime (7.00 am to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods.

The equipment was set up with microphones at 1.5 metres above the ground or local floor/roof level and, where possible, 1 metre from the facade of the subject building. In some cases, the measurements were made with the microphone at 1.5 metres above the ground or local floor/roof level but under otherwise free-field conditions (refer to section 3.5 of the NVIA).

All noise measurement instrumentation used in the surveys was designed to comply with the requirements of Australian Standard AS IEC 61672.1—2004 — Electroacoustics—Sound level meters, Part 1: Specifications (Standards Australia 2004) and carried appropriate and current NATA calibration certificates.

The results of the unattended ambient noise surveys are presented in Table 5 of the NVIA as $L_{Aeq}$ (energy-averaged) noise levels for the daytime and night-time periods. The 24-hour noise levels recorded at each monitoring location are graphically presented in Appendix C of the NVIA.

The noise levels display a typical diurnal trend with noise levels during the night-time reduced from the daytime. This is characteristic of urban and suburban areas where the ambient noise environment is primarily influenced by road traffic.
7.2.5 Attended airborne noise measurements

Attended ambient noise measurements were used to determine the various noise sources that influence the existing noise environment, with the observer noting various noise sources and the contributed noise level during each measurement.

Attended measurements were performed using a RION Type NA-28 sound level meter for a minimum period of 15 minutes at each location. Wind speeds were less than 5 metres per second at all times, and all measurements were performed at a height of 1.5 metres above ground or local floor level.

The results and noise environment during the attended measurements are provided in Table 6 of the NVIA.

7.3 Potential impacts

7.3.1 Construction noise assessment

Qualitative construction noise assessment

A qualitative assessment of the noise impacts along the alignment was undertaken as part of the NVIA (refer to section 9 of the NVIA) and is summarised discussed below. Construction activities with the potential to generate noise impacts were identified as part of the assessment and are summarised as follows:

- establishment and use of site compounds
- general excavation activities along the alignment, expected to involve conventional road excavation equipment including road saws, rock breakers, jackhammers, road profilers, excavators and trucks
- construction of operational rail infrastructure potentially involving the use of slipform machines, piling rigs, vibratory rollers, concrete trucks, cranes and trucks to undertake track formation, track works and the installation of overhead wire systems and cable supports
- structural works including construction of stops, and bridge construction and culvert strengthening expected to involve piling rigs, cranes, concrete trucks and rollers/compactors
- earthworks required for the formation of the maintenance facility and stabling yard, expected to involve conventional heavy excavation and earth moving equipment including bulldozers, excavators, rollers and graders
- other construction activities include pavement formation, and the construction of maintenance workshops and buildings
- substation construction.

The proposed major compound locations have previously been identified in section 2.2.3.

The qualitative assessment was based on the likely worst case at the nearest residential receivers to each of the proposed works (refer to Table 30 of the NVIA). Separate qualitative construction noise assessments were also undertaken for the construction compounds, stabling depot and maintenance facility and substations as discussed in sections 9.5 and 9.6 of the NVIA.
### Potential impacts

A qualitative assessment of the noise impacts along the alignment, based on the likely worst case at the nearest residential receivers to each of the proposed works is shown in Table 7.5.

#### Table 7.5 Qualitative construction noise assessment

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Activity</th>
<th>Indicative duration</th>
<th>Qualitative Assessment of Noise Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Day</td>
</tr>
<tr>
<td>Track works</td>
<td>Excavation</td>
<td>2 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Base preparation</td>
<td>2–3 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Reinforcement placement</td>
<td>2 weeks</td>
<td>Clearly Audible</td>
</tr>
<tr>
<td></td>
<td>Concrete and Baseplate placement</td>
<td>Up to 6–7 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td>Structures – Stops</td>
<td>Track, welds, and topping slab</td>
<td>5–6 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Excavation of existing pavement</td>
<td>1 week</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Formwork &amp; Reinforcement</td>
<td>2–3 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Footings</td>
<td>2 weeks</td>
<td>Clearly Audible</td>
</tr>
<tr>
<td></td>
<td>Concreting</td>
<td>1 week</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Finishing works</td>
<td>2–3 weeks</td>
<td>Moderately Intrusive</td>
</tr>
<tr>
<td></td>
<td>Reconfiguration of street</td>
<td>3–4 weeks</td>
<td>Moderately Intrusive</td>
</tr>
</tbody>
</table>

The most noise intensive works are expected to be road excavation activities which may require use of rock breakers. These impacts are expected to last for about two weeks in total at any single receiver along the length of the alignment. Receivers near to a proposed stop location would also be impacted by additional excavation activities over about one week as part of stop construction.

As sections of the Project would be constructed through urban areas, works also have the potential to disrupt traffic at many intersections throughout the Project area. Where appropriate, works to be undertaken across existing roadways or that require traffic diversions would be programmed to occur on weekends or at night to minimise disruption to the road network. Measures to mitigation potential noise impacts during construction are identified in section 7.4 below.

