14. Social and economic

This Chapter outlines the potential social and economic impacts associated with the construction and operation of the Project. This Chapter provides a summary of the Socioeconomic Impact Assessment prepared by SGS Economics contained as Technical Paper 10 in Volume 3 of this EIS.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential social and economic impacts risks presented in Table 14.1 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>J.1</td>
<td>Impacts to the operation of local businesses due to perceived adverse amenity and access constraints leading to reduced passing trade.</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>J.2</td>
<td>Removal of existing roadside memorials which are within the footprint of the Project, such as those associated/attached to existing trees along Northbourne Avenue.</td>
<td>Almost Certain</td>
<td>Moderate</td>
<td>Very high</td>
</tr>
<tr>
<td>J.3</td>
<td>Impact on local communities during construction, including reduction in amenity (such as noise, dust and visual impacts).</td>
<td>Likely</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>J.4</td>
<td>Creates the potential for local access to residential, business community facilities along the alignment.</td>
<td>Almost Certain</td>
<td>Positive</td>
<td>Beneficial</td>
</tr>
<tr>
<td>J.5</td>
<td>Potential for the community to perceive that the light rail infrastructure will create a barrier between the east and west sides of Northbourne Avenue/Flemington Road.</td>
<td>Possible</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

14.1 Environmental conditions and values

Population along the light rail corridor

The population of the ACT is currently 385,996 (ABS, 2015). It is projected to reach 400,000 by 2017 and 500,000 by 2033. ACT Government population projections by suburb (ACT Government, 2009) show that the greatest population growth in Canberra is expected to be in Gungahlin, the new developments of Molonglo, the inner north (including areas such as Braddon, Turner and Civic) and inner south (south of Lake Burley Griffin). Gungahlin/Hall is expected to grow by an estimated 58.6 percent between 2007 and 2019, the inner north is expected to grow by an estimated 17.6 percent.

Of the 10 most densely populated suburbs in the ACT, 6 are on the Project route and a further three are within 2 kilometres of the light rail route (walking or cycling distance). Only Banks (in Tuggeranong) is located away from the Project. In total, 48,446 people live in suburbs adjacent to the light rail route, and 82,446 people, or 21 percent of Canberra’s population, live in suburbs within approximately 1 kilometre of the Project alignment.

Census data from 2011 can show greater detail on where people live. Figure 14.1 provides a detailed map of population density (2011 data) along the Project alignment, and Table 14.2 provides an estimate of the number of people living within approximately 500 metres of each of the proposed light rail stops.
Figure 14.1 Population density along the Project alignment

Source: SGS, Economics, Technical Paper 10
Table 14.2  Population living with 500 metres of a light rail stop

<table>
<thead>
<tr>
<th>Light rail stop</th>
<th>Population within approximately 500 m of a proposed stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gungahlin Place stop (Gungahlin terminus)</td>
<td>1,100</td>
</tr>
<tr>
<td>Manning Clark Crescent stop</td>
<td>967</td>
</tr>
<tr>
<td>Nullarbor Avenue stop</td>
<td>622</td>
</tr>
<tr>
<td>Mapleton Avenue stop</td>
<td>1,449</td>
</tr>
<tr>
<td>Wells Station Drive stop</td>
<td>194</td>
</tr>
<tr>
<td>EPIC stop</td>
<td>8</td>
</tr>
<tr>
<td>Phillip Avenue stop</td>
<td>734</td>
</tr>
<tr>
<td>Swinden Street stop</td>
<td>825</td>
</tr>
<tr>
<td>Dickson stop</td>
<td>959</td>
</tr>
<tr>
<td>Macarthur Avenue stop</td>
<td>1,933</td>
</tr>
<tr>
<td>Condamine Street stop</td>
<td>3,581</td>
</tr>
<tr>
<td>Elouera Street stop</td>
<td>2,371</td>
</tr>
<tr>
<td>Alinga Street stop (City terminus)</td>
<td>2,303</td>
</tr>
</tbody>
</table>

Source: SGS, 2015  

**Note:** The data on which this figure was based is from the most recent Census (2011)

Some areas have become more densely populated since the census data was taken or are expected to become more densely populated in the future. For example, in Harrison, along Flemington Road between the Mapleton Avenue, Nullarbor Avenue and Well Station Drive stops, population density is shown as very low. This is because at the time the Census was collected, these Flemington Road sites were undeveloped. Now most of these street front properties have been developed with medium rise residential and business use, or are under construction.

Sensitive receivers

Sensitive receivers are those who are potentially impacted on by the Project; there are varying degrees of ‘sensitivity’ to impacts. A number of community and business stakeholders located near the Project would have the potential to be impacted by it. While not considered sensitive receivers in conventional terms, other uses such as recreational areas, public space and places of work may also be influenced by amenity and environmental impacts. Table 14.3 identifies potential sensitive receivers.

Table 14.3  Potential sensitive receivers

<table>
<thead>
<tr>
<th>Type of sensitive receivers</th>
<th>Comment</th>
<th>Specific examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local residents</td>
<td>The Project would affect a number of local residents, particularly those located within streets immediately next to the proposed Project alignment, as well as residents located within streets that provide access to the work sites for construction vehicles.</td>
<td>Generally medium density developments within Gungahlin and along Flemington Road. Lower density residential along most of Northbourne Avenue north of Civic.</td>
</tr>
<tr>
<td>Local businesses</td>
<td>The Project would affects a number of local businesses, particularly those located within streets immediately next to the Project alignment, as well as businesses located within streets that provide access to the work sites for construction vehicles.</td>
<td>Local businesses and offices are the dominant land use within Civic and around nodes such as Dickson.</td>
</tr>
<tr>
<td>Type of sensitive receivers</td>
<td>Comment</td>
<td>Specific examples</td>
</tr>
<tr>
<td>----------------------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Child care centres</td>
<td>A number of child care centres are located within 100 metres of the Project alignment.</td>
<td>Goodstart Early Learning – Braddon and Turner, Franklin Early Childhood School</td>
</tr>
<tr>
<td>Educational facilities</td>
<td>There are a number of educational facilities, where the affected community comprises staff, students and resident families.</td>
<td>Mother Teresa Catholic Primary School, Harrison School, Lyneham High School, Turner School</td>
</tr>
<tr>
<td>Religious and community centres</td>
<td>The Project alignment would pass a number of churches and community centres.</td>
<td>Twin City Church, Gungahlin, North Canberra Baptist Church, Uniting Church, Civic</td>
</tr>
<tr>
<td>Entertainment, leisure facilities, and recreational areas</td>
<td>There are a number of parks and recreation grounds within the vicinity of the Project alignment, as well as restaurants and cafes.</td>
<td>Gubur Dhaura Heritage Park, Harrison District Playing Fields, EPIC, Yowani Country Club, Canberra Racecourse, Haig Park</td>
</tr>
</tbody>
</table>

14.2 Investigations

A desktop assessment of potential social and economic impacts associated with the Project was undertaken as part of the Socioeconomic Impact Assessment by SGS Economics (Technical Paper 10). The social and economic impact study assessed the level of impact on an economic or social activity within the study area and determined if it would have a positive or negative impact. The assessment of likely impacts resulting from a particular proposal allows for the identification, prediction and, where possible, quantification of impacts as either likely benefits or negative impacts.

To assess the social and economic impacts of the Project the assessment included:

- an overview of the existing demographic, social and planning environment in which the Project would operate
- a description of the socioeconomic impacts that are likely to occur
- consideration of these impacts using an Impact Significance Framework, classifying them according to their type, significance, population impacted and whether they require mitigation.

14.3 Potential impacts

14.3.1 Positive economic impacts

A number of positive economic impacts are anticipated to occur during construction and operation of the Project. The net present value of the Project has been estimated as approximately $161 million, with a benefit cost ratio of 1.2 (including transport benefits, land use benefits and wider economic impacts) (ACT Government, 2014d). The benefits quantified in the Project Business Case included time savings worth $222 million, public transport operating savings of $54 million, land use benefits of $381 million and wider economic impacts of $198 million.
Time savings and transport benefits

The principal transport benefits from the Project would result from a reduction in total journey costs between Gungahlin and Civic. These include benefits to continuing users (those people who currently use public transport) and changing users (people whose mode of travel changes as a result of the Project). These benefits are expected to include increased amenity and reliability of the Project relative to alternative forms of transport and lower vehicle operating costs.

Public transport cost/fares

The Project would result in cost savings on bus services, as certain bus routes that operated along the Project corridor that would no longer be necessary, or can be run at reduced frequency. The Project Business Case (ACT Government, 2014d) estimated that the average fare per passenger on the Project would be $1.01 per trip (2014 dollars). This was based on the average 2014/2015 fare of $1.35 per trip, with a 25 percent discount to allow for the possibility of free interchanges between bus and light rail (ACT Government, 2014d, p136).

As noted in section 2.2.5, ticketing for the Project would be incorporated with the ACTION MyWay ticketing system, to ensure connections between the two are consistent. Whilst a formal ticket pricing system for the light rail has not yet been designed, the ticket pricing for the Project would be commensurate with existing ACTION ticket pricing at the time of Project commencement. This would include consideration of potential fare impacts associated with mode changes between existing bus services and the Project.

Final fare and ticket prices would be determined prior to the commencement of operations.

Housing supply and density uplift

The Project would support the ACT Government’s policy objective to improve housing supply, and increasing densities along the alignment. It would also improve the work/life balance of existing and new residents that live on or adjacent to the proposed alignment by providing improved access to homes, jobs, services and recreation facilities. Finally, the Project would drive improvements to amenity and liveability through public domain upgrades and the activation of streets and public spaces. Businesses, residents and visitors alike would benefit from streetscape improvements made to Flemington Road, the Federal Highway and Northbourne Avenue, in particular for suburbs such as Gungahlin and Dickson which have previously been identified as having existing master plans which aim to improve and further develop these areas.

Wider economic benefits

Wider economic benefits outside of the immediate vicinity of the Project alignment are also anticipated as a result of the operation of the Project. These indirect benefits arise from:

- reduced travel time between workers and jobs effectively bringing them closer together
- competition benefits from firms locating closer together, such as around light rail stops allowing for increased comparability of their products and services
- improved labour supply as improved transport availability to jobs would lead to greater productivity/efficiency of workers.
Business viability

Owing to the potential cumulative effect of the positive outcomes of the Project on the wider region and improved access, local businesses along the alignment would be expected to benefit from potential increased turnover, improving the overall viability of their businesses once the Project is operational. As a result of the likely enhanced attraction of locating a business in close proximity to the Project, the proposed light rail stops along the alignment, in particular the stop within the pedestrianised section of Hibberson Street and near Dickson, competition for space (and thereby commercial rents) could also increase across the wider region. This would represent a benefit for landowners.

In addition to the potential benefits during operation, the Project would present potential for increased trade during construction. This benefit is most likely to be experienced by businesses located in close proximity to construction sites or on routes to construction sites that sell goods to construction workers or related industries such as service stations, take-away food shops and hotels.

14.3.2 Negative economic impacts

Some negative economic impacts may also arise as a result of the Project. These are briefly discussed below.

Disruption to local businesses during construction

Some business may experience temporary disruption and access constraints due to perceived or actual severance during the construction of the Project (discussed in more detail below). They may also experience a temporary loss of visual amenity.

Impacts to businesses may also occur as a result of traffic delays and congestion may be both direct and indirect. Businesses may be directly affected as a result of a delayed or hindered access to work places or servicing areas owing to local traffic constraints and congestion. A business may be indirectly affected by increased traffic and therefore travel times for staff or deliveries on major thoroughfares along the alignment. Additional impacts may result from the redirection of buses as part of the proposed reconfiguration of the existing network.

The loss of power and utilities during construction, due to accidental or planned shutdowns of electricity or other utilities to enable construction works may also result in a negative impact to local businesses. Whilst significant advance notice would be given to all businesses of a power or utility shutdown, accidental events would be more difficult to manage.

Changes to existing arrangements for ACT government operations

The ACT Government has responsibility for maintaining and servicing the land along the Project alignment, through TAMS. As discussed in section 2.2.5 of this EIS, upon commencement of operations, responsibility for some aspects of maintenance would be transferred to Project Co. The construction process and the operation of the Project may cause disruption to some TAMS operations, such as rubbish collection, roadworks and maintenance, which many increase the costs of performing them.

The infrastructure and landscape maintenance responsibilities associated with the Project, in addition to temporary arrangements during construction, would be negotiated through ongoing consultation and agreement between CMA, Project Co and TAMS during the design and construction phase. During construction, this may involve Project Co or TAMS providing access to the other party, so that each can ensure the areas surrounding the Project are maintained to a suitable standard within their areas of responsibility.
14.3.3 Social impacts

The social impacts of the Project are expected to be positive. The potential social impacts of the Project are briefly discussed below.

**Improved mobility and social cohesion**

The Project is expected to improve mobility and social cohesion by allowing people to connect more easily with employment opportunities, social activities and services. In particular, it would improve transport options for people who do not have cars, who live in outer suburbs or who are mobility impaired. The Project would be designed to allow for wheelchair access, to ensure those with disabilities can access its benefits; and bicycle access to expand the potential reach and usage of the Project.

The Project would encourage improvement to the existing amenity of the area along the route, improve the ambience for pedestrians and communities through a redesign of outdoor areas and improved pedestrian crossings, thus improving social cohesion.

**Impacts on roadside memorials and to objects/sites of indigenous cultural significance**

The Project poses a risk of loss or damage to roadside memorial sites which are currently located within the Project impact footprint. Some of the trees on Northbourne Avenue bear existing memorials (or provide plaques in the ground) to notable Canberrans, or people who have died in road accidents at these locations. The potential for these sites to be impacted or removed as part of the Project may cause a sense of loss among residents who have lost family members at these location(s), or loss of a sense of heritage from the removal of plaques honouring notable Canberrans.

The Project also poses a potential risk of loss or damage to sites or objects of Indigenous cultural significance. These include archaeological deposits and heritage artefacts, particularly in the northern part of the study area, as well as in other areas of the Project footprint.

**Perception or actual severance (access constraints and physical separation resulting in direct or indirect impacts to local businesses)**

Physical severance can occur when a new transport development means that previous routes taken by people are blocked off, diverting them to a less convenient route which can create a disincentive to taking the journey at all. Psychological severance, or perception of severance, can occur when a new transport development produces noise, pollution, inconvenience or a perceived safety risk when crossing the development. This can result in some trips across the transport network being deterred, reducing social and community cohesion, inhibiting consumers from accessing businesses and potentially resulting in lost business.

Perceived and actual severance are likely during Project construction, as safety barriers, road closures and roadwork equipment would block parts of the route and create noise and a perception of safety hazards. This severance, or perception of severance, can result in a potential loss of trade for businesses along the alignment during construction. Each of these types of severance are briefly described below.

**Actual severance**

Physical barriers would be installed around the Project construction site for safety, which means that current informal crossings of Northbourne Avenue, Federal Highway, Flemington Road and Hibberson Street at places other than official crossings, would be unavailable for a period while the Project is under construction. This has the potential to affect pedestrians along the Project route, and any businesses, social groups or community facilities they may have wished to visit. These people may need to walk further to reach their destination, use an alternative transport method, decide to take fewer trips or decide to access their required services at a different location away from the Project alignment.
People, businesses and areas that are particularly likely to be directly affected by the Project during construction include:

- shoppers in Gungahlin who wish to cross Hibberson Street
- residents along Flemington Road who currently catch buses that drop them on one side of the road; or who have social activities or business transactions to make on the other side of the road
- businesses on Flemington Road that may lose foot traffic from people located the other side of the road, particularly low-cost purchases such as coffee and snacks
- residents of Dickson, Downer and Watson who walk to sporting facilities and EPIC on the other side of the Northbourne Avenue, or shops, restaurants etc. in Lyneham
- residents of Lyneham who shop, dine or drink at Dickson businesses
- businesses in Dickson with customers in Lyneham or O’Connor
- residents and businesses of Braddon and Turner who cross Northbourne Avenue.

