

Environment
Effects Statement

Chapter 18

Human health



Chapter 18

Human health

This chapter provides an assessment of the human health impacts associated with the construction and operation of North East Link. This chapter is based on the impact assessment presented in Technical report J – Human health.

North East Link would be constructed and operate within a highly urbanised area that includes long-established and diverse neighbourhoods and communities. The predicted changes to noise and vibration and air quality and the social changes anticipated have the potential to influence the health and wellbeing of the community.

The EES scoping requirements set out the following evaluation objectives:

- **Health, amenity and environmental quality** – To minimise adverse air quality, noise and vibration effects on the health and amenity of nearby residents, local communities and road users during both construction and operation of the project
- **Social, business, land use and infrastructure** – To manage effects of the project on land use and the social fabric of the community with regard to wellbeing, community cohesion, business functionality and access to goods, services and facilities.

To assess the potential effects of the project on the health and wellbeing of residents, the local community and road users, a health impact assessment was undertaken. The assessment included consideration of changes in noise and vibration levels, air quality changes and social changes.

Other aspects closely related to the human health evaluation objectives include air quality, noise, vibration, land use, business and social impacts. These are addressed in the following chapters and reports:

- Chapter 10 and Technical report B – Air quality
- Chapter 11 and Technical report C – Surface noise and vibration
- Chapter 12 and Technical report D – Tunnel vibration
- Chapter 13 and Technical report E – Land use planning
- Chapter 14 and Technical report F – Business
- Chapter 17 and Technical report I – Social.

What is human health?

The World Health Organisation defines health as 'a (dynamic) state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity'.

18.1 Method

Informed by the risk assessment described in Chapter 4 – EES assessment framework, the health impact assessment involved the following key tasks:

- A review of relevant national, state and local legislation and policy
- A study area for human health was established – the study area comprised an assessment of local government areas and suburbs that North East Link would intersect

The assessment of health impacts resulting from changes to air quality considered the study area for the air quality impact assessment as described in Chapter 10 – Air quality. The assessment of health impacts resulting from changes to noise and vibration levels considered the study area for the surface noise and vibration assessment as described in Chapter 11 – Surface noise.

- The existing conditions were characterised, including the population profile and existing health of the population
- The Victorian Environment Protection Authority (EPA Victoria) and the Victorian Department of Health and Human Services (DHHS) were consulted
- The potential health impacts during the project's construction and operation of the project were assessed – this included consideration of:
 - Changes in noise and vibration within the community
 - Changes in air quality within the local community related to the emissions from the tunnel ventilation structures
 - Changes in air quality related to changes in emissions from major surface roads
 - Exposure of vehicle occupants to air emissions present within the tunnel during operation
 - Potential for exposure to contaminated land
 - Health implications of social changes related to construction and operation of North East Link

What are the risk categories?

Risk levels were categorised as very low, low, medium, high or very high. When an impact is a known consequence of the project, the rating is indicated as 'planned'. The results of the risk assessment were used to prioritise the focus of the impact assessments.

Further detail on the assessment approach is provided in Section 18.2 below.

- Environmental Performance Requirements (EPRs) were developed in response to the impact assessment – Refer to Chapter 27 – Environmental management framework for the full list of EPRs.

18.2 Approach to assessing health impacts

This section summarises the approach for assessing health impacts. Further detail is provided at the Appendices of Technical report J – Human health.

The focus of the health impact assessment is to assess the project's benefits and any adverse impacts on the local community and users of the project by comparing the project's construction and operation with a 'no project' scenario.

A number of approaches to assessing health impacts were undertaken in response to the available guidelines and literature. Where health-based guidelines were available for air quality and noise and vibration, air or noise modelling results were compared against these guidelines. In instances where there was no threshold for adverse health effects, a risk assessment was undertaken. Qualitative assessments were undertaken for construction risks and potential health impacts associated with social changes.

The area of mental health, and the interconnections between physical health and mental health, is highly complex both at a community level as well as on an individual level. As a result of this complexity, this assessment has focused on and provided a qualitative assessment of the key aspects of mental health that may be impacted by the project, namely changes in stress and anxiety.