#### Construction compounds, stabling depot and maintenance facility

The main construction compounds, stabling depot and maintenance facility are located in areas away from sensitive residential receivers. The works at these locations would be established during standard daytime hours, although some activity would occur during the night-time, particularly movements of equipment. As these locations are fixed over a long period, noise could be mitigated if required by provision of solid hoardings or temporary noise barriers to minimise adverse impacts.
Substations

Substation construction would occur during standard daytime hours. Moderately intrusive impacts would be expected during construction, although noise impacts would vary from day to day and at different stages of construction depending on the equipment being used.

7.3.2 Construction vibration assessment

A construction vibration assessment was undertaken as part of the NVIA to consider the potential for structural damage due to construction vibration (refer to Section 10 of the NVIA). The ACT does not regulate the assessment of human comfort vibration impacts from construction projects. It is considered that temporary disturbances and infrequent events of short term duration (such as the vibration generated by construction or excavation) are acceptable.

Vibration goals

Vibration damage goals for buildings

Australian Standard 2187.2-2006 (Standards Australia 2006) recommends the frequency dependent vibration guideline values and assessment methods given in British Standard 7385-2-1993 (BSI 1993) as they ‘are applicable to Australian conditions’.

These standards set guideline values for vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk is usually taken as a 95 percent probability of no effect.

The recommended guideline limits for transient vibration to minimise risk of cosmetic damage to residential and industrial buildings are presented in Table 31 of the NVIA. A vibration damage screening level of 7.5 millimetres per second has been adopted for the purpose of assessing potential impacts.

Vibration damage goals for buried services

Vibration due to the construction process has the potential to effect services such as buried pipes, electrical and telecommunication cables.

In the absence of a comparable Australian standard, German Standard DIN 4150-3 1999 (German Standards 1999) provides guidance on safe vibration levels for buried pipe work. Table 32 of the NVIA details the DIN 4150-3 limits for short-term vibration. For long-term vibration the guideline levels presented in Table 32 of the NVIA should be halved.

Human comfort goals for construction vibration

The NSW Assessing Vibration guideline nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers as shown in Table 33 of the NVIA for intermittent vibration and Table 34 of the NVIA for continuous vibration. The guideline advises a low probability of adverse disturbance to building occupants would be expected at or below the preferred values.

The applicable human comfort vibration goal for intermittent vibration source is defined in terms of Vibration Dose Values (VDVs) where the permissible vibration level corresponding to the VDV varies according to the duration of exposure.
Safe working distances for vibration intensive plant

Table 35 of the NVIA provides indicative safe working distances for construction plant. Consistent with BS7385-2 and the NSW Assessing Vibration guideline, the recommendations for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. The human comfort safe working distances are conservative, developed with reference to the more stringent objectives for continuous vibration for typical residential building constructions.

Potential impacts

The major potential sources of vibration from the proposed construction activities are during vibratory rolling, vibratory piling and when using a rock breaking attachment on an excavator. Rock breaking, rock hammering and sheet piling are also considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient vibration guide values identified in Table 31 of the NVIA by 50 percent for these construction activities.

Cosmetic damage

The separation distance(s) between the proposed works and the nearest receivers would generally be sufficient so that nearby buildings are unlikely to suffer ‘Cosmetic Damage’ for most of the proposed construction equipment. However, based on the general work zones, some items of construction equipment have the potential to be operated within 20 metres of sensitive receivers, within the recommended safe working distances.

Similarly for the heritage-listed structures, the separation distance between the proposed works and these structures are generally sufficient (greater than 25 metres) that these structures are unlikely to incur cosmetic damage. The only potential exception is the proposed construction compound at the Visitor Information Centre on Northbourne Avenue, which is located directly adjacent (less than 20 metres) to a number of multi-unit residential blocks as part of the Northbourne Housing Precinct (e.g. Dickson Flats etc.). However, the risk of vibration impact at these locations are low as the operation of vibration intensive equipment is not likely to occur within the construction compounds as the compounds would be primarily used for storage of construction material and equipment.

Human comfort vibration

In relation to human comfort (response), the safe working distances in Table 35 of the NVIA relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are normally permitted. Vibration at the nearest receivers is likely to be perceptible at times during the works.

Based on the general work zones, some items of proposed construction equipment have the potential to be operated within 20 metres of residential receivers and within the recommended safe working distances. There is potential for ground vibration levels to exceed the human comfort criteria depending on the duration and nature of the construction activity.

Any exceedances would be expected to be of short duration.