Residents and businesses in Civic are likely to experience comparatively less actual severance, as some physical barriers already exist on traffic islands on Northbourne Avenue in Civic.

In addition, where intersection works are required, this would involve temporary closures of intersections throughout periods of the Projects’ construction impacting on vehicular traffic during these times (refer to Chapter 10 for further details).

**Perceived severance**

New transport projects can create perceived or psychological barriers while under development. For example, noise, dust and perceived danger can act as a deterrent to pedestrians and cyclists moving from one side of the proposed light rail route to the other. This means that even when crossings of the light rail route are available during construction and the route is reasonably convenient, some trips may still be deterred due to the unpleasantness of crossing a construction site.

The Project is unlikely to have a substantial increase in the perception of severance once the Project is completed and the light rail is operational, as severance has been in place for the most of the Project route, in the form of wide, heavily trafficked roads of Northbourne Avenue, Federal Highway and Flemington Road. The exception is Hibberson Street, which has been designed as a pedestrian-friendly street, which is anticipated to result in a lower perception of severance than currently exists.

**Demographic changes**

As shown in Figure 14.1, the Project route runs past some areas that are already densely populated, such as Braddon, and some areas that are expected to show increases in population density, such as Harrison and Franklin. Due to the convenience of living within walking distance of a light rail stop, it is expected there may be increased demand for properties around light rail stops, and increases in dwelling density in these areas. As a result, population density has the potential to increase along the Project alignment, in particular around proposed light rail stops.

This may result in lower population growth in other areas of Canberra not serviced by the Project, such as Belconnen, Woden and Tuggeranong; however these areas are already currently forecast to show relatively low population growths.
Urban design and visual impacts on amenity

Construction activities may be visually unpleasant, particularly once the existing trees along the Project alignment have been removed (refer to Chapter 8). During operation, elements such as the rail line, new stops, overhead wiring, lighting, substations and vehicles may be regarded as unattractive by some members of the population. The Project would continue to be designed to ensure the final product is aesthetically pleasing, with an improvement rather than a reduction in visual amenity. The Project would incorporate a series of detailed design principles for each precinct along the light rail route; for example removing cars, increasing tree plantings and widening footpaths in (Hibberson Street), improving pedestrian crossings and using single overhead wires to reduce the visual impact of light rail infrastructure.

Further discussion of potential urban design and visual impacts is provided in Chapter 9.

Security, safety and policing of light rail operations

The Project has the potential to result in perceived and actual risks of crime, harassment and deliberate property damage. These risks could occur on the LRVs themselves, at light rail stops and for people walking to and from the light rail stops, particularly at night. These risks to people making light rail trips are most likely similar to those faced by people catching buses.

Passenger safety would be the primary factor in the detailed design of the Project, particularly with respect to operation of the light rail. In addition, each of the new stops would be configured to provide a level pedestrian crossing between the new platforms to allow for access to both sides of the stop and the surrounding land uses. Signage, tactile warning markers and fencing barriers would assist in creating safe pedestrian crossing points. Other security measures would also be included at each stop including:

- closed circuit television (CCTV) cameras for passenger security and to deter vandalism
- an appropriate level of lighting would be provided to maximise passenger safety and to enable the operation of CCTV. Lighting levels would be determined during future design development of each stop
- emergency telephone/help point(s) and warning signs.

Measures to mitigate safety and security impacts are discussed in section 14.4.

14.3.4 Health impacts

It is expected that the health impacts of the Project would be positive. Several potential health impacts have been identified; including positive impacts (improved fitness from active transport and reduced pollution) and negative impacts (injuries, noise, dust and vibration). These impacts are briefly discussed below.

Improved health and fitness from active transport

Overall, the health impacts of the Project would be positive, with the main benefit experienced by people who will rely on active transport, and experience health benefits from additional walking and cycling to access the light rail instead of driving. Previous community consultation indicated that three-quarters of respondents would be more likely to catch light rail than a bus, and respondents were prepared to walk 600 to 800 metres to a light rail stop (SMEC Australia, 2013).

A person who is induced to catch public transport by the Project, who would walk that distance from home to a light rail stop, and a similar distance again from the light rail to their destination, and then takes the same route home, could walk up to 3 kilometres extra per day, compared to driving from home to their destination.
Reduced pollution

The Project would operate using electricity, while alternative forms of transport run on petrol (cars) or diesel (buses and some cars). If fewer trips along the light rail route are taken by car due to the modal shift away from cars to light rail, and bus services such as the 200 Red Rapid from Gungahlin to Civic are replaced with the Project, this would reduce vehicle emissions in dense residential areas. A review of the health effects of petrol and diesel emissions by the Bureau of Transport and Regional Economics (BTRE, 2005) found that emissions such as carbon monoxide, nitrogen oxide, ozone and particulate matter were associated with increased mortality, exacerbation of asthma, increases susceptibility to respiratory infection, reduction in respiratory function and heart disease.

Further details regarding the potential reduction in pollution associated with the Project is provided in Chapter 11.

Injury from construction accidents or collisions with vehicles and pedestrians

The Rail Safety National Law provides that rail transport operators must consider the safety of rail operations through all stages of the rail project lifecycle, from design through to construction, testing, commissioning, operations, maintenance and decommissioning. During construction, there is a risk of injury to workers constructing the light rail, and risk to members of the public who are near the construction site. A preliminary hazard analysis identified several potential risks during the operational phase of the Project, including:

- collision of Light rail vehicle with other vehicles, pedestrians, cyclists, other light rail vehicles, trees, street furniture, etc.
- electrocution of passengers, trespassers, Project workers
- light rail vehicle derailment
- passenger hazards; e.g. becoming caught in doors, falling while getting on or off the light rail vehicle, falling while inside the light rail vehicle
- overhead lines falling down or coming into contact with other road vehicles.

When the Project is operational, there is the possibility of new injury risks as a result of the introduction of an unfamiliar transport system. Unlike Sydney and Melbourne, Canberra does not have a history of light rail and so many Canberra residents will be unaware of the risks involved in using or being near light rail.

Noise, dust and vibration

Noise, vibration and dust have negative socioeconomic impacts from reduction in wellbeing for residents living and working near the light rail route. The construction of light rail stops, the demolition of existing road pavement, relocation of services and utilities, bridge construction works, and the installation of light rail tracks and associated ancillary infrastructure (e.g. overhead wires) would cause disturbance to surrounding land users. Dust and air pollution would be generated during construction, causing loss of amenity and potential health risks to the community, particularly individuals with pre-existing sensitivity.

Once the Project becomes operational, there would be noise and vibration impacts from light rail vehicles moving down the track. There would also be fixed noise sources arising from the Project including the stabling depot and maintenance facility and the proposed substations. It is unlikely that these light rail impacts would have a greater effect than vehicle traffic already operating on the light rail route.

Further discussion of potential noise and vibration impacts is provided in Chapter 7 and potential dust and other air quality and greenhouse impacts is further discussed in Chapter 11.
14.3.5 Significance of socioeconomic impacts

The significance of each impact of the impacts identified above has been classified according to the population potentially affected by the impact (few, some and many) and the size of the impact (minor, medium and large). The definition of each of these of these impacts, in addition to further details regarding the framework used for the assessment is provided in section 4.1 of Technical Paper 10.

Table 14.4 presents a summary and assessment of the qualitative impacts identified above. These impacts have been categorised against the following headings:

- **Construction or operational**: Construction impacts are temporary during the construction phase, while operational impacts are longer term once the Project is functional.
- **Size of impact**: The magnitude or severity of the impact for those affected.
- **Population affected**: The number of people affected.
- **Positive or negative**: Positive or neutral impacts require no mitigation.
- **Mitigation required**: Negative impacts are considered to require mitigation if they meet the following criteria: if they are large; if they are medium and affect some to many people, or minor impacts that affect many people.

Table 14.4 Summary assessment of potential socioeconomic impacts associated with the Project

<table>
<thead>
<tr>
<th>Impact</th>
<th>Category</th>
<th>Construction or operational?</th>
<th>Size of impact</th>
<th>Population affected</th>
<th>Positive or negative?</th>
<th>Mitigation required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time savings/transport benefits</td>
<td>Economic</td>
<td>Operational</td>
<td>Minor-medium</td>
<td>Many</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Public transport operation impacts</td>
<td>Economic</td>
<td>Operational</td>
<td>Medium</td>
<td>Many</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Land use impacts</td>
<td>Economic</td>
<td>Operational</td>
<td>Medium</td>
<td>Many</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Impacts on private property – construction</td>
<td>Economic</td>
<td>Construction</td>
<td>Minor</td>
<td>Some</td>
<td>Negative</td>
<td>No</td>
</tr>
<tr>
<td>Impacts on private property – operation</td>
<td>Economic</td>
<td>Operational</td>
<td>Minor</td>
<td>Some</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Wider economic benefits</td>
<td>Economic</td>
<td>Operational</td>
<td>Medium</td>
<td>Many</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Disruption to local businesses from severance</td>
<td>Economic</td>
<td>Construction</td>
<td>Medium</td>
<td>Some</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>Disruption to ACT Government operations</td>
<td>Economic</td>
<td>Construction and operational</td>
<td>Medium</td>
<td>Some</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>Improved social cohesion</td>
<td>Social</td>
<td>Operational</td>
<td>Minor</td>
<td>Many</td>
<td>Positive</td>
<td>No</td>
</tr>
<tr>
<td>Impact on roadside memorials</td>
<td>Social</td>
<td>Operational</td>
<td>Large</td>
<td>Few</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>Loss or damage to sites or objects of Indigenous cultural significance</td>
<td>Social</td>
<td>Construction</td>
<td>Large</td>
<td>Some</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>Perceived or actual severance</td>
<td>Social</td>
<td>Operational</td>
<td>Minor-medium</td>
<td>Many</td>
<td>Negative</td>
<td>Yes</td>
</tr>
<tr>
<td>Demographic changes</td>
<td>Social</td>
<td>Operational</td>
<td>Medium</td>
<td>Many</td>
<td>Neutral</td>
<td>No</td>
</tr>
</tbody>
</table>
## Proposed mitigation measures and offsets

A series of mitigation measures have been identified to mitigate the potential negative socioeconomic impacts identified in section 14.3 above, in particular, those identified as negative impacts in Table 14.4.

### During detailed design

- Impacts to private properties along the alignment would be minimised where possible during the detailed design of the Project. This would include measures such as the refinement of the Project impact footprint following detailed design of intersection works, or the rationalisation/minimisation of construction compounds required for construction of the Project by Project Co.

- A business landowner and engagement management plan (or similar) would be developed during the detailed design to be implemented during the construction of the Project. This plan would identify means by which to keep businesses and ACT government operations informed of the Project and methods to proactively support businesses through the construction phase to minimise disruptions.
During construction

- Safe, clearly designed and well signposted crossing zones would be maintained across the light rail route during construction, to reduce actual and perceived severance and mitigate the loss of business over the construction period and the loss of social connectedness.

- Engagement with the Office of the National Rail Safety Regulator would be undertaken to identify and remove or mitigate construction injury risks during construction.

- The Project would maintain open lines of communication with persons at risk of injury during the construction period, including road users, residents and construction workers. This would involve clearly publicising works to affected residents and travellers before they happen, for example through mailouts for residents and businesses on or near the light rail route, posters at bus stops and an updated website showing expected construction dates for each local area.

- Project Co would establish a complaints process to allow affected workers, commuters, businesses and residents to report on hazards that they may identify.

- With respect to potential impacts to roadside memorials and/or sites or artefacts of indigenous cultural significance the following processes would generally be undertaken:
  - Prior to removal of trees (or plaques), Project Co and CMA would engage in community consultation about meaningful ways to transfer the memorials on the old trees to new trees in the same or similar locations, when the new trees are planted. This consultation process would begin prior to construction begins, and before the trees (or plaques) are removed. Project Co and CMA would maintain open lines of communication about plans for the memorials, when they would be taken down and when they would be re-established.
  - Project Co would seek to engage with Canberra’s indigenous community regarding sites or artefacts of indigenous cultural significance. Wherever possible, it would ensure that sites or artefacts are subject to minimal disturbance. Where some disturbance is necessary, Project Co would seek to restore the site or artefact after the Project is complete.
  - Project Co would keep details of their engagements with the community, including any complaints or records of dissatisfaction. Once the Project is complete, Project Co would publish the locations of sites of indigenous cultural significance, roadside memorials and other sites, along with measures taken to preserve those sites.

Additional mitigation measures to minimise amenity impacts from issues such as noise, dust and visual impacts are provided in Chapters 7 (noise), 8 (planted trees), 9 (visual), and 11 (air quality).

During operation

- Design measures would be employed during the detailed design of the Project to ensure it does not create actual or perceived severance. This would encourage greater social and commercial connections across the light rail corridor. Some of the design principles that could be considered to reduce perceived and actual severance along the route would include:
  - Shared light rail/pedestrian zone in Hibberson Street, improving pedestrian access, widening footpaths and improving the streetscape, to increase the perception of safety for pedestrians crossing Hibberson Street.
  - Enhance connection to mixed-use nodes around light rail stops interchanges and enhancing visual and pedestrian connections.
  - Reinstate or enhance footpaths on both sides of Flemington Road, Mitchell and maintain views and pedestrian access to nature reserves where these are impacted by the Project.
  - Consider access and mobility when designing intersections on Northbourne Avenue to reduce the severance effect of the major road, and introducing more informal crossing points as part of a detailed design process.
- LRVs, stops and crossings would be designed during the detailed design phase with road and rail safety in mind, to reduce the risk of injury along the light rail route and on LRVs themselves. Measures which would be considered would include:
  - All stops on medians would have signalised pedestrian crossings for pedestrian safety.
  - The design of vehicles and track would comply with any relevant Australian or international standards.
  - Call buttons would allow passengers to connect directly with the driver to alert them of onboard incidents, or if the driver is unresponsive, with the Operations Control Centre.
  - The placement of poles supporting Overhead Line Equipment (OLE) would take into consideration the risks of collision with road vehicles. All right turns across the light rail tracks would be signalised, with right turn lanes provided.
- A public education campaign would be implemented prior to commencement of, and during initial operation of the Project to inform commuters how to safely catch the light rail, cross the tracks and drive, walk or cycle safely around the light rail.
- A number of measures to improve the safety of light rail passengers would be included in the Project and finalised during detailed design. These measures would include:
  - Buttons at each light rail stop that connect direction to Operations Control Centre staff for emergency assistance.
  - Integrated lighting and closed circuit television (CCTV) security cameras at all light rail stops. Lighting would be brighter than surrounding areas to improve perception of security and reduce the risk of falls.
  - Stops would be designed with the principles of Crime Prevention through Environmental Design (CPTED), which ensure visibility through the whole platform to the surrounding street. This would engender a greater feeling of safety among light rail users and deter crime.
  - LRVs and stops would be fitted with CCTV.
- Regular reviews of crime and safety perceptions on the light rail and around light rail stops would be conducted by Project Co to identify ways in which safety can be improved on an ongoing basis.
- The final requirements for infrastructure and landscape maintenance responsibilities associated with the Project, in addition to temporary arrangements during construction, would be negotiated through ongoing consultation and agreement between CMA, Project Co and TAMS during the design and construction phase with a view to the establishment of a maintenance interface agreement between Project Co and TAMS for the operations phase of the Project.

14.5 Expected conditions

The Project is expected to provide a positive outcome for existing business during operation, with reduced transport costs and times allowing increased patronage along the Project route, particularly around light rail stops. The development of the Project is anticipated to allow for increased mobility along the Project alignment helping to improve social and economic connections within the northern region of Canberra.

The Project is also anticipated to be a catalyst for the future urban growth of the northern regions of Canberra, including Gungahlin, the new developments of Molonglo and other existing inner north suburbs (including areas such as Braddon, Turner and Civic). The Project is expected to assist in meeting the transport needs of these growing suburbs in addition to providing opportunities for developing other areas, such as Dickson, which is also planned for future growth and commercial expansion (refer to Chapter 3).