18.2.1 Assessing health impacts from changes in noise and vibration

The assessment of health impacts related to noise and vibration was based on the assessment provided in Chapter 11 – Surface noise and vibration. The assessment of health impacts related to the operation of the project involves the quantification of health risks and impacts resulting from changes in noise. The assessment considered the project-specific noise targets as well as proposed noise mitigation measures, specifically noise walls. The assessment considered the available data relating to health effects associated with exposure to noise, including guidance from the World Health Organisation (WHO) (2018). Health effects are specifically related to changes in road traffic noise. The key effects evaluated include mortality (that is, shortening of lifespan), cardiovascular effects (incidence of hypertension and ischaemic heart disease), noise annoyance and sleep disturbance.

The approach to assessing health impacts from noise and vibration were:

- Community/population health impacts were assessed on the basis of the change in population risk (for the population evaluated close to the project and related to key surface roads) and health incidence (change in the number of cases). There is very limited guidance available in relation to acceptability of community risks related to changes in noise. For the North East Link assessment, guidance developed for the evaluation of health impacts from changes in air quality available from the National Environment Protection Council (NEPC) was used. As such, the following were adopted:

Acceptable population risk for changes in noise levels $\leq 1 \times 10^{-5}$

- Localised health impacts were calculated to assess the potential significance of maximum increases in noise due to the redistribution of local traffic. As this is a localised impact it is not possible to calculate an increased population incidence and the calculation of risk relates to a maximum localised risk, not a population risk. Due to limitations related to applying the exposure-response functions to localised impacts, these localised risks are semi-quantitative and a risk management target has been adopted to identify where changes in localised impacts may be considered to be elevated and require mitigation. As such, the following was adopted:

Risk management level for localised risk for changes in noise levels $\geq 1 \times 10^{-4}$

- The assessment of changes in annoyance and sleep disturbance requires some consideration of what level of change may be of concern in terms of health, and complaints. The assessment presented has focused on the key measures of highly annoyed and highly sleep disturbed as prescribed by the WHO (2018). As such, the following were adopted:

Acceptable change in population highly annoyed ≤ 5 per cent

Acceptable change in population highly sleep disturbed ≤ 3 per cent.

Construction impacts have been addressed on the basis of a qualitative assessment, where potential impacts and the identification of relevant management measures to minimise noise and vibration impacts were evaluated.

18.2.2 Assessing health impacts from changes in air quality

The assessment of health impacts related to changes in air quality was based on the assessment presented in Chapter 10 – Air quality. The health impact assessment considered community health impacts, to inform the assessment of the health effects of the project, as well as localised health impacts, to inform management decisions in relation to the magnitude of localised impacts. Different approaches were employed for the assessment of construction and operation health impacts as follows.

What are acute and chronic health impacts?

'Acute' exposure refers to contact with a substance that occurs once and only for a short period of time, typically an hour or less, but may be up to 14 days.

'Chronic' exposure refers to contact with a substance that occurs repeatedly over a long time, with exposures occurring for more than 10 per cent of a lifetime.

The assessment of operation impacts involved quantification of health risks and impacts resulting from changes in air quality, including:

- Assessment of potential cumulative (that is, background levels plus project contribution) acute and chronic health impacts from changes in air quality where health-based guidelines are available. This approach applies to a number of air toxics as well as carbon monoxide. This assessment has utilised current health-based criteria for acute and chronic exposures.
- Assessment of potential incremental lifetime carcinogenic risks from changes in concentrations of benzene, 1,3-butadiene, polycyclic aromatic hydrocarbons and diesel particulate matter. There are no specified thresholds for these carcinogens. As such, the risk of incremental lifetime risk of cancer was assessed adopting the following:

Incremental carcinogenic risk, acceptable risk $\leq 1 \times 10^{-6}$

- Evaluation of the potential cumulative and incremental health impacts from changes in air quality related to nitrogen dioxide and particulates such as PM_{2.5} and PM₁₀. The assessment of exposures to changes in concentrations of nitrogen dioxide and particulate matter has considered exposure-response relationships established from large epidemiological (population) studies. These studies have identified a number of key health-effects related to exposure to changes in nitrogen dioxide and particulate matter that include mortality (shortening of lifespan) and morbidity (increased hospitalisations and emergency department visits), particularly associated with cardiovascular and respiratory disease. These relationships are not established for the assessment of specific sources or localised impacts, such as the impacts from North East Link.