Locations with vibration sensitive equipment

The National Archives of Australia has been identified as a location with equipment that is potentially sensitive to vibration, although the nature, location and sensitivity of this equipment are not currently known. Ongoing consultation with this receiver would occur during future stages of the Project to prevent impacts to equipment that is sensitive to vibration. Measurements of existing ambient vibration levels would be undertaken as part of the building condition surveys (outlined in section 7.4).
If other receivers with equipment that is sensitive to vibration are identified during future stages of the Project, measurements of existing ambient vibration levels should also be undertaken at these receivers. This information would be used to inform the site-specific Construction Noise and Vibration Management Plan (CNVMP) for works near these locations (refer to section 7.4).

### 7.3.3 Operational noise assessment

The operational noise assessment undertaken for the Project assessed the following:

- airborne noise
- ground borne noise
- noise from fixed sources.

These are discussed further in the sections below.

**Assessment of airborne noise during operation**

The NSW *Rail Infrastructure Noise Guideline* (RING) (NSW EPA 2013) has been adopted by the Project as the guideline to be used in the assessment and management of potential airborne noise. The RING requires noise to be assessed at opening, and for a future design year typically 10 years after opening. For this Project a single indicative future scenario is assessed based on the identified design service frequencies.

The Project is a new light rail line development. The relevant RING airborne noise trigger levels for residential land uses are presented in Table 7.6.

**Table 7.6 Airborne light rail noise triggers for residential land use**

<table>
<thead>
<tr>
<th>Sensitive land use</th>
<th>Noise trigger level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day time 7.00 am to 10.00 pm</td>
</tr>
<tr>
<td>Residential</td>
<td>60 $L_{A\text{eq}(15\text{hour})}$ and $L_{A\max}$</td>
</tr>
</tbody>
</table>

Note: $L_{A\max}$ refers to the maximum noise level not exceeded for 95 percent of rail pass-by events and is measured using the ‘fast’ response setting on a sound level meter. $L_{A\text{eq}}$ refers to the ‘energy average noise level’ evaluated over a defined time period. The $L_{A\text{eq}}$ can be likened to a noise dose representing the cumulative effects of all the noise events occurring in the relevant time period.

The relevant RING airborne noise trigger levels for non-residential sensitive receivers in Table 7.7 are applicable at times of day or night when the building or premise is in use.

**Table 7.7 Airborne light rail noise triggers for sensitive land uses other than residential**

<table>
<thead>
<tr>
<th>Sensitive land use</th>
<th>Noise trigger level dBA (when in use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools, educational institutions and child care centres</td>
<td>40 $L_{A\text{eq}(1\text{hour})}$, Internal</td>
</tr>
<tr>
<td>Places of worship</td>
<td>40 $L_{A\text{eq}(1\text{hour})}$, Internal</td>
</tr>
<tr>
<td>Open space – passive use (e.g. parkland, bush reserves)</td>
<td>60 $L_{A\text{eq}(15\text{hour})}$</td>
</tr>
<tr>
<td>Open space – active use (e.g. sports field, golf course)</td>
<td>65 $L_{A\text{eq}(15\text{hour})}$</td>
</tr>
</tbody>
</table>
For receivers exposed to high existing noise levels, it is reasonable to assume that some form of noise mitigation is inherent in the construction of external facades, together with provision of mechanical ventilation to allow windows on noise affected facades to be kept closed. As such, a minimum (highly conservative) outside-to-inside attenuation of around 25 dBA for such receivers has been assumed. Receivers in quieter areas have been assumed to have operable windows with an outside-to-inside attenuation of 10 dBA.

Other potentially noise-sensitive receivers require separate project-specific noise goals. Recommended ‘satisfactory’ internal noise levels from AS2107 (Standards Australia 2000) are reproduced in Table 7.8 for other such receiver types identified within the Project area.

Table 7.8  AS 2107 recommended ‘satisfactory’ internal noise levels

<table>
<thead>
<tr>
<th>Description</th>
<th>Time period</th>
<th>Classification</th>
<th>AS 2107 L&lt;sub&gt;Aeq&lt;/sub&gt; (dBA)1</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV/Radio Studio</td>
<td>When in use</td>
<td>Film or Television Studios, Talks Studios²</td>
<td>25</td>
</tr>
<tr>
<td>Libraries</td>
<td>When in use</td>
<td>Reading areas</td>
<td>40</td>
</tr>
<tr>
<td>Conference Centres</td>
<td>When in use</td>
<td>Conference and Convention Centres with sound reinforcement</td>
<td>35</td>
</tr>
</tbody>
</table>

Note 1: Design noise levels specified in AS 2107 (Standards Australia 2000) as internal noise levels.

Note 2: These receivers are typically well insulated from external noise break-in. For the purpose of this assessment, an outside-to-inside attenuation of 25 dB has been assumed.

Operational noise modelling

A noise prediction model for the operation of the Project has been developed using SoundPLAN V7.3 noise propagation software.