The potential social and economic impacts associated with the project are expected to be adequately managed through the mitigation measures identified such that the expected conditions associated with these impacts would be minimal.
14.6 Residual risks

Based on the mitigation measures identified in section 14.4, an assessment of the residual social and economic risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 14.5.

Table 14.5 Residual social and economic 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>J.2</td>
<td>Removal of existing roadside memorials which are within the footprint of the Project, such as those associated/attached to existing trees along Northbourne Avenue.</td>
<td>Very high</td>
<td>Almost Certain</td>
<td>Minor</td>
<td>High</td>
</tr>
<tr>
<td>J.3</td>
<td>Impact on local communities during construction, including reduction in amenity (such as noise, dust and visual impacts).</td>
<td>High</td>
<td>Possible</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>J.5</td>
<td>Potential for the community to perceive that the light rail infrastructure will create a barrier between the east and west sides of Northbourne Avenue/Flemington Road.</td>
<td>High</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>

Note for residual risk ID J.2: The consequence of this risk has been reduced as through the implementation of the identified processes and protocols for managing affected roadside memorials, it is considered that the residual consequence on these sites would be reduced.
15. Utilities and services

This Chapter considers the potential impact on utilities from the Project. The existing utilities within the Project impact footprint are considered along with the potential adjustments which may be required for new utilities required for the Project.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential utility and services risks presented in Table 15.1 below.

Table 15.1 Initial utility and service 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>K.1</td>
<td>Disruption to asset owner access to services and utilities.</td>
<td>Possible</td>
<td>Major</td>
<td>High</td>
</tr>
<tr>
<td>K.2</td>
<td>Damage to services and utilities during construction (including safety risks, such as earth potential rise).</td>
<td>Possible</td>
<td>Major</td>
<td>High</td>
</tr>
<tr>
<td>K.3</td>
<td>Electrolysis corrosion risks caused by potential stray leakage currents from the running rails into surrounding earth causing cause electrolysis corrosion of nearby buried metalwork.</td>
<td>Possible</td>
<td>Major</td>
<td>High</td>
</tr>
</tbody>
</table>

15.1 Environmental conditions and values

Underground and overhead utilities in the Canberra area have a substantial footprint and interface with the existing road infrastructure. As such, the utilities protection or relocation component of the Project would require detailed management.

The light rail would pass over or near a number of existing overhead and underground utilities along the Project alignment. Critical areas include the Northbourne Avenue and Federal Highway median, and intersections along the alignment. The types of utilities to be affected by the Project include:

- underground and overhead electrical cables (high and low voltage)
- water supply mains
- sewer
- stormwater
- gas mains
- street lighting
- telecommunications cables.

Further consultation with utility providers would continue to occur to inform the ongoing design development of the Project (Chapter 21 presents information regarding the consultation process with utility owners that has been undertaken to date).
15.2 Investigations

The location of utilities within the Project impact footprint has been determined from the following primary sources:

- Dial Before You Dig (DBYD) enquiries
- AutoCAD data supplied by service authorities
- Territory and Municipal Services GIS database (drainage)
- existing survey information
- underground utility survey
- ongoing consultation with utility and other asset owners (refer to Chapter 21).

DBYD enquiries were undertaken in February 2014 to determine the location of utilities along the proposed rail corridor. A subsequent DBYD enquiry was completed in April 2014 to determine the location of utilities at the site of the proposed depot. DBYD data was supplemented by additional data received in March 2014 from service authorities to form electronic 2D utility information.

Between July 2014 and January 2015, an underground utility survey (UUS) was undertaken along the light rail corridor within the existing road reserve. The survey included the following:

- surface electronic detection (tracing) of non-hydraulic utilities
- individual potholing of non-hydraulic utilities and water mains and survey of exposed utility
- trenching across the median in Northbourne Avenue and survey of exposed utilities
- survey of additional stormwater and sewer utilities.

15.3 Potential impacts

15.3.1 Construction

Construction impacts to underground and overhead services and utilities would include potential for injury to construction workers or the wider community in the unlikely event that utility services are accidentally damaged during excavation, plant movement or general civil works.

Relocation and disruption to existing services

Construction of the Project requires augmentation and/or relocation of a number of minor utility services along the Project alignment. Construction within the median of the Federal Highway/Northbourne Avenue between Flemington Road and the intersection of Northbourne Avenue and Antill Street/Mout Street requires the relocation of a major gas main. This gas main may be relocated to the eastern verge of Federal Highway/Northbourne Avenue. Detailed consideration would be given to the design development and execution of the gas main relocation to ensure it is conducted safely and efficiently.

If the utilities and services along the Project alignment cannot be protected during relocation, users of these services (including residential, commercial and industrial properties along the Project alignment) may experience short disruptions. Disruption in disconnecting and reconnecting utility services to individual landowners and occupiers would be kept to a minimum.
The extent and timing of these impacts and any works required to relocate or replace services would be confirmed during detailed design in consultation with the relevant utilities providers and impacted stakeholders. To minimise disruption of services to properties along the alignment, replacement services (where required) would be provided prior to disconnection of existing services. Ongoing consultation between Project Co and property owners would occur to provide sufficient notification of any interruptions to services throughout the construction period.

Despite thorough utility investigations, as discussed in section 15.2, a risk of the discovery and/or damage to unknown utilities within the Project footprint during construction would still remain. Mitigation measures to reduce the uncertainty of unknown utilities are described in section 15.4.

Potential impacts to construction workers and members of the public

Transmission of large electrical currents through the ground (known as ‘earth potential rise’) could potentially occur as a result of damaged power cables or mains. In the unlikely event that an existing electrical cable is damaged during construction, this could have the potential to injure construction workers and members of the community standing close to the damaged power utility. This potential hazard is unlikely to occur due to the management measures proposed as part of the project.

Damage to other mains (such as gas, water or sewer) could also result in injury to construction workers and community members. Mitigation measures to reduce the potential for impact from strikes to services are described in section 15.4.

New utilities

As discussed in section 2.2.2, the Project would require a number of new utility infrastructure to allow for the operation of the project. Utility infrastructure and services required for the Project include:

- cabling for communications systems (e.g. for CCTV systems, emergency telephones/help points, public address, passenger information displays)
- cabling for the signalling system
- cabling for power supply between the feeder connection points, overheard wiring system, substation locations and the main track alignment
- trackside signalling equipment (e.g. post-mounted signals, location cabinets, track circuits, points machines, etc.)
- local power supply for stops (cabling, distribution boards, switchboards, etc.), lighting, signage, CCTV systems, public address and security systems
- water supply (e.g. for cleaning activities).

The installation of new services is unlikely to result in any significant impacts during construction. Minor disruptions to the supply of utility services to landowners may however occur where these new services are connected to existing services.

15.3.2 Operation

Operation of the light rail would require an additional draw of power to run the LRVs and electrical equipment (such as lighting and emergency help points at each stop). The project would therefore include the installation of seven substations along the rail corridor to augment the local power systems and supply the Project with the required power to operate the light rail.

Impacts to other utilities during operation are anticipated to be minimal. Access to all existing utilities, for routine maintenance and inspection would be maintained during operation.
Electrolysis corrosion

Corrosion on the surface of a conductor results when electric current leaves the metallic conductor and travels via an ionic path through the soil. If left uncontrolled, stray currents can be detrimental for a number of the Project components and third-party assets such as metallic utility pipes and cables. At-risk assets would also include the light rail system fixed components including surface, above-ground and below-ground structures and adjacent facilities along the alignment. Management of this potential impact is discussed in section 15.4 below.

15.4 Proposed mitigation measures and offsets

A Utility Management Plan would be prepared prior to construction and would include, as a minimum, processes and procedures for:

- the design and approval process, construction and inspection requirements, handback process, access and maintenance requirements for existing and proposed utilities
- a list of all utility services to be treated. The list would include risks and mitigation measures for each utility service
- identification of key delivery management personnel in the utility service treatment team
- detailed construction methodologies
- unknown utility methodology.

Construction

Management of construction works (underground utilities)

The following mitigation measures would be implemented to manage impacts to utilities and services during construction.

- Investigations would be carried out during the detailed design of the Project to ensure all appropriate measures are in place to minimise the potential risks to existing utilities and services prior to commencement of construction works.
- Project Co would check the locations of existing underground utilities and services prior to commencing construction works.
- Should the location of any utilities be identified to be in conflict with the Project, a formal review of the proposed works at these location(s) would be undertaken in consultation with Project Co and the relevant utility organisations. Alternative arrangements would be determined to provide a beneficial outcome for the community, service provider and project in terms of safety and constructability.
- The discovery and/or damage to unknown utilities would follow procedures outlined in the utility management plan (refer below). This would provide for the identification of the utility owner, evaluation of whether the utility is currently in use and a danger to workers and the community. The overall strategy for the preferred hierarchy of utilities treatment as part of the Project would include the following:
  - do nothing – avoid impact on utilities where possible
  - protect – protect utilities in their existing locations where feasible
  - relocate – utilities to be relocated only where no other options are feasible or acceptable.
- Utilities that run parallel with the Project alignment for a length greater than 10 metres and would be impacted by the Project would be relocated rather than protected.
All utility service relocations would comply with the TAMS *Design and Construction Standards for Urban Infrastructure* as described in AS 5488, or other relevant standard(s) as required.

Two zones of utilities that run perpendicular to the Project have been identified:
- clash detection zone – an area extending 2.5 metres from the centre of the Project alignment, to a depth ranging from 0.55 metres to 0.75 metres depending on the rail design
- build over zone – an area extending 2.5 metres from the centre of the Project alignment, to a depth 2 metres below the clash detection zone.

These would be typically treated on the following basis (subject to detailed design):
- utility below build over zone – do nothing
- utility within build over zone – protection or possible relocation
- utility within clash detection zone – relocation
- longitudinal utilities impacted – relocation
- structure (i.e. pit within clash zone) – relocation.

Management of construction works (aboveground utilities)

Assets with insufficient clearance would require relocation (including potential undergrounding of these assets). The 11 kV and 33 kV crossings would require undergrounding, and would be agreed between Project Co and ActewAGL during the detailed design phase (prior to construction).

Consultation and engagement with utility owners and affected land owners

During the ongoing development of the Project, CMA and Project Co would continue to engage with all appropriate service utility providers (e.g. electricity, communication and water services) regarding potential impacts to services. Prior to the commencement of construction works, consultation would be undertaken with affected utility owners, including (but not limited to) Actew Water (Icon Water), ActewAGL, Jemena, Telstra, TransACT, Optus, NBNCo, ICON, AAPT and TAMS.

Affected landowners and occupiers would also be consulted in a timely manner to arrange acceptable time(s) for works that may cause disruption.

Operation

The Project would be designed to operate in an energy efficient manner with minimum drawdown on local power. However, the operation of the Project would require installation of seven substations along the alignment to operate the LRVs.

Access points would be provided as part of the detailed design to allow for access during routine maintenance operations.

Consultation with TAMS and other utility/service providers would be undertaken during detailed design to ensure appropriate measures are taken regarding the potential integration of future utilities and to ensure that the Project does not preclude the development or installation of these proposed utilities.

Electrolysis corrosion

The recommended mitigation strategy for electrolysis corrosion is to minimise stray current at source to the greatest extent possible by careful attention to the design, installation and testing of the rail insulation. Project Co would develop, implement, and maintain a Stray Current Plan, which would identify how Project Co would comply with stray current requirements.
15.5 Expected conditions

Utilities within the Project impact footprint would be maintained, protected or relocated depending on their proximity to the project alignment as discussed in section 15.4. These management measures would allow for access to utilities for maintenance and reduce future impacts of the Project.

15.6 Residual risks

Based on the mitigation measures identified in section 15.4, an assessment of the residual utility and services risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 15.2.

<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>K.1</td>
<td>Disruption to asset owner access to services and utilities.</td>
<td>High</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td>K.2</td>
<td>Damage to services and utilities during construction (including safety risks, such as earth potential rise).</td>
<td>High</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td>K.3</td>
<td>Electrolysis corrosion risks caused by potential stray leakage currents from the running rails into surrounding earth causing electrolysis corrosion of nearby buried metalwork.</td>
<td>High</td>
<td>Remote</td>
<td>Major</td>
<td>Low</td>
</tr>
</tbody>
</table>
16. Waste, energy and resources

This Chapter describes the handling of materials and waste during all stages of the Project. This involves the waste to be disposed in the landfill, materials required for construction and operation.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential waste, energy and resources impacts risks presented in Table 16.1 below.

Table 16.1 Initial waste, energy and resources 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>L.1</td>
<td>Increased waste from construction of infrastructure and ancillary structures (such as depot facility buildings). Environmental hazards associated with the disposal of construction waste, including potentially hazardous/contaminated materials (e.g. asbestos, contaminated spoil).</td>
<td>Almost Certain</td>
<td>Minor</td>
<td>High</td>
</tr>
<tr>
<td>L.2</td>
<td>Increased demand on resources (e.g. electricity, fuel, concrete, water) resulting in reduced availability of resources for the local community.</td>
<td>Likely</td>
<td>Minor</td>
<td>Medium</td>
</tr>
<tr>
<td>L.3</td>
<td>Increase in energy consumption associated with manufacturing building materials and infrastructure and during construction.</td>
<td>Almost Certain</td>
<td>Minor</td>
<td>High</td>
</tr>
<tr>
<td>L.4</td>
<td>Increase in energy consumption associated with operation of light rail infrastructure.</td>
<td>Almost Certain</td>
<td>Moderate</td>
<td>Very high</td>
</tr>
</tbody>
</table>

16.1 Overview

The consumption of resources and production of waste are inherently linked. By minimising resource consumption, waste production is typically reduced as is the resultant impact on the environment. Resource and waste management would be prioritised according to the resource management hierarchy.

- avoidance of unnecessary resource consumption
- resource recovery (including reuse, reprocessing, recycling and energy recovery)
- disposal.

The Project has the potential to utilise a range of different resources and generate a number of different waste types throughout its construction and operational phases. Construction of the Project would require the use of a range of resources such as electricity, water, fuel, concrete and paving materials (such as materials required for stop platforms). Other resources would be required for infrastructure such as signals, signage, fit out of the stops, landscaping and retaining walls. Minimal waste and resource use is anticipated to occur during operational of the Project.
16.2 Investigations

A desktop review was undertaken to identify the potential construction resource, energy and waste management impacts associated with the construction and operation of the Project. The Greenhouse Gas Emissions Estimation prepared by WSP (Technical Paper 7) was also reviewed as part of the consideration of waste, energy and resource impacts associated with the Project.

16.3 Potential impacts

16.3.1 Construction resource and waste management

Demand on resources

Potential sources of waste during construction would include earthworks, vegetation clearing, drainage works, demolition, equipment maintenance, road infrastructure upgrades, waste concrete, wood and metal, materials packaging and worksite office activities. Construction of the Project would increase demand on local and regional resources, but would not result in resources becoming scarce or in short supply within the Canberra or greater regional area. Concrete, backfill and equipment for the rail systems and construction of the stops and depot would require imported materials for construction works.

Bulk materials required for the project include:

- Diesel
- rail (steel)
- structural steel
- concrete
- asphalt
- general fill material
- water
- PVC ducts.

The estimates quantities of bulk materials have been previously identified in section Table 2.4 of this EIS. Other resource requirements would be determined during the detailed design and construction phase.

Waste

The construction of the Project would generate various types of wastes and increase waste to landfill during the construction phase. Generated waste would be managed in accordance with ACT EPA Guidelines and would include:

- demolition waste from existing structures (including concrete, bricks and steel)
- construction waste materials (including packaging, concrete, bricks, crushed rock, steel and timber)
- liquid wastes (including waste fuels, paints, oils and chemicals)
- cleared vegetation
- wastewater (including site run-off and water used to control dust)
- domestic wastes (including food scraps and putrescible wastes, aluminium cans, glass bottles, plastic and paper containers used by construction workers)
- sewage from construction site facilities
- possible contaminated materials (including but not limited to asbestos and contaminated spoil).
Hazardous material use during construction

During construction, potentially hazardous materials would be stored and used on-site at the proposed construction compounds, laydown areas and other ancillary work areas. Potentially hazardous materials that may be required to be stored on-site during construction would include fuels, chemicals, lubricating oils, cement, epoxy, paints or other hazardous liquids and materials required. The refuelling and maintenance of construction plant and equipment would be undertaken within designated areas at these construction sites, and typically using specialised refuelling contractors equipped with appropriate spillage response equipment and training.