Community/population health impacts were assessed on the basis of the change in population risk (for the population close to the project and key nearby roads affected) and health incidence (change in the number of cases). There is very limited guidance available in relation to acceptability of community risks related to changes in nitrogen dioxide and particulate matter. For the North East Link assessment, guidance developed for the assessment of health impacts from changes in air quality available from the National Environment Protection Council (NEPC) was used. The following risk management level was adopted:

Risk management level for population risk for changes in nitrogen dioxide and particulates $\geq 1 \times 10^{-5}$

Localised health impacts were calculated to assess the potential significance of maximum increases in nitrogen dioxide and particulate matter as a result of the redistribution of traffic and changes to traffic volumes. Localised health impacts refer to the potential impacts in specific locations, as compared with the impacts to a population. Due to limitations related to applying the exposure-response functions to localised impacts, these localised risks are semi-quantitative, where a risk management target has been adopted to identify where changes in localised impacts may be considered to be elevated and require mitigation. The following risk management level was adopted:

Risk management level for localised risk $\geq 1 \times 10^{-4}$

Construction impacts have been addressed on the basis of a qualitative assessment, where potential impacts and the identification of relevant management measures to minimise impacts (including nuisance dust) were evaluated.

18.2.3 Assessing health impacts of social changes

The assessment of health impacts related to social changes was based on the assessment presented in Chapter 17 – Social. The assessment of health impacts of social changes considered the construction and operation of the project.

This included a qualitative assessment of the social characteristics which have potential to affect the health of the community (positively or negatively). Changes in air quality, noise, traffic composition and movement, pedestrian and cycle access and safety, the availability of recreational uses, connectivity (or displacement) of the community, the availability of open space, the availability of tree canopy and the urban environment formed part of the assessment. The assessment of health impacts of social changes is qualitative and was informed by a range of published studies. The chapter only presents an assessment of the key potential social impacts, however a broader range has been considered as presented in Technical report J – Human health.

18.2.4 Dealing with uncertainty

The assessment of health risks and impacts incorporated data and information has uncertainty. To account for uncertainty, the assessment of health impacts was underpinned by a number of conservative inputs including:

- The assumptions adopted in modelling air quality and noise impacts
- The characterisation of exposure to changes in air quality and noise levels
- The exposure-response relationships used to assess health effects.

This means the health impact assessment for North East Link presents an overestimation of the potential health impacts, rather than an underestimation.

One important aspect is the composition of the vehicle fleet and the emissions profile of vehicles that has been assumed in the air modelling. The assessment has considered a conservative scenario where the air modelling uses vehicle emissions factors predicted for the year 2020 and a more realistic scenario that uses vehicle emissions factors predicted for 2025. The conservative approach that uses vehicle emission factors for 2020 does not take into account the improvements in vehicle technology and the progressive retirement of older vehicles that are anticipated to occur beyond this date, and after North East Link's opening.

The aim of this approach was to provide a more realistic representation of how emissions to air from vehicles during North East Link's operation could impact health, particularly in relation to emissions of nitrogen dioxide and particulate matter. The assessment of health impacts due to air quality changes as presented in Section 18.5.2 of this chapter presents findings for the conservative and realistic approaches to assessment.

18.3 Existing conditions

This section outlines the existing conditions of the North East Link study area that relate to human health. The social demographics and existing health trends are important when considering equity aspects of health for the project.

Much of the study area is residential in nature. A number of public conservation and recreation zones are located in the southern part of the project corridor. The study area also includes a number of areas noted to be of environmental significance and where vegetation is protected through planning overlays.