Light rail noise levels have been predicted in SoundPLAN with the Nordic Rail Traffic Noise Prediction Method (Kilde 1984) as it calculates both L<sub>Amax</sub> and L<sub>Aeq</sub> noise levels. The calculation factors the speed and length of the LRV to determine the maximum potential noise levels at a receiver during a passby event.

The calculation includes the contribution from direct noise, the noise diffracting over obstacles or barriers and the noise reflecting off buildings. Factors which are considered in the noise modelling are described in Sections 4.4.1 to 4.4.8 of the NVIA and included:

- LRV source noise emissions
- noise emissions at low speeds
- LRV speeds
- daily LRV operations
- rail surface discontinuities
- curving and flanging noise
- noise from warning bells
- surrounding environment.
Predicted operational airborne noise levels

Noise level contours have been calculated with a grid spacing of 20 metres. The contour plots for the daytime, night-time and maximum noise levels have been predicted at 1.5 metres above ground level to be representative of ground floor receiver heights. Operational noise contour plots are provided in Appendix D of the NVIA.

Due to the proximity of the receivers and the urban setting, the difference in noise impacts at the ground floor and first floor levels is expected to be negligible. Noise impacts have also been calculated at individual receiver points to inform the NVIA.

Potential operational noise impacts are discussed below.

Assessment of ground borne noise during operation

Ground-borne noise results from the transmission of vibration rather than the direct transmission of noise through the air. The vibration is generated by the wheel/rail interaction and is transmitted from the track via the ground into the building structure. The vibration energy can cause the floor and walls to faintly vibrate and radiate the energy as airborne noise within the building.

The Project alignment would be on or adjacent to existing road traffic networks which, along with the airborne noise of the LRVs, will generate airborne noise which would be expected to mask ground-borne noise at many receivers.

The relevant airborne noise trigger levels for residential and some other sensitive land uses are described in the RING and are presented in Table 7.9.

Table 7.9 Ground-borne noise triggers – RING

<table>
<thead>
<tr>
<th>Sensitive Land Use</th>
<th>Time of day</th>
<th>Internal Noise Trigger Level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Daytime 7.00 am to 10.00 pm</td>
<td>$40 L_{\text{ASmax}}^1$</td>
</tr>
<tr>
<td></td>
<td>Night-time 10.00 pm to 7.00 am</td>
<td>$35 L_{\text{ASmax}}$</td>
</tr>
<tr>
<td>Schools, educational institutions, places of worship</td>
<td>When in use</td>
<td>$40$–$45 L_{\text{ASmax}}^2$</td>
</tr>
</tbody>
</table>

Note 1: $L_{\text{ASmax}}$ refers to the maximum noise level not exceeded for 95 percent of rail pass-by events and is measured using the ‘slow’ response setting on a sound level meter.

Note 2: The lower value of the range is applicable where low internal noise levels are expected, such as in areas assigned to studying, listening and praying.

The RING states that ground-borne noise levels are relevant only where they are higher than the airborne noise from railways, and where the levels are expected to be audible within habitable rooms.

The RING does not provide guidance on acceptable ground-borne noise levels for other sensitive receptor types. Trigger levels for a more detailed review of impacts on other sensitive receptor types are proposed in Table 18 of the NVIA.

Assessment of noise from fixed sources during operation

The alignment includes three groups of fixed noise sources:

- the stabling depot and maintenance facility, located in Mitchell
- electrical substations (distributed along the route)
- stops (distributed along the route).
The noise limit for each receiver will depend on the particular Land Use Zone identified for the receiving land parcel. As these three fixed noise sources are all expected to include activities that occur outside of the expected time periods (shown in Table 10 of Technical Paper 3), assessment of noise impacts is required. Table 20 of the NVIA summarises noise limits for all ACT land use types.

**Stabling depot and maintenance facility**

The stabling depot and maintenance facility would be treated as an industrial noise source by the EPA, and as such would be required to meet the relevant zone noise limits for surrounding land.

Noise modelling was carried out for the stabling yard and maintenance facility using the CONCAWE noise prediction algorithm in SoundPLAN version 7.3. Table 22 of the NVIA shows sound power levels used to model the various stabling and maintenance noise sources. The scenario modelled for the stabling yard and maintenance facility is summarised in Table 24 of the NVIA.

Figure 7.2 shows the predicted noise level contours from the operation of the Stabling yard and maintenance facility with the exclusion of any noise mitigation measures.

Additional specific noise mitigation measures were applied to the predicted noise levels for the stabling yard and maintenance facility to achieve compliance with adjacent zone noise limits (refer to Figure 7.3).
Potential impacts

Airborne noise impacts – light rail operation

The majority of residential and other noise sensitive receivers are predicted to comply with the daytime noise trigger levels, but exceedances of the RING night-time trigger levels have been identified at a proportion of residential receivers, triggering a review of reasonable and feasible mitigation measures.