Potentially hazardous materials would be transported to and from construction sites on public roads. Spills and leaks during transportation may result in the contamination of land and waterways outside of the Project impact footprint. This risk would be managed through the use of contractors who are certified to transport those potentially hazardous materials and have adequate environmental management procedures to address risks associated with spills and leaks during transportation.

Any hazardous waste arising from construction of the project would be removed and disposed in accordance with relevant ACT EPA guidelines. Further discussion regarding the potential impacts of hazardous materials usage during the construction of the Project is provided in Chapter 19.

Impacts of increased energy consumption during construction

Manufacturing of building materials and infrastructure would require energy consumption during construction. Details regarding the potential energy consumption during construction of the Project is provided in Chapter 11.

16.3.2 Operational resource and waste management

Demand on resources

The maintenance and occasional repair of Project infrastructure during operation would require some limited amounts of resources. However, these activities would not place a significant demand on resources.

Waste

Typical wastes during operation would be minimal and would potentially include maintenance waste from LRVs and track work. Some waste would also be generated by general maintenance and repair work that would occur at the stabling depot and maintenance facility. These would require various management measures and disposal processes in accordance with ACT EPA Guidelines.

Wastes generated by the operation of the Project would potentially include wastewater from general maintenance activities, oils and other materials used during track maintenance, and trimmed vegetation from vegetation and landscaped areas to maintain a clear corridor for operation of LRVs. Rail users may also generate small amounts of general waste and litter at stops. Additionally, wastewater would be generated from cleaning LRVs at the stabling depot and maintenance facilities.

Hazardous material storage and use during operation

Some hazardous materials, such as cleaning chemicals, fuels, chemicals, lubricating oils, paints or other hazardous liquids and materials required for the ongoing operation of the Project would be stored at the stabling depot and maintenance facility at Mitchell. These materials would be stored in accordance with relevant ACT EPA guidelines (refer to section 16.4) and are not anticipated to impact on the operation of the Project or surrounding land uses. Further discussion regarding the potential impacts of hazardous materials storage and usage during the operation of the Project is provided in Chapter 19.
16.4 Proposed mitigation measures and offsets

Construction

As part of the overarching CEMP for the Project, a waste and recycling management plan would be prepared for the Project prior to construction works commencing. The plan would detail standard environmental management measures to manage resource consumption and to avoid, re-use and dispose of waste during construction. These measures would include:

- investigating opportunities to re-use or recycle other construction and demolition waste
- applying the waste hierarchy (avoid, minimise, re-use/recycle, dispose) during construction
- preparing and maintaining a waste management system on site (including recycling)
- promoting minimal resource use as a design target
- treating any wastewater collected prior to discharge, in accordance with current standards
- chipping leaf material and small branches of native vegetation for use as mulch in revegetation or landscaping works
- disposing all other green waste from vegetation removal to a green waste recycling facility
- maintaining work sites in a tidy state, and appropriately disposing of all general litter (including food scraps, plastics, glass bottle)
- providing reuse and recycling training and infrastructure at construction sites
- setting construction reuse and recycling targets and monitoring waste generated to manage and classify waste for disposal in accordance with the relevant ACT EPA Guidelines
- using a licensed contractor to remove contaminated waste, under current ACT EPA Guidelines
- where appropriate, sourcing of materials would be undertaken using locally available resources and materials.

All waste generated and surplus spoil from the construction of the Project would be transported to the West Belconnen Resource Management Centre, or another appropriate facility, as detailed in section 2.2.3. Initial consultation with ACT NoWaste has been undertaken by CMA to confirm the facilities suitability of this facility for the disposal of waste associated with the Project. At this time, it is considered that this facility has the capacity to process, recycle or dispose of all waste generated by the Project.

Storage, stockpiling disposal and reuse of materials

Measures for the storage, stockpiling and disposal of materials would include:

- Stockpiles would be located on relatively level ground and away from areas of ecological or heritage value or from drainage lines and waterways.
- Stockpiling of materials within the median along Northbourne Avenue would be limited where possible to minimise visual impacts.
- Prior to removal of material for off-site disposal, these materials would be assessed for suitability for beneficial reuse. Where material is intended for beneficial reuse, a beneficial reuse assessment (BRA) would be undertaken in accordance with the ACT EPA 2014, Information Sheet 4 – Requirements for the reuse and disposal of contaminated soil in the ACT.
- Any hazardous materials required for the operation and maintenance of the Project would be stored in accordance with relevant ACT EPA guidelines.
Operation

Measures for the management of waste and resources during operation of the Project would include:

- Rubbish bins would be provided for passengers and users to appropriately dispose of any general or putrescible wastes.
- Reuse and recycling facilities would be provided at the stabling depot and offices for the use of staff. Collection of this waste would be managed by Project Co during operation of the Project.
- Waste generated during maintenance of the Project (including track and other maintenance works) would be disposed of to an appropriate local waste management facility.
- Storage of chemicals associated with the operation and maintenance of the LRVs would be designed in line with the appropriate ACT EPA guidelines and legislative requirements.
- Hazardous material procedures (including procedures for managing spills, and the refuelling and maintenance of vehicles/equipment) would be developed and implemented during operation of the Project to minimise impacts associated with chemical spills and leaks. These procedures would adequately address activities at the proposed stabling depot and maintenance facility at Mitchell, as well as other general maintenance facilities along the Project alignment.

16.5 Residual risks

Based on the mitigation measures identified in section 16.4, an assessment of the residual waste, energy and resources risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 16.2.

<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>L.1</td>
<td>Increased waste from construction of infrastructure and ancillary structures (such as depot facility buildings). Environmental hazards associated with the disposal of construction waste, including potentially hazardous/contaminated materials (e.g. contaminated spoil).</td>
<td>High</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>L.2</td>
<td>Increased demand on resources (e.g. electricity, fuel, concrete, water) resulting in reduced availability of resources for the local community.</td>
<td>Medium</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>L.3</td>
<td>Increase in energy consumption associated with manufacturing building materials and infrastructure and during construction.</td>
<td>High</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>L.4</td>
<td>Increase in energy consumption associated with operation of light rail infrastructure.</td>
<td>Very high</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
</tbody>
</table>
17. Land use

This Chapter provides a summary of the existing land use along the Project alignment and provides an overview of the potential construction and operational impacts of the Project on these land uses.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential land use impacts risks presented in Table 17.1 below.

**Table 17.1  Initial land use 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>M.1</td>
<td>Impacts on public property including footpaths and open spaces along the proposed alignment as a result of construction of the Project.</td>
<td>Likely</td>
<td>Minor</td>
<td>Medium</td>
</tr>
<tr>
<td>M.2</td>
<td>Potential for temporary reduction in property amenity and value due to construction impacts.</td>
<td>Likely</td>
<td>Minor</td>
<td>Medium</td>
</tr>
<tr>
<td>M.3</td>
<td>Loss of public open space and associated social impacts.</td>
<td>Unlikely</td>
<td>Minor</td>
<td>Very low</td>
</tr>
<tr>
<td>M.4</td>
<td>Potential for increase in property amenity and value due to new light rail infrastructure.</td>
<td>Possible</td>
<td>Positive</td>
<td>Beneficial</td>
</tr>
<tr>
<td>M.5</td>
<td>Acquisition of private land for the Project.</td>
<td>Almost certain</td>
<td>Minor</td>
<td>High</td>
</tr>
</tbody>
</table>

17.1 Environmental conditions and values

Existing land uses along the Project alignment

The project would be located within an urban environment with varied characteristics. The nature and character of land uses within the vicinity of the Project from the Gungahlin terminus stop to the Civic terminus stop are provided below. As illustrated in Figure 17.1, existing land use surrounding the corridor varies with distinct clusters of land use zoning evident along much of the route.

Northern corridor section (Gungahlin and Flemington Road)

The northern part of the corridor is located in the urban district of Gungahlin, which as a development corridor undergoing ‘greenfield’ urban development, is characterised by varying extents of urban development and infrastructure provision. The Gungahlin town centre (at the northern extent of the study area) contains undeveloped blocks, which will eventually become similar to other urban district centres in metropolitan Canberra like Belconnen, Tuggeranong and Woden. The surrounding suburbs are similarly at varied degrees of development with townhouse style residential development occurring in the suburbs adjacent to the Project corridor.

The industrial suburb of Mitchell marks a change between the residential area of the north and the underdeveloped areas between Mitchell and Northbourne Avenue. This section is undeveloped, however includes the Canberra Racecourse and EPIC.
Figure 17.1 Land Use/Custodianship

Legend
- Project Alignment
- Depot boundary
- Stop platform
- Land use policy description
  - ZF - Community facilities
  - G21 - Core zone
  - C22 - Business zone
  - C23 - Services zone
  - C24 - Local centre
  - C25 - Mixed use
  - CES - Lakeside and accommodation
  - DES - Designated
- R1 - General industry
- R2 - Industrial mixed use
- R21 - Broadacre
- R22 - Rural
- R23 - Infill, edges and buffer areas
- R24 - River corridor
- NU25 - Mountainous and bushland
- PU21 - Urban open space
- PU22 - Restricted access recreation zone
- RZ1 - Suburban
- RZ2 - Suburban core
- RZ4 - Medium density residential
- RZ5 - High density residential
- TS21 - Transport
- TS22 - Services
Southern corridor section (Federal Highway and Northbourne Avenue)

The southern part of the corridor is defined by the nationally significant Federal Highway and Northbourne Avenue, which forms the primary gateway to Canberra. The Federal Highway is defined by residential land uses to the east and open space uses (sporting ovals, golf Course etc.) to the west. Northbourne Avenue is defined by its wide median and adjacent commercial buildings, which occupy relatively large blocks (allowing for areas of open car parking between buildings) and landscaping of a good quality.

The inner northern suburbs on either side of Northbourne Avenue were developed in the 1950’s expansion of Canberra, and although some intensification of residential development has occurred along some sections of Northbourne Avenue and the adjacent suburbs, the area currently contains a predominant amount of post-war residential housing. These suburbs are serviced by a number of district centres, the largest and most significant along the Project alignment is Dickson.

The southern end of the Project alignment is characterised by the commercial and retail/business uses associated with Civic.

Recreation facilities

There are a number of formal and informal recreation facilities which currently exist along or within close proximity to the alignment which are considered as part of the Project. These facilities include:

- Gubur Dhaura Heritage Park
- Harrison District Playing Fields
- Canberra Racecourse
- EPIC
- Yowani Country Club
- Southwell Park (including the ACT Netball courts, Canberra Archery Club and Hockey ACT)
- Haig Park
- A range of other local parks along and within close proximity to the Project alignment.

Potential future land uses within the vicinity of the Project

Current and proposed urban development along the Project corridor between Gungahlin and Civic is identified in existing ACT Government strategies and available master plans. With respect to potential future land use developments along the Project corridor, a review of EPD’s current DA and EIS registers was undertaken (May 2015). This search identified a range of major developments which are currently under consideration by EPD along the Project corridor. These developments include:

- mixed use commercial and residential units in Braddon – this proposal includes construction of a new 6 storey mixed use development, comprising of commercial ground and first floor tenancies and 5 levels of 60 residential units
- multi dwelling unit development in Gungahlin – this proposal includes the construction of a standalone 22 storey building, comprising a total of 243 residential apartments
- mixed use commercial and residential units in Gungahlin – this proposal includes construction of new mixed use development including 2 commercial tenancies and 155 residential units
- mixed use commercial and residential units in Gungahlin – this proposal includes construction of a 3 storey development consisting of ground floor commercial unit and a 2 storey single dwelling
- multi dwelling unit development in Gungahlin – this proposal includes the construction of a standalone 20 storey building, comprising 192 residential apartments and retail at ground floor
- multi dwelling unit development in Gungahlin – this proposal includes the construction of a standalone 19 storey building, comprising a total of 192 residential apartments
- multi dwelling unit development in Lyneham – this proposal includes the construction of 4 new 3 storey residential units with attached garages
- multi dwelling unit development in Turner – this proposal includes the construction of 6 new dwellings with attached garages.

The interaction of the Project with existing ACT Government strategies and current master plans has previously been discussed in section 3.4 of this EIS.

17.2 Investigations

A site investigation was undertaken in January 2015 to view and confirm adjacent land uses and potentially sensitive land uses within a close proximity. Aerial photographs of the Project corridor were also used to confirm observations from the site visit and to identify land uses further away from the immediate Project corridor. The data collected was compared to zoning information accessed via the ACTMAPI website (http://www.actmapi.act.gov.au/home.html).

17.3 Potential impacts

17.3.1 Construction impacts

Property acquisition and impact to public land and facilities

The permanent footprint of the Project is within the existing transport corridor along Flemington Road, the Federal Highway and Northbourne Avenue which is owned and maintained by the ACT Government. However, some portions of private land would require Territory land or lease boundary realignments as previously discussed in section 2.2.4 of this EIS.

Outside of the existing transport corridor, the operation of the Project is unlikely to impact on public land and facilities. Access to all public land and facilities would be maintained during the operation of the Project.

Temporary land take

Construction of the Project would require the temporary use of land outside of the permanent Project footprint but within the identified construction footprint (as identified in Section 2.23 and Figure 2.15a to 2.15e) for the following activities:

- construction of pedestrian access paths to light rail stops
- where new signalised intersections are proposed
- the construction compounds and construction vehicle access points.
The use of these sites would be subject to consultation with relevant landowners, other stakeholders and/or TAMS. The impacts of the temporary use of these sites have been assessed as part of this EIS. Impacts such as damage to vegetation and existing local infrastructure (footpaths, kerbs etc. and public access restrictions are expected to be short term in nature. These areas would be reinstated upon completion of construction in the area.

**Impacts to public land and recreation facilities**

Outside of the existing transport corridor, construction of the Project is unlikely to impact on public land and facilities during construction. As shown on Figure 2.2c and described in section 2.2.4 of this EIS, some minor works to the access arrangements to the Lyneham Sport Precinct would be required to accommodate the stop and intersection, and improving the existing car parking for the ACT Netball site. These works may have some temporary impacts to the sporting facility during the construction period. During construction, access to this site would be maintained through a modified access arrangement.

**Property amenity**

The construction of the Project may adversely affect the amenity of some adjoining land uses due to impacts such as:

- noise generated by construction activities (refer to Chapter 7)
- dust generated by construction activities (refer to Section 11.3)
- traffic disruption associated with construction traffic and potential temporary road closures (refer to Chapter 10)
- visual impacts associated with tree removal, stockpiles and construction vehicles/equipment (refer to Chapter 9).

Amenity-related impacts on adjacent properties would be most significant in areas where residential properties or other sensitive land uses are either located directly adjacent to construction activities (predominantly within the vicinity of the new stops) or where residential/sensitive receivers have an unscreened view of the construction areas.

Amenity impacts are anticipated to be relatively short term in nature (during the construction works period) and would be managed in accordance with the mitigation measures identified in the relevant impact assessment chapters noted above.

**17.3.2 Operational impacts**

**Recreation**

As noted above, the permanent footprint of the Project would be largely within the existing transport corridor along Flemington Road, the Federal Highway and Northbourne Avenue. Outside of the existing transport corridor, the operation of the Project is not anticipated to impact on any existing formal or informal recreation facilities. Access to all existing recreation facilities such as local and regional parks, EPIC, the Canberra Racecourse other recreational facilities would be maintained during the operation of the Project.
Impacts to land use and property in the vicinity of the Project

A positive land use benefit may arise from the Project leading to higher urban density along the route. The increase in urban density may result in:

- an increase in land value
- more efficient and available access to public infrastructure and services (such as health, education and utilities)
- urban densification benefits from increased productivity and energy efficiency.