Residential receivers

The residential receivers predicted to experience the highest noise levels along the alignment are summarised in Table 7.10. This table is intended to indicate worst-case noise levels at the facades of sensitive receivers nearest to the Project alignment. These noise levels have been calculated for point receivers located at a distance of 1 metre from the worst affected level of the most exposed facade of each building in each NC.

Where exceedances of the $L_{Aeq}$ and $L_{Amax}$ RING trigger levels for residential receivers (refer to Table 7.6) are apparent, they are indicated in Table 7.10 in bold.
Table 7.10  Residential operational airborne noise impacts

<table>
<thead>
<tr>
<th>Precinct</th>
<th>Noise Assessment Trigger Level</th>
<th>Daytime $L_{Aeq(15h)}$</th>
<th>Night-time $L_{Aeq(9h)}$</th>
<th>$L_{Amax}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Catchment Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canberra Civic Centre</td>
<td>NC01</td>
<td>60</td>
<td>55</td>
<td>77</td>
</tr>
<tr>
<td>Inner North Canberra</td>
<td>NC02.1</td>
<td>60</td>
<td>55</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>NC02.2</td>
<td>60</td>
<td>56</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>NC02.3</td>
<td>58</td>
<td>53</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>NC02.4</td>
<td>58</td>
<td>53</td>
<td>76</td>
</tr>
<tr>
<td>Gungahlin District</td>
<td>NC03.1</td>
<td>No residential receivers in this NC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NC03.2</td>
<td>60</td>
<td>55</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>NC03.3</td>
<td>64</td>
<td>60</td>
<td>84</td>
</tr>
</tbody>
</table>

Rail noise could trigger levels during the night time that exceed the night-time trigger levels at residential locations, typically by up to 5 dBA.

The daytime trigger levels are broadly commensurate (though using different time periods and measurement index) with the daytime noise trigger levels used in the ACT for noise from road traffic. The ACT does not have night time noise trigger levels for road traffic.

The predicted daytime average and maximum rail noise levels during a passby without noise mitigation comply with the residential noise trigger levels along the majority of the alignment. Only one location classified as residential has been identified where there is potential for exceedance of both the daytime and maximum noise goals, and an exceedance of more than 5 dBA in the night-time noise goals. This location is the residential buildings adjacent to the Gungahlin terminus. At this location, the exceedance is due to proximity, with the residential building facades located only 10 metres from the track centres.

A number of locations also have exceedances of less than 5dBA above the night time noise trigger level. The decision to adopt more stringent night-time noise trigger levels for this assessment means that the project will be required to consider reasonable and feasible noise mitigation measures at almost all locations when developing the detailed design.

**Non-residential receivers**

Noise levels have also been predicted to all identified potentially noise-sensitive non-residential receiver locations adjacent to the alignment.

Predicted exceedances of the proposed assessment trigger levels (refer to Table 7.7 and Table 7.8) in Table 7.11 are presented in **bold**.
Table 7.11 Assessment of Non-Residential Noise Sensitive Receivers

<table>
<thead>
<tr>
<th>Location/Receiver</th>
<th>Noise Level Goal (dBA)</th>
<th>Predicted External Noise Level (dBA)</th>
<th>Estimated Internal Noise Level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canberra City Uniting Church L_Aeq 40 dBA internal</td>
<td>61 L_Aeq(1hour)</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>ABC Canberra (radio/TV studio) L_Aeq 25 dBA internal</td>
<td>53 L_Aeq(15hour)</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>EPIC Conference Centre L_Aeq 35 dBA internal</td>
<td>56 L_Aeq(15hour)</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>National Archives of Australia L_Aeq 40 dBA internal</td>
<td>62 L_Aeq(15hour)</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Southwell Park Rugby League Club L_Aeq(15hour) 65 external</td>
<td>54 L_Aeq(15hour)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Netball ACT L_Aeq(15hour) 65 external</td>
<td>52 L_Aeq(15hour)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Yowani Country Club L_Aeq(15hour) 65 external</td>
<td>53 L_Aeq(15hour)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Block 3 Section 129 Harrison Urban Open Space L_Aeq(15hour) 60 external</td>
<td>52 L_Aeq(15hour)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note 1 Based on an outside to inside noise reduction of 25 dB through a closed façade.

Based on a conservative assumption of an outside to inside noise reduction through closed façades of around 25 dBA, a marginal exceedance of the internal noise level goal (refer to Table 7.8) has been predicted at one location, the ABC Canberra TV and radio studios. The identified exceedance is around 3 dBA.

The 25dBA facade assumption used here is expected to be conservative, particularly for a building that is understood to include structural isolation measures designed to minimise road traffic noise intrusion. As a result, internal noise levels resulting from the Project are likely to be significantly lower than estimated in Table 7.11.

**LRV warning bells**

Noise from LRV warning bells would not be expected to result in any significant impacts on the basis they would only be required in emergency situations or where the driver considers there to be a danger to public safety.

**Airborne noise impacts – fixed sources**

**Stabling yard and maintenance facility**

As shown in Figure 7.2, the controlling night time 55 dBA L_{A10(15min)} noise limit is predicted to be exceeded along the stabling yard and maintenance facility boundary adjacent to the stabling roads and fixed plant on southern boundary. There is also a marginal exceedance of the night time 55 dBA L_{A10(15min)} noise limit along the eastern boundary due to the open roller doors of the maintenance building. These exceedances are a result of noise level predictions modelled without mitigation measures.

With mitigation measures applied to the noise level predictions, the night-time noise goals for the stabling and maintenance facility can be met by provision of noise barriers, or with shorter barriers and a partial roof enclosure that provides equivalent sound attenuation as these barriers.

Noise mitigation has been considered to address areas exceeding the night time 55 dBA L_{A10(15min)} noise limit (refer to section 7.8).
Electrical substations

Without noise attenuation measures electrical substations would exceed the operational night time zone noise standards, which range from 35 dBA to 55 dBA depending on their location. Exceedance levels are predicted to vary from 8 dBA to 28 dBA (refer to Table 27 of Technical Paper 3 for individual substation exceedances). The electrical substations at all locations could be designed to meet the noise goals by implementing appropriate sound attenuating enclosures. The design of these would be carried out during the detailed design phase.

Operational noise at stops

Currently, the only notable noise sources at the stops that are not fixed to the LRVs themselves would be the Public Address (PA) systems. A qualitative assessment of PA system noise impact has been undertaken and the impacts are likely to be minimal. This would need to be assessed further when the design of such systems is progressed, and stop locations are finalised.

Noise made by people is not regulated in the ACT. However, it is possible to make the qualitative assessment that as all stops are located in areas where other public transport (bus) stops already exist and/or are already used by pedestrians, noise from passengers is not expected to be a cause of significant additional noise impacts.

Ground borne noise and vibration impacts

With appropriate selection of high-resilience trackforms adjacent to sensitive areas, no exceedances of the ground-borne noise goals would be expected. When considering whether such mitigation is reasonable, it should be noted that at many receivers, airborne noise generated by the adjacent existing road traffic networks, and by the LRVs themselves would be expected to mask ground-borne noise at many receivers.

Table 16 of the NVIA shows the estimated vibration dose at the identified representative locations. Operational vibration levels are predicted to comply with the human comfort VDV criteria at all locations and no exceedance of the operational human comfort or cosmetic structural damage ground vibration criteria are predicted anywhere adjacent to the alignment as discussed below. Feasible and reasonable mitigation measures are discussed in section 7.5.

7.3.4 Operational vibration assessment

Vibration goals

Human disturbance

The RING refers to the NSW Assessing Vibration (NSW DEC 2006) guideline for vibration criteria for rail proposals, which are considered intermittent sources of vibration. The vibration guideline nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers as shown in Table 7.12. The applicable human comfort vibration goal for intermittent vibration source is defined in terms of Vibration Dose Values (VDVs). The VDV varies according to the duration of exposure; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

The vibration guideline advises a low probability of adverse comment or disturbance to building occupants would be expected at or below the preferred values.
Table 7.12  Preferred and maximum vibration dose values for intermittent vibration

<table>
<thead>
<tr>
<th>Building type</th>
<th>Preferred VDV (m/s(^{1.75}))</th>
<th>Maximum VDV (m/s(^{1.75}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Daytime</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>Residential Night-time</td>
<td>0.13</td>
<td>0.26</td>
</tr>
<tr>
<td>Offices, schools, educational institutions and places of worship</td>
<td>0.40</td>
<td>0.80</td>
</tr>
<tr>
<td>Workshops</td>
<td>0.80</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am

Predicted operational vibration dose values

Table 7.13 shows the estimated vibration dose at representative locations closest to the alignment.

Table 7.13  Predicted human comfort operational vibration dose values

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance (m)</th>
<th>Indicative speed (km/h)</th>
<th>VDV (m/s(^{1.75}))</th>
<th>Complies?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Daytime</td>
<td>Night-time</td>
</tr>
<tr>
<td>Gungahlin Terminus</td>
<td>10</td>
<td>30</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Canberra Archives</td>
<td>17</td>
<td>70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Civic Terminus</td>
<td>28</td>
<td>30</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Other (Residential)</td>
<td>25</td>
<td>70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Potential impacts

Operational vibration levels are predicted to comply with the human comfort VDV criteria at all locations.