Some residents along the light rail route may express concern that their property amenity and land values may be affected negatively by the Project. The land use and property impacts on amenity and land prices of other light rail projects around the world indicate that potential impacts are positive (ACT Government, 2014c), even where the construction process reduces amenity in the short term. Whilst increased land values may result in a positive impact for property owners, increased land values could also result in rate increase. Therefore, any increase in property values may be seen as a deferred benefit (until the future sale of the land). Whist this may occur, it is anticipated that the potential increase in any rates payable, as a direct result of the Project, would be minimal.

As described previously, some small amounts of land along the Project route would require a land lease boundary realignment at the Yowani Country Club and Lyneham Sports Precinct. This requirement for land boundary realignment may, to a small extent, reduce the land available for sporting and social activities, however the land proposed is on the edge of the property. In addition, some land at the EPIC site may also require some existing land boundary realignment for the widening of Flemington Road, which may slightly reduce car parking at the site or reduce the area available for events at this location. The impact of this, however, is expected to be minimal.

Any future developments along the Project alignment would also be positively integrated with the Project by providing an opportunity to develop a transit-orientated development around future urban development areas. The Project would also be a catalyst for the economic development of land in the vicinity of the transport stops as a result of the greater accessibility, thereby improving overall property amenity and values along the alignment.

Property amenity

The operation of the Project would result in some adverse amenity impacts for some adjoining land uses including:

- noise from LRV operations, stop activities and maintenance activities (however this is anticipated to be low (refer to Chapter 7)
- visual intrusion – from the new stops and Project alignment (refer to Chapter 9)
- increased commuter traffic (primarily pedestrian) within the local area resulting from the operation of the Project (refer to Chapter 10).

These issues and management measures to mitigate impacts are further discussed in the relevant impact assessment chapters noted above. The operation of the Project is also anticipated to result in positive amenity impacts for some adjoining land uses through the encouragement of a shift away from private vehicle to public and active transport options (light rail, walking, cycling etc.) thereby reducing traffic impacts on the existing local and arterial network and improving local air quality (refer to Chapter 11).
Impact to existing uses of land along the Project corridor

As discussed in section 2.2.4 of this EIS, the majority of the Project would be contained within the existing road reserve and central median between Gungahlin and Civic. However, some land outside the existing road reserve would be partially impacted both during the construction (for use as temporary construction compounds) and operation of the Project (for permanent Project elements including the stabling depot and maintenance facility, substations and road widening works). These land parcels are listed in Table 2.10 of this EIS.

The use of these parcels for the Project would impact the following land use zonings:

- CZ2 – Business
- CZ5 – Mixed Use
- IZ1 – General Industry
- NUZ3 – Hills Ridges and Buffers
- PRZ1 – Urban Parks and Recreation
- PRZ2 – Restricted Access Recreation
- NUZ1 – Broadacre.

These land uses permit a range of potential uses (other than light rail) ranging from commercial, retail, industrial and open space uses. A majority of these land uses would only be impacted during the construction period (as temporary construction compounds). The use of these parcels of land would result in a temporary restriction of the identified potential land use throughout the construction period. Following the construction of the Project, these parcels of land would continue to be available for use in accordance with their identified land zonings.

Where permanent Project elements (including the stabling depot and substations) are proposed on land parcels, other than those designated as transport corridor, there would be an impact to the future use of these parcels. Of these elements, the greatest potential impact to existing land uses would be the establishment of the stabling and maintenance facility at Mitchell, which would impact on the following existing land uses:

- IZ1 – General Industry
- NUZ3 – Hills Ridges and Buffers.

The development of the stabling depot and maintenance facility would therefore potentially remove the future use of this land for the intended purposes currently identified for these zones. However, as noted in section 3.3.3 of this EIS, a Territory Plan variation has commenced for the Project. This variation includes two proposed elements with respect to the stabling and maintenance facility site. These are:

- amendment to the definition of IZ1 – General Industry zone to include light rail depots as a permissible development on this zone (through the amendment of the current ‘Municipal depot’ definition)
- extension of the IZ1 zoning further to the south and amend the boundary of the current NUZ3 – Hills Ridges and Buffers zone area and reserve overlay as it appears on the Territory Plan.

Once the Territory Plan variation has been completed, the proposed use of the site as a light rail stabling depot and maintenance facility would be consistent with the intended use of the land and would therefore not impact the intended use of these parcels of land (subject to approval of the Territory Plan variation).
With respect to the siting of the proposed substations, these Project elements would be located on urban parks and recreation land (PRZ1). The development of the substations would reduce the amount of open space available at each site, however would not limit the ongoing use of the remaining land surrounding each substation for the intended purpose of open space and recreation.

Potential future land uses within the vicinity of the Project

As identified in section 17.1 above, a number of development sites have been identified along and in the vicinity of the Project corridor. The development of these sites is anticipated to integrate positively with the Project as the light rail would provide a high quality transport option for the future residents of these residential developments, in addition to providing access to the proposed retail and commercial components of these developments for customers and employees respectively.

A range of further smaller scale redevelopments could occur throughout the Project corridor and broader region to take advantage of the improved transport network the Project would provide. These developments would also be expected to integrate positively with the Project by providing an opportunity to further develop centres such as Dickson, in line with the current master plan for this area.

Any future developments along the Project corridor and in particular future developments proposed for sensitive land uses, would be required to consider the potential impacts of the Project (subject to approval) on that development and the potential impacts of that development on the Project.

17.4 Proposed mitigation measures and offsets

The Project has been designed to minimise the overall impact on adjoining land uses. Community and stakeholder consultation is required during the construction of the project to mitigate potential land use and amenity issues, particularly for sensitive land uses within the immediate vicinity of the project. Information would be provided to the local community on a regular basis throughout the construction of the project to ensure they are adequately informed of the works at any given time. The appropriate sequencing of construction activities would also be managed to ensure that impacts on public land or the local road network would be minimised as far as practicably possible.

While construction impacts to properties adjacent to the Project would be temporary in nature, management measures would be required to ensure these impacts do not have adverse impacts on the amenity of these areas. A number of management measures have been designed to reduce amenity-related impacts on adjacent land uses and are discussed in Chapter 7 (noise), Chapter 9 (visual amenity), Chapter 10 (traffic), and Chapter 11 (air quality).

17.5 Expected conditions

The Project would be largely within the existing transport corridor along Flemington Road, the Federal Highway and Northbourne Avenue. Outside of the existing transport corridor, the operation of the Project would not impact on existing land uses. Access to all public land and facilities would be maintained during the operation of the Project.
17.6 Residual risks

Based on the mitigation measures identified in section 17.4, an assessment of the residual land use risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 17.2.

Table 17.2 Residual land use 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>M.1</td>
<td>Impacts on public property including footpaths and open spaces along the proposed alignment as a result of construction of the Project.</td>
<td>Medium</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>M.2</td>
<td>Potential for temporary reduction in property amenity and value due to construction impacts.</td>
<td>Medium</td>
<td>Possible</td>
<td>Minor</td>
<td>Low</td>
</tr>
<tr>
<td>M.5</td>
<td>Acquisition of private land for the Project.</td>
<td>High</td>
<td>Almost certain</td>
<td>Minimal</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Note for residual risk ID M.5: The consequence of this risk has been reduced as the potential consequence for Territory land or lease boundary realignments would be limited to only a small number of properties, in particular the Yowani Country Club.
18. Climate change

This Chapter outlines a high level review of the risks of climate change and the potential impact to the construction and operation of the Project. This Chapter provides a summary of the Climate Change Impact Assessment prepared by WSP and contained as Technical Paper 11 in Volume 3 of this EIS.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential climate change impacts risks presented in Table 18.1 below.

Table 18.1 Initial climate change 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>N.1</td>
<td>Potential impacts to the Project resulting from climate change impacts such as:</td>
<td>Possible</td>
<td>Major</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>- predicted increased frequency, severity and duration of extreme temperature (days exceeding 35°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- predicted increased frequency and severity of extreme wind events.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18.1 Environmental conditions and values

18.1.1 Existing climate conditions

Existing climate conditions recorded for the ACT region between 1990 and 2009 consisted of annual average maximum temperatures of 26°C to 28°C, annual average minimum temperatures of 2°C to 4°C, annual average rainfall of between 400 and 800 millimetres and approximately 10 hot days per year (maximum temperatures above 35°C). A comparison of the existing climatic conditions and predicted future climatic conditions, including the average daily Forest Fire Danger Index and Severe fire weather days, is provided in Table 18.2.

18.2 Investigations

The climate change risk assessment and risk management approach undertaken as part of the Climate Change Impact Assessment (Technical Paper 11) has been conducted in accordance with the following documents:


The climate change projections used in this assessment have been derived and collated in accordance with the Australian Standard (AS 5334) ‘Climate change adaptation for settlements and infrastructure’, which suggests that the following six consecutive steps should be applied to determine the climate change context that will inform the climate change risk assessment and subsequent adaptation responses:

- define the greenhouse gas emissions scenario
- define future time slices
- define the climate variables
selection of climate data

determine other associated impact studies required

obtain past meteorological record.

A detailed description of the above steps is provided in Section 2 of the Climate Change Impact Assessment (Technical Paper 11).

The Climate Change Impact Assessment does not address potential impacts of the construction stage of the Project given its relatively short duration and the potential for climate change impacts are unlikely to cause disruption to construction. As the Project has a long design life, climate change impacts have been identified for both 2030 and 2070.

18.2.1 Predicted climate condition scenarios

Overview

Since 1990 the Intergovernmental Panel on Climate Change (IPCC) has been collecting, managing and researching the potential impacts of climate change on a global scale. The IPCC has developed a set of scenarios to explore potential future climate change using complex, computer-based Global Climate Models. The scenarios differ in their assumptions about future changes in population, economic development, energy technologies and other factors, resulting in growing differences in the GHG concentrations in the atmosphere and hence the degree of projected climate change.

The IPCC Special Report on Emissions Scenarios (SRES, 2000) identified four scenario families (A1, A2, B1 and B2) that explored alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting GHG emissions. In 2007 the IPCC released the Fourth Assessment Report (AR4) (IPCC 2007), which used the Special Report on Emissions Scenarios to provide projections for climate change variables such as temperature, sea level, rainfall and extreme weather. The IPCC Fifth Assessment Report (IPCC 2013) provides updated global projections for a range of climate change models and shows that emissions are currently tracking above the high emission scenarios from AR4 at a global scale.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BOM) have also released climate change projections for Australia that provide updated national and regional information on how the climate may change to the end of the 21st century. The projections are based on results of the climate system, historical trends and model simulations of the climate response to global scenarios of greenhouse gas and aerosol emissions. These projections form part of the predictions presented in the IPCC Fifth Assessment Report (IPCC 2013). For each climate variable, the projected change is accompanied by a rating (low, medium, high or very high) to provide the level of confidence in the projection, based on the type, amount, quality and consistency of the evidence from the models’ output.

Selection of timescales

Climate change projections are published by CSIRO and the OEH for years 2030, 2070 and 2090. These represent the years for which the majority of climate change models apply, and therefore the years for which the most reliable climate projections are available. As the Project has a long design life, climate change impacts have been considered for both 2030 and 2070.
18.3 Potential impacts

18.3.1 Predicted future climate conditions

Predicted future conditions are provided in Table 18.2. The following provides a summary of the climatic changes that are considered likely to affect the Project:

- Warming is projected to intensify in the ACT with an increase in average temperatures and a decrease in cooler nights.
- Temperature extremes are expected to change, with the annual average number of days over 35°C, in Canberra increasing to potentially twice as many by 2070 without global action to reduce emissions.
- Frost risk days (minimum temperatures under 2°C) are projected to decrease across the Murray Basin cluster and could halve by 2090.
- Average yearly rainfall is likely to stay fairly stable in the ACT, however the rainfall is expected to increase in summer and autumn, and decrease in winter and spring.
- Due to the projected overall increase in temperatures, days of extreme heat and drier conditions, the risk of high fire danger days and bushfire is projected to increase.
- An increase in extreme rainfall events, with storm events and wind speeds becoming more intense across the region.
- Small changes for solar radiation and relative humidity by 2030, with a high confidence there will be increased winter and spring radiation (related to decreases in cloudiness associated with reduced rainfall) along with a projected decrease for relative humidity later in the century.

Greater detail regarding these potential changes is provided in Technical Paper 11 and summarised in Table 18.2 below. Table 18.2 provides the details of baseline averages from 1990 to 2009 and the projected climate changes for the years 2030 and 2070 as modelled by the NSW and ACT Regional Climate modelling (NARClIM) project (NSW OEH 2014).

### Table 18.2 Summary of the projected changes for the ACT

<table>
<thead>
<tr>
<th>Variable</th>
<th>1990-2009 (Baseline)</th>
<th>Change by 2030</th>
<th>Change by 2070</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual maximum temperatures</td>
<td>Average 26 to 28°C</td>
<td>+0.5 to +1.0°C</td>
<td>+1.5 to +2.5°C</td>
</tr>
<tr>
<td>Annual minimum temperatures</td>
<td>Average 2 to 4°C</td>
<td>+0.5 to +1.0°C</td>
<td>+1.5 to +2.0°C</td>
</tr>
<tr>
<td>Number of hot days per year (maximum temperatures above 35°C)</td>
<td>10</td>
<td>+1 to +5</td>
<td>+10 to +20</td>
</tr>
<tr>
<td>Number of cold nights per year (minimum temperatures below 2°C)</td>
<td>70 to 90</td>
<td>-20 to -10</td>
<td>-30 to -20</td>
</tr>
<tr>
<td>Rainfall</td>
<td>Average annual 400–800mm between 100–300mm each season</td>
<td>Summer (0% to +5%) Autumn (+5% to +10%) Winter (-5% to +0%) Spring (-10% to -5%)</td>
<td>Summer (+10% to +20%) Autumn (+5% to +20%) Winter (-5% to 0%) Spring (-10% to -5%)</td>
</tr>
<tr>
<td>Average daily Forest Fire Danger Index (FFDI)</td>
<td>Summer (11.4) Autumn (7.2) Winter (2.6) Spring (6.4)</td>
<td>Summer (+0.5 to +1.0) Autumn (-0.5 to -0.0) Winter (&gt;0 to +0.5) Spring (+0.5 to +1.0)</td>
<td>Summer (+0.5 to +1.0) Autumn (-0.5 to -0.0) Winter (&gt;0 to +0.5) Spring (+1.0 to +1.5)</td>
</tr>
<tr>
<td>Severe fire weather days (FFDI above 50)</td>
<td>Summer (0.8) Autumn (0.2) Winter (0.0) Spring (0.2)</td>
<td>Summer (&gt;0 to +0.5) Autumn (-0.5 to -0.0) Winter (0.0) Spring (&gt;0 to +0.5)</td>
<td>The magnitude of change is not yet known.</td>
</tr>
</tbody>
</table>
18.3.2 Potential impacts to the Project

The Project may be susceptible to a variety of climatic factors and seasonal variations in climate. As a result, data for the following location-specific climate variables relevant to the Project are presented in Chapter 3 of the *Climate Change Impact Assessment* (Technical Paper 11) and include:

- solar radiation
- annual mean maximum temperature and summer mean maximum temperature
- highest temperature
- temperature (heatwaves) – average number of days over 35°C
- annual mean rainfall
- seasonal mean rainfall
- extreme rainfall
- rainfall intensity
- wind speed
- relative humidity
- average annual potential evaporation
- hail
- cyclones
- bushfire risk.

An initial risk assessment was completed as part of the *Climate Change Impact Assessment* to identify key risks associated with the Project. A number of potential climate change impacts were considered to have an impact on the Project medium overall risk rating (refer to Section 4 of Technical Paper 11), and are detailed in Table 18.