7.4  Proposed mitigation measures and offsets

Restriction of construction hours and night works

‘Normal’ construction hours for the project are currently expected to be 7.00 am and 6.00 pm Monday to Saturday, with no work on Sundays and Public Holidays. This further restriction of construction hours is intended to minimise the likely impact to noise-sensitive receptors. However, the nature of the project means evening and night work would be required in all areas, and especially around road intersections. Construction works would be required outside of standard hours where:

- Temporary road closures and other measures are required by the police and other regulatory authorities for the safe delivery of material/ equipment.
- Works have the potential to disrupt commuter services and road networks.
- Works are required to be completed to maintain health and safety, avoid loss of life or injury and to prevent environmental damage.
Any construction works proposed to take place outside ‘normal’ construction hours would be subjected to an individual assessment and approval process on a case by case basis. In general, this process is would include:

- identification of the duration, location, type of activities and type and number of construction equipment involved
- assessment of the potential noise and vibration impact associated with the proposed construction activities and determination of the number and type of sensitive receivers potentially impacted
- identification of any reasonable and feasible mitigation measures to be implemented
- consultation with the potentially impacted receivers to inform them of the proposed out of hours works, and providing an opportunity for impacted receivers to provide feedback
- minimising out of hours works as much as practicable (e.g. deliveries of equipment and materials could be made, or disposal of construction waste may be delayed until on the following day).

**Construction noise**

The reasonableness of the identified feasible mitigation measures would be considered during the construction planning and site establishment phases of the Project, and in the development of CNVMPs. Mitigation measures that would be considered are summarised as follows:

- for construction concentrated in a single area, such as at the stops, worksites, substation construction sites, bridge sites and stabilising/maintenance facility locations, temporary acoustic fencing/barriers around the site perimeter would be considered where feasible and reasonable to mitigate off-site noise levels. Noise walls are effective for receivers at or near ground level but not effective for receivers overlooking the sites
- given the potentially high noise levels at some residential receivers schedule daytime construction, where practicable, for excavation, demolition or rock breaking activities, and for activities concentrated in a single area (i.e. activities that do not move along the alignment, and do not require out of hours activities for safety reasons or to minimise disruption to road networks)
- night works would be programmed to minimise the number of consecutive nights work impacting the same receivers
- if working adjacent to schools, particularly noisy activities would be scheduled outside normal school hours, where possible
- avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers would result in reduced noise emissions
- equipment which is used intermittently is to be shut down when not in use
- where possible, the offset distance between noisy plant items and nearby noise sensitive receivers would be as great as possible
- where possible, equipment with directional noise emissions would be oriented away from sensitive receivers
- regular compliance checks on the noise emissions of all plant and machinery used for the Project would indicate whether noise emissions from plant items were excessive. This also identifies defective silencing equipment on the items of plant
- where possible heavy vehicle movements would be limited to daytime hours
- reversing of equipment would be minimised where possible so as to prevent nuisance caused by reversing alarms
- loading and unloading would be carried out away from sensitive receivers, where practicable.
For sensitive receivers that operate outside standard construction hours, reasonable and feasible noise mitigation options and measures would be developed in consultation with the receiver. Project Co would communicate with the affected premises to clearly explain the timing, duration and likely noise level of the works.

A CEMP would be prepared during the detailed design phase and implemented through all construction activities. A best practice-type CNVMP would be included in the CEMP to provide the framework and mechanisms for the management and mitigation of all potential noise and vibration impacts from the construction works. This plan would be designed to minimise, to the fullest extent practicable, noise and vibration impacts during construction.

**Construction vibration**

Mitigation measures that would be considered to minimise potential construction vibration impacts are summarised as follows:

- relocate vibration generating plant and equipment to areas within the site in order to lower the vibration impacts
- investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment
- use lower vibration generating items of excavation plant and equipment e.g. smaller capacity rock breaker hammers, where feasible
- minimise consecutive works in the same locality (if applicable)
- use dampened rock breakers and/or ‘city’ rock breakers to minimise the impacts associated with rock breaking works
- if vibration intensive works are required within the safe working distances, vibration monitoring or attended vibration trials would be undertaken to ensure that levels remain below the cosmetic damage criterion
- building condition surveys would be completed both before and after the works to identify existing damage and any damage due to the works
- ongoing consultation with identified sensitive receiver would occur during future stages of the Project to prevent impacts to vibration sensitive equipment.

**Operational noise**

**Airborne noise during operation**

The detailed design of the Project would include consideration of the following feasible mitigation options:

- minimise LRV auxiliary noise levels
- optimise schedules to minimise idling time at the Gungahlin terminus
- minimise source levels by optimisation of the track design
- investigate the feasibility of absorptive paving trackforms or grassed trackforms
- minimise wheel and rail roughness through maintenance practices.

These measures would be expected to result in a light rail system with best-practice noise emissions.
During the detailed design stage, an Operational Noise and Vibration Review (ONVR) would be prepared. The ONVR would update the noise predictions with more detailed speed profiles, and incorporate any other changes to the design with the potential to affect the noise impact. The ONVR would identify which of the above mitigation measures have been determined to be reasonable and feasible and would therefore be implemented.