**Table 18.3 Potential climate change impacts on the Project**

<table>
<thead>
<tr>
<th>Project element</th>
<th>Climate variable</th>
<th>Potential climate change impact</th>
<th>Overall risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracks</td>
<td>Increased annual mean temperature</td>
<td>Extreme high temperatures could cause track buckling, which may lead to derailment, and increased maintenance costs.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td>More rapid deterioration of the tracks and points over time and requirement for frequent maintenance.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Drainage</td>
<td>Changes to rainfall (droughts and intense rainfall)</td>
<td>Inundation of drainage infrastructure, with resulting damage, service disruption and safety risk.</td>
<td>Medium</td>
</tr>
<tr>
<td>infrastructure</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The projected periodic extreme dry and wet periods would increase the potential for erosion of substrate and ballast materials, causing increase washout. This could cause infrastructure instability and disruption in the event of collapse.</td>
<td>Medium</td>
</tr>
<tr>
<td>Overhead</td>
<td>Increased annual mean temperature</td>
<td>Overhead wiring sagging, snagging, degradation, decrease in efficiency and heat related damage would cause disruption to services, increase maintenance requirements and safety risk.</td>
<td>Medium</td>
</tr>
<tr>
<td>wires</td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Project element</td>
<td>Climate variable</td>
<td>Potential climate change impact</td>
<td>Overall risk</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------</td>
<td>---------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Signalling, electrical and communication equipment</td>
<td>Increased annual mean temperature</td>
<td>Extreme temperatures may lead to interruptions in mains power supply and reduced functionality of signals or equipment. Heat related damage and material deterioration would have variable impacts on the reliability, functionality and speed of signalling and communication equipment. Increase in maintenance requirements and safety risk.</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Structures (e.g. stops, depots and stabling yards)</td>
<td>Increased annual mean temperature</td>
<td>Exposure to increased temperatures and solar radiation may result in faster deterioration of materials. This could result in more frequent maintenance. Passenger comfort could be affected leading to reduced passenger numbers.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td>Material impact from bushfires on structures would be more likely to occur in areas near open bush/grass land and not in more urban and built up areas.</td>
<td>Medium</td>
</tr>
<tr>
<td>Bridges and culverts</td>
<td>Increased annual mean temperature</td>
<td>Impact on structural integrity associated with movement at expansion joints due to extreme temperatures.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Changes to rainfall (droughts and intense rainfall)</td>
<td>The projected periodic extreme dry and wet periods would increase the potential for erosion of substrate and ballast materials, causing increase washout. This could cause infrastructure instability and disruption or safety risk in the event of collapse.</td>
<td>Medium</td>
</tr>
<tr>
<td>Carriageways and pavements (hardstand areas)</td>
<td>Increased annual mean temperature</td>
<td>Extreme temperatures could cause damage and the faster deterioration of materials (e.g. extreme heat causing asphalt to melt). The projected periodic extreme dry and wet periods would increase the potential for erosion of substrate and ballast materials, causing increase washout. This could cause infrastructure instability and disruption in the event of collapse.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Changes to rainfall (droughts and intense rainfall)</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>In filled excavations, ballast and sub-grade</td>
<td>Increased annual mean temperature</td>
<td>The projected periodic extreme dry and wet periods would increase the potential for erosion of substrate and ballast materials, causing increase washout. This could cause infrastructure instability and disruption in the event of collapse.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Changes to rainfall (droughts and intense rainfall)</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Signage</td>
<td>Increased annual mean temperature</td>
<td>Exposure to increased temperatures and solar radiation may result in faster deterioration of materials.</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increased number of hot days over 35°C</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Increase in risk of bushfires</td>
<td></td>
<td>Medium</td>
</tr>
</tbody>
</table>
### 18.4 Proposed mitigation measures and offsets

There are four possible approaches in responding to climate change:

- **Avoid** – avoid locating assets in vulnerable areas
- **Adapt** – design and/or design standards to operate in predicted climate conditions
- **Defend** – install defences at or around critical infrastructure
- **Retreat** – develop and implement plans to relocate from the vulnerable area.

In order to address potential impacts and inform further design and operational considerations, the following mitigation measures would be considered:

- Consideration to designing the drainage infrastructure, bridges and culverts to accommodate increased intensity of runoff caused by changes in rainfall (droughts and intense rainfall events). Consideration in the detailed design to adapting or upgrading this infrastructure at a future date. This provides options in the future (with greater certainty regarding rainfall projections) to design further adaptation measures to manage potential increased surface water runoff and localised flooding.
- Regular inspections of the infrastructure would be undertaken. Should excessive deterioration be identified, minor or more regular maintenance activities may be required within the design life of the project.
- Inspection of infrastructure after storm, bushfire or heatwave events would be undertaken to determine damage and appropriate maintenance requirements.
- Materials would be selected to prevent accelerated degradation of infrastructure. Additionally, the design would take into account the impact of extreme or prolonged heat events on materials.
- Shading would be provided at the stops for user protection and comfort in extreme heat.

Additional mitigation measures which would complement the measures identified above are provided in section 12.4 (water and hydrology) and section 20.4 (bushfire).
18.5 Expected conditions

As the climate becomes more extreme and frequent in its severity, there are clearly going to be implications for the operation phase of the Project and therefore the expected conditions. While rail infrastructure is considered relatively well protected against the effect of climate change compared to other transport infrastructure, there are some key areas that pose high vulnerability (despite the implemented mitigation measures):

- **Tracks**: Various lengths of track would be differently affected by climate change impacts. Problems of poor traction would occur during flooding, especially where conductor rails are present. Projections show that Canberra is expected to become warmer, with an increase in the duration and severity of hot spells which may contribute to greater likelihood of rail buckling.

- **Overhead power lines**: Increased summer temperatures would potentially increase the sag of overhead power cables; possible mitigation measures include using regulated tension wiring to counter thermal expansion. This may reduce the clearance between various structures, such as between cables and structures like trees and passing vehicular traffic.

18.6 Residual risks

Based on the mitigation measures identified in section 18.4, an assessment of the residual climate change risks associated with the Project have been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 18.4.

<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>N.1</td>
<td>Potential impacts to the Project resulting from climate change impacts such as:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- predicted increased frequency, severity and duration of extreme temperature (days exceeding 35°C)</td>
<td>High</td>
<td>Unlikely</td>
<td>Major</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>- predicted increased frequency and severity of extreme wind events.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
19. Hazard and risk

This Chapter provides an assessment of potential risks as a result of the Project and risks to the Project such as environmental hazard, occupational health and safety hazards and human health hazards.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential hazards and risks which are presented in Table 19.1 below.

### Table 19.1 Initial planted tree 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>O.1</td>
<td>Injury or fatality due to undertaking construction works in close proximity to sensitive receivers (e.g. schools), major arterial/regional roads and highly pedestrianised areas.</td>
<td>Possible</td>
<td>Catastrophic</td>
<td>Very high</td>
</tr>
<tr>
<td>O.2</td>
<td>Potential impacts of EMF resulting from the operation of the light rail, including potential impact to sensitive equipment along the alignment.</td>
<td>Possible</td>
<td>Moderate</td>
<td>Medium</td>
</tr>
<tr>
<td>O.3</td>
<td>Injury or fatality due to collisions between LRVs and pedestrians within highly pedestrianised areas.</td>
<td>Possible</td>
<td>Catastrophic</td>
<td>Very high</td>
</tr>
<tr>
<td>O.4</td>
<td>Injury or fatality due to collisions between road and LRVs at signalised crossings and locations where road traffic would be maintained adjacent to the Project.</td>
<td>Possible</td>
<td>Catastrophic</td>
<td>Very high</td>
</tr>
</tbody>
</table>

19.1 Environmental conditions and values

The existing environment of the Project encompasses roads and urban areas. There are inherent risks in the existing environment including:

- road accidents
- extreme weather
- electricity
- pedestrian/cyclist accidents.

The Project has the potential to cause a range of hazards and risks during both construction and operation due to changes to the current road conditions along the Project alignment. The implementation of appropriate management measures would reduce the likelihood and severity of these hazards.

19.2 Investigations

A Preliminary Hazard Analysis (PHA) workshop was held Friday 4 April, 2014. The aim of the workshop was to undertake initial hazard identification and risk assessment to determine the scope and extent of safety risk presented by the Project and to develop a list of potential hazards that may be eliminated or controlled during initial design activity. The PHA focused on a number of areas including:

- the integration of the Project with the existing physical infrastructure in Canberra
- hazards during construction of the project
- hazards during operation of project including impacts to customers, staff and third parties.
19.3 Potential hazards and risks

19.3.1 Construction hazards and risks

Hazards and risks associated with the construction phase of the Project can be broadly categorised into the following three areas:

- environmental hazards — including discharge of potentially hazardous or other materials to the environment
- occupational health and safety hazards — including any activity or outcome that may affect the health and/or safety of site personnel and visitors due to the failure to implement safe work procedures on site
- construction hazards — resulting from the materials required to complete construction of the project, and materials required to maintain plant and machinery during the operation of the project (generally associated with the light rail component).

These three areas are discussed in more detail below.

Environmental hazards

Environmental hazards associated with construction of the Project could arise during the transport, use and storage of hazardous materials on site, as well as the unearthing of contaminated soils/groundwater.

During construction, potentially hazardous materials would be securely stored on-site at the proposed construction compounds (discussed in section 2.2.3 and shown in Figures 2.15a to 2.15e) in accordance with the relevant legislation. The types of potentially hazardous materials that may be required during the construction of the project are shown in Table 19.2. The refuelling and maintenance of construction plant and equipment would be undertaken within designated areas at these construction sites.

Table 19.2 Indicative list of hazardous materials potentially required on site during construction

<table>
<thead>
<tr>
<th>Potential hazardous material</th>
<th>Likely method of storage on site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>20-litre drums and carry cans</td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>20-litre drums</td>
</tr>
<tr>
<td>Oxy-acetylene</td>
<td>Cylinders (up to 55 kilograms) in rack</td>
</tr>
<tr>
<td>Petrol</td>
<td>20-litre drums</td>
</tr>
<tr>
<td>Cement</td>
<td>Bags/pallets (in container)</td>
</tr>
<tr>
<td>Premix concrete</td>
<td>Bags/pallets (in container)</td>
</tr>
<tr>
<td>Concrete curing compounds</td>
<td>20-litre drums</td>
</tr>
<tr>
<td>Epoxy (plumbers’) glue</td>
<td>Small containers</td>
</tr>
<tr>
<td>Contaminated waste</td>
<td>Stored in bunded area or removed from site directly</td>
</tr>
<tr>
<td>Paint</td>
<td>20-litre drums</td>
</tr>
</tbody>
</table>
Potentially hazardous materials would also be required to be transported to and from construction sites on public roads. Spills and leaks during transportation could result in the contamination of land and waterways outside of the project area. This risk would be managed through the use of delivery contractors who are certified to transport hazardous materials and have adequate environmental management procedures to address risks associated with spills and leaks during transportation.

As described in Chapter 13, there are a number of potential sources of soil and/or groundwater contamination along the project alignment. Construction activities, if not managed correctly, have the potential to result in the release of these contaminants into the wider environment.

Sensitive environmental receivers such as watercourses, water bodies and flora and fauna may be impacted by potentially hazardous materials used during construction if appropriate environmental management measures are not implemented. Potential discharges to the environment from the construction phase would be managed or eliminated by the implementation of environmental management measures during construction activities and in accordance with the Project CEMP.

**Occupational health and safety hazards**

Occupational health and safety hazards could arise during construction, where inadequate hazard/risk identification, reporting and monitoring systems are not implemented and/or maintained. Hazards and risks to human health and safety that could occur during the construction include:

- undertaking construction works close to publically accessible/highly trafficked areas (e.g. within/adjacent to pedestrian footpaths within Canberra CBD and the Gungahlin pedestrianised/light rail only zone)
- undertaking construction works close to sensitive community facilities (e.g. schools, childcare centres and hospitals)
- undertaking construction works within or adjacent to major arterial and regional roads (such as Northbourne Avenue, the Federal Highway and Flemington Road)
- undertaking construction works in the vicinity of existing services and utilities (e.g. high voltage power lines, gas mains, etc.)
- failure to shut down/isolate services and utilities proposed to be relocated as part of the Project (e.g. electricity cables and gas mains)
- undertaking construction works close to existing buildings and vibration sensitive structures
- encountering asbestos, contaminated land and other potentially hazardous materials during construction (e.g. demolition of existing structures) and associated risks associated with the handing, stockpiling, transporting and disposal of such material
- the use and storage of hazardous materials
- the use of heavy machinery
- works which may impact or restrict emergency access from existing building and/or emergency vehicles.

**Construction hazards**

The uncovering of contaminated materials has the potential to result in health impacts to construction workers, the environment and members of the community that come into contact with such materials. Without adequate management, the contamination of land and waterways outside of the project footprint could result from runoff, dust generation, or spills or accidents during the transportation of contaminated materials. The potential for soil contamination within the Project footprint are discussed further in Chapter 13.
Overhead wires and subsurface utilities could also pose construction hazards to site workers and the environment. As outlined in Chapter 15, a number of underground electricity and gas mains have been identified in the vicinity of the proposed works, a number of which would require protection or relocation. Damage to services and utilities during construction could result in injury to site workers and members of the community. The management of utilities and services are discussed further in section 15.4.

Bushfire hazards such as hot works (activities that generate both heat and sparks), pose a significant risk of igniting flammable material nearby if these activities are not conducted in accordance with standard work procedures or other hot works licences/permit requirements. Additional bushfire hazards and mitigation measures are discussed in Chapter 20.

19.3.2 Operational hazards and risks

Hazards and risks associated with the operation of the Project would primarily be due to:

- the movement of LRVs through highly pedestrianised areas such as the Gungahlin pedestrian/light rail only zone, resulting in the potential for collisions/accidents
- potential collisions between road vehicles, pedestrian and/or cyclists with and LRVs at signalised crossings or along the remainder of the Project alignment
- injury to maintenance staff from activities occurring within the proposed stabling depot and maintenance facility, or at other locations along the project alignment (e.g. collision with motor vehicles while undertaking maintenance work adjacent to traffic)
- electromagnetic fields (EMF) from proposed electricity substations and overhead wiring
- potential damage to Project infrastructure due to vandalism
- accidental interactions with the overhead wiring (including during maintenance activities) or damage to Project infrastructure caused by falling tree branches (particularly overhead wiring)
- utility failure (power or communication system failure)
- the handling, storage, use and disposal of chemicals and other potentially hazardous materials at the stabling depot and maintenance facility and at other locations along the project alignment (e.g. use of herbicides on landscaping) (discussed in greater detail in Chapter 16)
- natural events (including flooding and extreme weather events) and impacts of climate change (changed frequency of natural events) (discussed in greater detail in Chapter 18)
- bushfires (discussed in greater detail in Chapter 20)
- external events outside the control of the Project (i.e. events occurring at adjacent facilities).

Key hazards are discussed further in the following sections.

Collisions with pedestrians, cyclists and road vehicles

The Project would result in the potential risk of collisions between LRVs and pedestrians/cyclists, or LRVs and road traffic, particularly where the alignment must cross roads carrying vehicular traffic or where pedestrians must cross or interact with the Project alignment.

For the pedestrianised section in Gungahlin and at road intersections, LRV drivers would be required to give due consideration to pedestrian movements, assessing LRV speeds and braking requirements against their perceptions of actual or potential hazards. On observing a stationary obstacle in path of the LRV, the driver should be able to stop the LRV by use of the service brake only.
LRVs would also be fitted with warning bells that would only be used as needed such as in the event of emergencies or where the driver considers there is a danger to public safety (such as pedestrians crossing a track while approaching or departing a stop). Detailed safety reviews would occur during detailed design to identify requirements for mitigation to manage and reduce the risk of incidents arising from collisions during operation.

The management of hazards associated with the movement of LRVs through the existing road network and highly pedestrianised areas has been reinforced in many major cities (such as Strasbourg, France and Linz, Austria and Melbourne) through widespread and targeted educational programs and detailed design considerations for the vehicles and stops. A similar approach would be applied to managing potential hazards or risks associated with the Capital Metro Project.

**Electromagnetic fields (EMFs) and stay currents**

Potential EMF sources associated with the proposal include 750 Volt overhead contact wires, buried cables and to a lesser extent, running rails. The LRVs themselves are also a source of EMF. The magnetic field strengths from electrical LRV operations on the Project are not expected to be greater than for other comparable light rail systems.

Types of EMF associated with light rail systems like the Project include high frequency emissions, and low frequency emissions. High frequency emissions could affect electronic and sensitive equipment. Low frequency EMF is considered a health hazard under long term exposure if the emission levels are high. Users of the light rail would only be exposed to LRV generated EMFs for short period of time. Consequently, this poses no health issue.

The Project would be designed to comply with appropriate Australian and international standards, thereby minimising the risk associate with EMF exposure. The only potential issues may arise with sensitive electronic equipment located in buildings near the system. The LRVs would be required to comply with internationally recognised standards for electromagnetic compatibility, and so should not present any EMF emissions issues.

The potential sensitive receptors which may be potentially affected by the Project have been identified as including the following:

- Capital Pathology
- NICTA Canberra Research Laboratory
- Orthopaedics ACT (MRI)
- Aspen Medical (MRI)
- National Capital Diagnostic Imaging (MRI)
- Canberra Imaging Group (MRI)
- Canberra Dance Theatre (Audio Frequency)
- Canberra Theatre Centre (Audio Frequency)
- The Street Theatre (Audio Frequency)
- Dundunba African Drum + Dance (Audio Frequency)
- Robs Garage Rehearsal Studio (Audio Frequency)
- SingSingSing Vocal Studios B.M.A (Audio Frequency)
- Optus Satellite Earth Station (Audio Frequency)
- Radio Station 2CA 1053 AM (Audio Frequency)
- ABC Canberra (Audio Frequency)
Community Radio 1XXR 98.3FM (Audio Frequency)

The John Curtin School of Medical Research (MRI).

Stray leakage of currents from the running rails into surrounding earth would need to be minimised, as this could cause electrolysis corrosion of nearby buried metalwork. The Project design proposes the running rails are encased within insulating material, ensuring this issue is mitigated.

Appropriate measures would be incorporated into the final design to ensure that electromagnetic compatibility is achieved between the power supply equipment and all other system equipment. Should the levels of electromagnetic fields not comply with applicable Codes and Standards, the solution to such issues would involve shielding or similar measures to the affected equipment.

Vandalism and malicious damage to the Project

Vandalism to the Project would represent a potential impact to Project infrastructure during operation of the Project. This would include damage to LRVs (such as physical damage to LRV carriages and graffiti) or potential damage to stop infrastructure. The Project would be designed to ensure it is safe for customers and users the Project. The following key safe design features and measures would be implemented (to be finalised during detailed design) that would assist in minimising potential vandalism and malicious damage to the Project:

- a lighting design that would ensure all areas along the Project alignment is lit and therefore safe. This would include appropriate levels of lighting at the stabling depot and maintenance facility at Mitchell, where potential for vandalism (such as graffiti) would anticipated to be higher
- closed circuit television (CCTV) to enhance security
- security measures within the stabling depot and maintenance facility
- close co-operation would occur between Project Co and ACT Police in identification and targeting of offenders, information sharing, etc.

19.4 Proposed mitigation measures and offsets

Construction

A Construction Emergency Response Plan (CERP) would be prepared to outline incident response procedures and contingency plans to manage and respond to identified hazards and risks. The plan would include a process for notifying of environmental and safety incidents as well as contact details for Project Co’s Health and Safety management team and emergency services. A Hazardous Materials Management Plan also would be prepared and implemented, as part of the overarching CEMP, and would detail standard environmental management measures to manage the handling, storage and transport of hazardous materials during construction, in accordance with relevant ACT EPA guidelines and legislative requirements regarding safe work procedures.

Mitigation measures that would be included in the CERP and/or Hazardous Materials Management Plan would include the following:

- Hazardous materials would be managed in accordance with the Project occupational health and safety plan and relevant Safe Work Method Statements (SWMS) and Job Safety and Environmental Analysis (JSEA).
- Hazards and risks associated with construction activities would be identified prior to construction and documented in the SWMS, including controls to minimise and manage hazards. A process for regularly reviewing work practices/procedures would be implemented throughout construction to identify report and respond to any new environmental hazards/risks.
Environmental management measures would be developed and implemented as part of the CEMP to address the following issues:

- chemical spills and leaks (as documented in section 13.4 of this EIS)
- surface and water quality (as documented in section 12.4 of this EIS)
- disposal of contaminated materials (as documented in section 13.4 of this EIS)
- disposal of contaminated groundwater (as documented in section 12.4 of this EIS)
- traffic, transport and access (as documented in sections 10.4 of this EIS)
- the management of services and utilities (as document in section 15.4 of this EIS).

Construction worksites located adjacent to public areas would include hoarding (where appropriate) to minimise risks of injury as a result of unsecured debris, tools and other objects.

All work, health and safety legislation would be complied with during construction to remove or mitigate potential injury risks.

**Operation**

Operational hazards and risks would be addressed through design, the application of community education programs, and standard mitigation measures and plans (where required). These measures would include the following:

- Targeted road safety campaigns to raise awareness around the operation of LRVs would be used in the lead up to the opening of the light rail and during operation to promote the safe operation of the proposal. This would focus on raising awareness and promoting safe behaviours in shared zones and at key crossings.

- Targeted consultation with identified sensitive receivers listed in section 19.3 for EMF, would be undertaken to inform the detailed design. Any issues identified would be resolved on a case by case basis with solutions such as monitoring and, if necessary, protective screening at the site of the sensitive equipment.

- All cables would be buried within ducts and would adhere to all International and Australian electrical standards in terms of distances from surrounding cables (i.e. adjacent high voltage cables require minimum separation in accordance with industry standards).

- Storage of chemicals associated with the operation and maintenance of the LRVs would be designed in line with the appropriate EPA guidelines and legislative requirements.

- Hazardous material procedures (including procedures for managing spills, and the refuelling and maintenance of vehicles/equipment) would be developed and implemented during the operation of the project to minimise potential for impacts associated with chemical spills and leaks. These procedures would adequately address activities at the site for the proposed depot, as well as other general maintenance facilities that would occur along the project alignment.

- Compliance with the Office of the National Rail Safety Regulator would be undertaken to mitigate potential injury risks during operation.

- Close co-operation would occur between Project Co and ACT Police in identification and targeting of offenders, information sharing, etc. where incident(s) occur during the operation of the Project.
19.5 Expected conditions

The identified hazards and risks for the operation of the Project would be considered during the detailed design of the project to minimise their likelihood and severity. Any residual hazards and risks would be managed appropriately, as outlined in section 19.4.

A key operational hazard would be the collision of LRVs with pedestrians and vehicles. The proposed alignment occupies the central median from Gungahlin through to the CBD, and as result the project would have minimal interaction with the road corridor and adjacent footpaths. This would limit the likelihood of collisions between LRVs and vehicles/pedestrians along the project alignment, increasing the safety for workers, patrons and road corridor users.

The risk of collisions would be highest at the pedestrianised/light rail only zone in Gungahlin and intersections along the project alignment. The mitigation measures outline in section 19.4 would be implemented to manage these risks.

19.6 Residual risks

Based on the mitigation measures identified in section 19.4, an assessment of the residual hazards and risks associated with the Project has been considered (for risks previously identified as being medium or above). These residual risks are identified in Table 19.3.

Table 19.3 Residual hazard and 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>O.1</td>
<td>Injury or fatality due to undertaking construction works in close proximity to sensitive receivers (e.g. schools), major arterial/regional roads and highly pedestrianised areas.</td>
<td>Very high</td>
<td>Remote</td>
<td>Catastrophic</td>
<td>Medium</td>
</tr>
<tr>
<td>O.2</td>
<td>Potential impacts of EMF resulting from the operation of the light rail, including potential impact to sensitive equipment along the alignment.</td>
<td>Medium</td>
<td>Unlikely</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>O.3</td>
<td>Injury or fatality due to collisions between LRVs and pedestrians within highly pedestrianised areas.</td>
<td>Very high</td>
<td>Remote</td>
<td>Catastrophic</td>
<td>Medium</td>
</tr>
<tr>
<td>O.4</td>
<td>Injury or fatality due to collisions between road and LRVs at signalised crossings and locations where road traffic would be maintained adjacent to the Project.</td>
<td>Very high</td>
<td>Remote</td>
<td>Catastrophic</td>
<td>Medium</td>
</tr>
</tbody>
</table>
20. Bushfire

This Chapter outlines the potential bushfire impacts associated with the construction and operation of the Project. This Chapter provides a summary of the Busfrie Risk Assessment prepared by Grant Fleming Environmental contained as Technical Paper 12 in Volume 3 of this EIS.

The Project PEA (Parsons Brinckerhoff, 2014a) initial risk assessment for the Project identified the potential bushfire impacts risks presented in Table 20.1 below.

Table 20.1 Initial planted tree impacts risks associated with the Project

<table>
<thead>
<tr>
<th>ID</th>
<th>Potential impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.1</td>
<td>Potential impact of bushfires from areas adjacent to the alignment impacting on the operation of the Project.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>Risk rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlikely</td>
<td>Minor</td>
<td>Very low</td>
</tr>
</tbody>
</table>

20.1 Environmental conditions and values

20.1.1 Fire prone land

The ACT Strategic Bushfire Management Plan (SBMP) version 3 (ESA 2014a) is based upon a risk bushfire risk assessment used across the whole of the ACT. This bushfire risk assessment process has been used to map bushfire prone areas (BPA) across the ACT that has a high bushfire risk. The entire ACT rural area is considered to have a high bushfire risk, as are the urban interface areas that are adjacent to forest and grasslands. The location of BPAs which may impact on the Project are shown in Figure 20.1. The mapping of BPAs within and adjacent to the Project impact footprint indicates that the BPAs commence north of the junction of Swinden Street and Northbourne Avenue on the Project alignment through to Gungahlin.

Development within a BPA requires an assessment under Australian Standards AS 3959 – Construction of buildings in bushfire prone areas to determine the mandatory construction standards. This is relevant to some of the proposed substations and the proposed stabling depot and maintenance facility at Mitchell.

20.1.2 Asset Interface – land use

Land use within and adjacent to the Project impact footprint has been mapped to identify land that has the potential to carry a bushfire, that is, undeveloped or vacant land that interfaces with the Project alignment (refer to Figure 20.2). Land that is designated as an ACT Park or Nature Reserve, agricultural land or undeveloped industrial or residential land may also be identified in this process. The ability of this undeveloped or vacant land that interfaces with the Project alignment to carry a bushfire is further defined in section 3.3 of the Bushfire Risk Assessment (Technical Paper 12).

The potential of land to carry a bushfire towards or away from the Project alignment has also been considered as part of the assessment of the Project.
Figure 20.1  Fire prone land in the vicinity of the Project alignment
Figure 20.2  Asset interface land use in the vicinity of the Project alignment
20.1.3 Site conditions

Topography

The local topography including slope and aspect are determinants of the parts of the fire (e.g. head, flank, back) that an asset may be exposed to. The southern portion of the Project alignment is located between the ridgetop of Black Mountain Reserve/Canberra Nature Park, approximately 2.3 to 2.5 kilometres due west of Northbourne Avenue and Mount Ainslie. The ranges that are typically part of the ACT parks and reserves system that support extensive vegetation communities have the potential to support large bushfires, however this same potential does not exist for the Project alignment. Lake Burley Griffin forms a natural barrier to the south of the Project and beyond the lake there is extensive residential development beyond Capitol Hill indicating that it is not probable for bushfires to spot across the lake from the south. At Gungahlin the township is generally protected from bushfire to the northwest due to the presence of Yerrabi Pond, Gungahlin Lakes Golf Course and Gungahlin Pond that extend from the northeast to the southwest, and beyond these waterbodies by the residential areas of Amaroo, Ngunnawal and Nichols.

Slope

Slope can affect bushfire behaviour with fires burning faster up slope than down slope, in particular when aligned with the prevailing wind direction. A fire burning up a 10 degree slope will generally spread at double the rate of a fire on level ground (Bushfire CRC 2009). Likewise a fire burning up a 20 degree slope will generally spread at a rate that is four times the rate of spread across level ground (Bushfire CRC 2009). The majority of the land surrounding the site is comparatively flat with a slope of 0 to 5 degrees.

Aspect

Aspect is another topographical factor that can affect bushfire behaviour. North facing slopes receive more solar radiation that dries surface fuel faster than on south facing slopes (Bushfire CRC 2009). The general topography along the Project alignment is that of a comparatively flat valley floor from Civic along Northbourne Avenue to the junction of Federal Highway with Flemington Road. Aspect would have little practical impact upon bushfire behaviour between Civic and the junction of Federal Highway with Flemington Road. Some more westerly to north-westerly aspect slopes cross Flemington Road between the intersection of Federal Highway with Flemington Road and Gungahlin, which may aid the spread and run of a fire towards the Project alignment.

20.2 Investigations

A desk top assessment of potential bushfire impacts during construction and operation was undertaken as part of the Bushfire Risk Assessment (Technical Paper 12). The Bushfire Risk Assessment was undertaken conducted with reference to number of existing standards including:

- AS/NZS ISO 31000:2009 risk management principles and guidelines
- ACT Strategic Bushfire Management Plan Version 3 (SBMP)
- ACT Bushfire Management Standards
- AS3959-2009 Construction of buildings in bushfire prone areas.
20.3 Potential impacts

20.3.1 Construction impacts

Potential sources of impact during construction

The bushfire ignition risk associated with Project construction, by definition, would generally only exist in those areas that are capable of supporting a bushfire, as identified in Figure 20.1. While a fire may occur anywhere along the Project alignment including the associated infrastructure and construction compounds, only bushfire was the subject of the risk assessment undertaken. The consequence of an ignition event occurring would depend greatly upon a variety of factors including the location of the ignition, availability of fuel, fire danger rating at the time of the ignition (e.g. catastrophic fire danger) and initial response to the incident.

Some of the potential sources of ignition of bushfires resulting from construction of the Project are described below:

- **Hot works** – Activities that generate both heat and sparks, which are conducted at the construction site, pose a significant risk of igniting flammable material nearby if these activities are not conducted in accordance with standard work procedures or other hot works licences/permit requirements. Activities such as welding and grinding would have the potential to result in bushfire ignition. The potential risk associated with these works would increase when these activities are undertaken in or adjacent to long dry grass.

- **Construction vehicles and motor vehicles** – The risks associated with vehicles (e.g. construction plant or motor vehicles) include the collision of a vehicle with a power pole or infrastructure that could result in either a spark, arc from a power supply or fire from split fuel being ignited. There is also a risk associated with vehicles driving through long grass that may be ignited either from a spark or due to the hot vehicle exhaust system. Construction machinery (such as graders or dozers) has the potential to ignite flammable material due to the generation of a spark from striking a stone or from electrical equipment on the vehicle.

- **Interaction with existing services** – Excavation associated with the Project has the potential to severe power, gas or fuel lines that are buried and to dislodge overhead power lines, resulting in potential ignition of a fire.

- **Chemical fire** – The inappropriate storage or isolation of incompatible or flammable chemicals from potential ignition sources including static electricity may cause a chemical fire or explosion. The failure to clean up a flammable chemical spill or address leaking containers could also lead to a potential fire. Flammable chemicals would also need to be secured to prevent arson.

- **Electrical fault** – Equipment used during Project construction, if not maintained in proper working order would present a risk of generating a bushfire through a static discharge or arcing of equipment. This equipment would include generators, power tools, portable lighting, heaters, air conditioners and any powered device.

- **Landscaping** – Mulch storage may present a bushfire risk if a large volume of material is stored in a large pile for an extended period of time. The ability of mulch to self-combust, the production of methane (includes the potential for explosion) under favourable conditions and the potential for arson attack all contribute to the potential bushfire risk associated with storing mulch. Mulch may be used as a landscaping material or it may be generated during the Project’s construction phase when removing and chipping of existing vegetation along the route.