**Ground borne noise during operation**

The assessment of operational ground-borne noise indicates that high-resilience trackforms should be considered in residential areas where feasible to control ground-borne noise impacts. High resilience trackforms may also be required to mitigate ground-borne noise impacts to the ABC Canberra studios.

With appropriate selection of high-resilience trackforms adjacent to sensitive areas, no exceedances of the ground-borne noise goals would be expected. When considering whether such mitigation is reasonable, it should be noted that at many receivers, airborne noise generated by the adjacent existing road traffic networks, and by the LRVs themselves would be expected to mask ground-borne noise at many receivers.

**Noise from fixed sources during operation**

**Stabling yard and maintenance facility**

To provide indicative high-level information on typical mitigation for these activities, typical approaches to controlling noise and vibration from this facility might include:

- limiting certain activities to the daytime period
- optimising curve radii as part of the design to reduce the risk of flanging or squeal
- specification of quiet LRV air conditioning units and other auxiliary plant
- locating high noise generating activities inside acoustic enclosures/sheds
- use of non-tonal audible alarm systems
- design of maintenance hard stand areas and turning spaces so that vehicles do not need to reverse unnecessarily
- PA systems designed to minimise noise impact using measures such as speaker selection and placement.

Noting the exceedances detailed in section 7.3, specific additional noise mitigation measures have been considered in the form of noise barriers along the affected property boundaries. It is also recommended that noisy activities would be scheduled to occur during day time periods wherever possible. If maintenance activities which may generate high levels of noise are required to occur at night the maintenance building roller doors would be shut to reduce noise emissions from this source where this would not result in non-compliance with Work Health and Safety legislation (e.g. during extreme heat events). The requirement for and design of mitigation measures would be reviewed in more detail once more information on the equipment and noise sources is available.
Substations

The substations at all locations would be designed to meet the noise goals by provision of a combination of the following indicative typical noise mitigation measures:

- maximising set-backs as far as practical when finalising locations
- enclosing the major noise sources
- consideration of specific acoustic attenuation to ventilation openings (sound attenuating louvres, attenuated duct runs etc.), and locating these openings away from noise-sensitive receivers (i.e. direct these towards the road/rail corridor) as far as practical (subject to detailed design of the structure).

Substations would be located as far as possible from sensitive residential receivers to minimise operational noise impacts. This measure would also minimise construction noise impacts.

7.5 Expected conditions

The majority of residential and other noise sensitive receivers are predicted to comply with the maximum noise trigger levels during a passby, and with the daytime average noise trigger levels. However, exceedances of the RING night-time average noise trigger levels have been identified for residential receivers along the length of the alignment.

One location (within the suburb of Gungahlin) classified as residential has been identified where there is potential for exceedance of both the daytime and maximum noise goals, and an exceedance of more than 5 dBA of the night-time noise goals. At this location, the exceedance is due to proximity, with the residential building facades located only 10 metres from the track centres. Since this location is adjacent to a stop, the air-conditioning fans and other auxiliary equipment on the roof of the LRVs are likely to be the dominant source of noise. Selection of quiet fan designs for air-conditioning systems and minimising the idling time at stops are keys to reducing noise impacts near terminus stops.

Given the linear nature of the Project, the duration of the noisiest activities at most locations would be relatively short. This is considered to be similar to the existing situation, which currently includes vehicles passing by the identified receivers, including existing private vehicles, buses and trucks for similar periods of time, although with greater/more consistent frequency than would occur for the LRVs.

7.6 Residual risks

Based on the mitigation measures identified in section 7.4, an assessment of the residual noise and vibration risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 7.14.

Table 7.14 Residual noise and vibration risks

<table>
<thead>
<tr>
<th>ID</th>
<th>Potential impact</th>
<th>Original residual risk rating</th>
<th>Residual likelihood</th>
<th>Residual consequence</th>
<th>Residual risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1</td>
<td>Increased noise and vibration from construction plant, equipment, trucks and vehicles</td>
<td>Very high</td>
<td>Likely</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>C.2</td>
<td>Construction vibration that exceeds adopted criteria for human comfort and adopted criteria for cosmetic damage to buildings.</td>
<td>Medium</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>ID</td>
<td>Potential impact</td>
<td>Original residual risk rating</td>
<td>Residual likelihood</td>
<td>Residual consequence</td>
<td>Residual risk rating</td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>---------------------</td>
<td>----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>C.3</td>
<td>Increase in noise for noise sensitive receivers including:</td>
<td>Video</td>
<td>Possible</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>■ increased noise due to operation of light rail vehicles (including elements such as warning bells)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ increase in noise around the proposed depot location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ noise from fixed project elements such as substations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.4</td>
<td>Potential for increased levels of vibration due to operation of light rail vehicles.</td>
<td>High</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>C.5</td>
<td>Operational vibration affecting vibration sensitive equipment.</td>
<td>High</td>
<td>Remote</td>
<td>Major</td>
<td>Low</td>
</tr>
</tbody>
</table>