Further detail regarding the bushfire risk assessment for construction of the Project is provided in Table 18 of the *Bushfire Risk Assessment* (Technical Paper 12).
20.3.2 Operational impacts

A risk assessment was undertaken as part of the Bushfire Risk Assessment (Technical Paper 12). The following sections identify the potential operational interaction between the Project and potential bushfires and include identification of:

- sources of potential bushfire risk
- bushfire risks to the Project
- bushfire risks initiated by the Project
- potential fire runs to and from the Project.

Sources of potential bushfire risks

Power lines

A likely source of for the ignition of a bushfire would occur through with the breakage of wires or poles which make up the overhead line equipment for the Project. This may occur as a result of actions such as:

- motor vehicles or LRVs colliding with an overhead line equipment pole, causing it to come down
- trees or tree branches along the Project alignment causing a breakage to, or arching of, overhead wiring.

Maintenance and repair works

Another potential source of bushfire ignition would be hazards associated with maintenance procedures. These risks are substantively the same as those hazards identified for the construction phase (such as hot works, movement of motor vehicles, etc. – described above) and would be associated with repair and maintenance of track and at the stabling depot and maintenance facility as well as repairs to overhead wiring as required throughout the operation of the Project.

Human activity/arson

A malicious act (e.g. arson) is considered to be the greatest bushfire risk threatening the Project, whether the attack is located within adjacent bushfire prone land or at a Project site where the fire may escape to become a bushfire. Project Co would need to manage security at substations (such as through appropriate security fencing) and the proposed stabling and maintenance facility at Mitchell to minimise the risk of an arson attack being successful.

Other potential causes of ignition associated with human activities would include the inappropriate actions of individuals such as discarding lit cigarettes and matches, placing hot metal into a general waste bin or failing to correctly dispose of materials that are subject to spontaneous combustion, e.g. solvents.

Lightning

The potential for a lightning strike cannot be altered, however the potential damage caused by a lightning strike can be mitigated to an extent and this is reflected as part of the risk assessment presented in the Bushfire Risk Assessment (Technical Paper 12).
Bushfire risks to the Project

The primary potential impact of a bushfire on the Project would be damage to Project infrastructure and the remote possibility of injury or death to Project staff (e.g. LRV operator or staff at the stabling depot and maintenance facility). The Project infrastructure most at risk of bushfire attack includes:

- ** Stops along the alignment** – a number of the stops located along Flemington Road including at Manning Clark Crescent, Well Station Drive, EPIC and Phillip Avenue as these stops are located adjacent to identified bushfire prone lands (Figure 20.1).
- ** Stabling depot and maintenance facilities** – Bushfires would present a potential building and property damage risk to stabling depot and maintenance facility buildings, including any LRVs stored at the stabling depot during operation of the Project.
- ** Overhead line equipment** – overhead wiring would be present along the entire length of the Project alignment. Potential bushfire risks to this infrastructure would be similar to those that exist for other forms of above-ground electrical wiring, and would include damage to power poles or overhead wiring itself.
- ** Substations** – The substation located at along Flemington Road near Kate Crace Street and the stabling and maintenance depot substation at Mitchell are located within close proximity to vegetated areas that have the potential to carry a bushfire and are therefore at greater risk of being impacted by a bushfire than the remainder of the substations along the Project alignment.

With the exception of smoke and ember attacks from bushfires located away from the Project alignment, the impacts of a bushfire on the Project would most likely be geographically restricted to the Project alignment interface areas identified in Figure 20.1 and Figure 20.2 that are north of the intersection of the Barton Highway and Federal Highway. The remaining half of the Project alignment south of this area is classified as non-fire prone land and is likely to experience insignificant impacts from bushfire.

The southern extent of the Project alignment could come under ember attack from a bushfire on Black Mountain under certain conditions and that the classification of land as not being fire prone does not provide a guarantee that the area would not be impacted by a bushfire.

Bushfire risks initiated by the Project

The following section provides a brief discussion regarding the potential impacts a bushfire ignited due to operation or Project presence. The type of bushfire that is most likely is a grassfire, although woodland does occur at the Project alignment interface in several locations but is restricted in its extent. Due to the predominance of grassland, the heat expected to be generated by a Project related fire is lower than that associated with bushfires in woodland or forested areas.

The potential impact of a Project initiated bushfire (subject to the conditions present at the time of ignition) would include:

- potential damage to existing infrastructure outside the Project footprint (power lines and other utilities services etc.)
- impact (including total property damage) to existing buildings adjacent to bushfire prone land in areas such as Gungahlin, Harrison, Mitchell and Lyneham
- impact to existing habitat and individuals of threatened species which currently occupy identified bushfire prone land
- potential human injury or fatality.
Potential fire runs to and from the Project

Fire run towards the Project alignment

Fire run refers to a low bushfire risk at the interface of bushland/grassland and an asset. These fire runs are the most likely location of impacts to the Project during construction and operation. The calculation of fire run from a bushfire is based upon the fastest moving part of the fire (called the head) that spreads generally in the direction of the wind. The fire runs that exist on land that interfaces with the Project alignment and which could support a bushfire that could impact on the Project are presented in Figure 20.3.

The most significant fire run towards the Project alignment occurs across the Crace Nature Reserve extending from a westerly direction eastwards towards to the Project alignment and from the TAMS Mitchell waste timber storage facility (near Crace Hill). This fire run (approximately 1,840 metres) could intersect the TAMS Mitchell waste timber storage facility or enter into the woodland area that extends to Flemington Road. A fire in this area could potentially burn to Flemington Road between Sandford Street and Randwick Road.

A fire run of approximately 1,455 metres extends across the Mulanggari Grasslands Nature Reserve in a south west to north east direction intersecting the Project alignment along Flemington Road between Kate Crace Street and Manning Clark Crescent. A fire run of approximately 830 metres also extends from the Canberra Riding Club on Randwick Road, south east to the Project alignment at Federal Highway. The alignment of this fire run corresponds with north-westerly winds that are typically associated with days of extreme/catastrophic fire danger increasing the potential for a bushfire to impact upon the Project alignment at this location.

Fire run from the Project alignment

The length of fire run associated with a bushfire that originates from the Project alignment can be the same distance calculated for a bushfire moving towards the Project alignment, with the direction of fire run simply reversed. However, this approach does not take into consideration the probable wind directions on days of extreme/catastrophic fire danger.

The longest potential fire run originating from the Project alignment of approximately 825 metres occurs for a fire ignition between Lysaght Street and Callan Street on the eastern side of Flemington Road. The hill at this location has a gentle slope of between 6 and 10 degrees with a north-west aspect that would aid the spread and speed of a bushfire at this location. This fire run extends south-east under the influence of a prevailing north-westerly wind to Old Well Station Road that would form a fire break, although a much longer fire run would be possible if the bushfire jumped Old Well Station Road.

Two shorter fire runs occur from the Project alignment in a south west to north east direction across vacant grassland at Gungahlin. The first fire run of approximately 230 metres occurs on the northern side of Hibberson Street between Kate Crace Street and Hinder Street and extends to Anthony Rolfe Avenue that forms a fire break. The second fire run of approximately 270 metres occurs on the northern side of Flemington Road across the adjacent vacant land between Kate Crace Street and Hamer Street in a south-west to northeast direction. These fire runs both extend towards residential areas on the northern side of Anthony Rolfe Avenue.
Source: Grant Fleming Environmental, Technical Paper 12

Figure 20.3   Length of potential fire runs from the Project alignment
20.4 Proposed mitigation measures and offsets

20.4.1 Construction bushfire management measures

A series of potential mitigation measures have been identified to minimise the potential bushfire impacts identified above during construction of the Project. These measures are outlined below.

General measures

- bushfire protection measures and requirements would be included within the site induction for contractors working on the Project
- electrical equipment and other plant and machinery would be maintained in operational order that is fit for purpose and to prevent potential sparks
- all legislative requirements regarding safe work procedures would be met, including chemical handling and storage
- an Emergency Management Plan would be developed as part of the Project which would include details regarding communications protocols between the Project and emergency services during construction.

Compound sites

- temporary project buildings would be constructed in accordance with Australian Standards AS 3959 – Construction of buildings in bushfire prone areas
- a fire break up to 5 metre wide would be maintained around temporary site buildings (where practicable and not impacting on sensitive biodiversity or ACT registered trees)
- where practicable, a 20 metre building protection zone would be identified and maintained clear around all new and temporary building footprints during construction. Roads would be included within the building protection zone as part of the separation distance
- trees that are proposed to be retained within the identified asset interface areas would have the lower branches trimmed to a height of 2 metres above the ground
- the canopy of any tree retained would be 10 metres from any building. Where this separation distance cannot be achieved by trimming branches, removal of the tree would be considered (trees are that are sensitive biodiversity or ACT registered trees would be exempt from this requirement)
- gutters and the roof of any temporary site buildings would be checked on a regular basis and cleared of flammable material
- weeds would be managed at the site to ensure that they do not constitute a fire hazard.

Hot works

- hot works would not be permitted on days when a Catastrophic fire danger has been declared
- areas where hot works are to be conducted would be cleared of flammable vegetation and materials in all directions to a distance of 5 metres (where practicable)
- a spotter would be used when hot works are conducted in areas where flammable materials cannot be removed and a fire fighting equipment would be present when conducting hot works
- a post work check of any hot works would be conducted after completion
- the management of potential impacts associated with hot works would be included as part of the overall Emergency Management Plan which would be developed.
Vehicle use

- All vehicles/mobile plant entering site would be fitted with fire extinguishers.
- Motor vehicles would not drive over long dry grass (wherever practicable) and would remain within defined parking and trafficable areas.

Landscaping

- Retained vegetation would be watered regularly during the bushfire season to retain moisture, in particular on days of forecast high or above fire danger.
- Mulch or other vegetation including organic waste would not be permitted to be burnt at any time.
- Mulch would be placed in landscaped areas as soon as is possible to reduce the on-site storage time.
- Stockpiled material would be kept as dry as possible and kept in small piles to reduce the likelihood of self-combustion.

Waste management

- Construction waste would be removed from the site in a timely manner so as not to cause a fire risk or obstruct emergency vehicle access.
- Unauthorised access to waste receptacles would be prevented, i.e. locked covers and/or fencing to prevent public access or fires being lit.

Security

- Project Co would ensure the site is secured as soon as is practicable to prevent unauthorised access and arson attack.
- A security presence would be maintained along the Project site and would be actively patrolled after hours during the bushfire season.

20.4.2 Operation Bushfire Management Measures

A series of potential mitigation measures have been identified to minimise the potential bushfire impacts identified above during operation of the Project. As part of the operational mitigation measures, a series of proposed additional or revised asset protection zones have been proposed for future consideration.

Design

- Substations and the stabling and maintenance depot at Mitchell would be constructed in accordance with Australian Standards AS 3959 – Construction of buildings in bushfire prone areas.
- Where substations are located in a bushfire prone area, detailed design of the feeder power lines would consider the use of aerial bundled cable (insulated) or underground cables in accordance with the recommendation of the 2009 Victorian Bushfires Royal Commission (Parliament of Victoria 2010).
- CCTV would be provided at stops to assist in deterring potential arson or other malicious activities.

Landscaping

- Where trees are in the vicinity of the light rail overhead catenary, they would be maintained to provide clear safety zone. Regular maintenance of overhanging and adjacent vegetation would be undertaken by qualified and experienced arborists.
- Landscaping at the substations and the Mitchell stabling depot and maintenance facility would be designed in accordance with Planning for Bushfire Protection guidelines (NSW RFS 2006).
lower branches on pine trees. If present within the Project operational footprint, would be removed to a height of 2 metres from the ground in declared bushfire prone areas

coarse mulch would be considered for placement adjacent to roadways as discarded cigarettes are less likely to ignite this material (FESA 2009).

### Asset Protection Zones

- Proposed asset protection zone (APZs) (as identified in *Bushfire Risk Assessment* (Technical Paper 12)) would be considered for implementation by Project Co and CMA as part of detailed design and be endorsed by the ACT Emergency Services Agency and incorporated into the Regional Fire Management Plans and annual Bushfire Operation Plans (refer to section 20.4.3 below).

#### 20.4.3 Potential asset protection zones

An asset protection zone (APZ) is defined by NSW Rural Fire Service (2005) as ‘a fuel reduced area surrounding a built asset or structure.’ An APZ can comprise a combination of perimeter roads, fire trails or managed lands so that a fire path is not created between the hazard and the asset. An APZ provides:

- a buffer zone between a bush fire hazard and an asset
- an area of reduced bush fire fuel that allows fire suppression
- an area from which back burning may be conducted
- a relatively safe area for firefighters to operate in and allows emergency services access (NSW RFS 2005).

Where forest or woodland interfaces with the asset, the APZ can be made up of an Inner Asset Protection Zone (IAPZ) and an Outer Asset Protection Zone (OAPZ). The IAPZ is located adjacent to the asset with a low fuel hazard, reducing the level of ember attack, direct flame contact and radiant heat impact, and provides a defensible space with increased safety under some conditions (ESA 2014b). The OAPZ is a fuel reduced area that is designed to reduce the potential flame length by slowing the rate of spread, filtering embers and suppressing crown fires.

### Determination of APZ

Nominally the APZ is located at the interface of the hazard and the asset, however APZs take into consideration the nature and spatial location of other assets and both the practical and strategic advantages in positioning the APZ. For these reasons APZs may not always be established at the interface between the hazard and a particular asset. An example of this process is shown along the Project alignment where Flemington Road passes through Sections 230 and 231, Gungahlin (proposed construction compound site) that are undeveloped land. The APZ is presently positioned to protect residential properties to the west, north and east of this land. The presence of the Project alignment as an asset may require these APZs to be shifted to improve protection for the Project assets.

The potential positioning and type of APZs associated with the Project, taking into account the location and nature of existing fire management zones, are shown in Figure 20.4 and Figure 20.5. Some minor additional clearing may be required in order to establish the proposed APZs (subject to discussion between Project Co, CMA and other relevant stakeholders). In the case of grasslands additional mowing or slashing would be undertaken rather than clearing. Where additional clearing is determined to be required as part of any proposed APZ, the potential ecological impacts of this clearing would need to be considered.
Figure 20.4 Existing and proposed asset interface management zones (north)
Figure 20.5  Existing and proposed asset interface management zones (south)
The ACT Emergency Services Agency would be required to approve the proposed asset protection zones associated with the Project prior to finalising these zones. Any additional APZs would be considered during the detailed design phase of the Project. CMA and Project Co would engage and consult with relevant agencies regarding the need for and any potential management requirements of proposed APZs prior to implementation.

**Impact assessment of APZs**

This EIS does not currently consider the potential impacts of any clearing required as part of potential future APZs. As noted above, any additional APZs would be considered during the detailed design phase of the Project.

The potential impacts associated with the establishment and maintenance of any agreed future APZs – predominantly biodiversity but potential visual and heritage impacts associated with the potential establishment of an APZ at Haig Park – would be assessed in accordance with the standard ACT planning and approvals process to assess this change to the current Project. This assessment would be undertaken by Project Co prior to commencement of any works to implement any agreed APZs.

### 20.5 Expected conditions

While areas of land north of the intersection of Swinden Street and Northbourne Avenue are declared BPA and therefore considered to have a high bushfire risk, this risk is typically associated with grasslands that would carry bushfires of lower intensity than areas of forest or woodland. The comparative bushfire risk would therefore be more accurately described as moderate across the majority of the grasslands adjacent the Project alignment from the intersection of Swinden Street and Northbourne Avenue to Gungahlin.

The bushfire risk in the southern half of the Project alignment, south of the intersection of Swinden Street and Northbourne Avenue through to Civic is low.

Some adjustment/consideration of additional APZs may also occur as part of the existing conditions during operation of the Project (subject to discussion between Project Co, CMA and other relevant stakeholders).

### 20.6 Residual risks

As the initial risk rating for potential bushfire risks was assessed as being very low, no further assessment of residual risks has been undertaken as part of the Project.