Existing conditions for air quality, noise and vibration and a profile of the existing community informing the social impact assessment are documented in Chapter 10 – Air quality, Chapter 11 – Surface noise, Chapter 12 – Tunnel vibration and Chapter 17 – Social.

18.3.1 Population profile

North East Link would extend from the M80 Ring Road (otherwise known as the Metropolitan Ring Road) in the north and extend along the Eastern Freeway in the south. The population in the suburbs directly affected by the project, as well as some adjacent suburbs that may also be affected by the project, were considered in the health impact assessment. Local government areas (municipalities) and suburbs included in the assessment were:

- Whittlesea, including the suburbs of Bundoora West, Bundoora North, Mill Park South, Thomastown and Lalor
- Nillumbik, including the suburb of Greensborough
- Banyule, including the suburbs of Bundoora, Greensborough, Watsonia North, Watsonia, Macleod, Yallambie, Rosanna, Viewbank, Heidelberg, Eaglemont, Ivanhoe East
- Manningham, including the suburbs of Bulleen, Doncaster, Doncaster East, Donvale, Nunawading
- Boroondara, including the suburbs of Balwyn North, Kew East and Kew
- Whitehorse, including the suburbs of Mont Albert North, Box Hill North, Blackburn North, Nunawading
- Yarra, including the suburbs of Alphington, Fairfield, Clifton Hill and Abbotsford.

Population growth

Significant population growth is predicted in the Yarra and Whittlesea municipalities with a lower rate of growth predicted in the other municipalities. Population growth can cause disproportionate increase in more sensitive and vulnerable populations, including young children and the elderly, in some areas. However these need to be considered in the context of the existing demographics.

Demographics

A selected range of demographic measures for the population of interest were compared with greater Melbourne. As described in Chapter 17 – Social, socio-economic advantage and disadvantage can be defined broadly in terms of people’s access to material and social resources and their ability to participate in society. The demographic measures relating to socio economic advantage and disadvantage that were examined for this assessment included median age, household income, mortgage repayment and rent, average household size and the unemployment rate.

The Australian Bureau of Statistics’ (ABS) Index of Relative Socio-economic Disadvantage (IRSAD) was considered as part of the assessment. This index summarises a range of information about the economic and social conditions of people and households in an area. The index indicates social advantage using a score out of 10, with a low score indicating greater disadvantage and a high score indicating relative lack of disadvantage.

Analysis of the demographic measures of the suburbs listed above indicated that all suburbs are in a position of relative social advantage, many lying at the highest decile of 10 in the ABS IRSAD. Bundoora and Watsonia were the lowest ranking of the identified suburbs, with a value of six.

18.3.2 Existing health of the population

The existing health of the population potentially impacted by North East Link has been considered as part of this assessment to determine if they would be particularly sensitive to changes associated with the project’s construction or operation.

Health behaviours

To assess the existing health of the communities surrounding North East Link, a review of the health data for the municipalities of Banyule, Boroondara, Manningham, Nillumbik, Whitehorse, Whittlesea and Yarra was undertaken. The data demonstrated that for most of the health behaviours evaluated, the study area is statistically similar to that for Victoria.

There were however some statistically significant differences for particular health behaviours including:

- Lower prevalence of smoking in Whitehorse
- Lower prevalence of short-term risk from alcohol-related injury in Whittlesea and higher prevalence in Nillumbik and Yarra
- Lower prevalence of long-term risks from alcohol-related harm in Whittlesea and a higher prevalence in Boroondara and Nillumbik
- Lower prevalence of poor fruit and vegetable intake in Nillumbik
- Lower prevalence of sufficient physical activity in Whittlesea and higher prevalence in Boroondara
- Lower prevalence of overweight in Whitehorse and Yarra

- Lower prevalence of obesity in Yarra
- Lower prevalence of high or very high psychological distress and fair or poor self-reported health in Nillumbik.

The data indicates the populations of some of the municipalities of interest undertake health related behaviours that are significantly more adverse than those for the wider Victorian population. Those behaviours particularly relate to alcohol consumption and physical activity.

Prevalence of disease and hospitalisations

A review of the available data in relation to mortality, the prevalence of disease and hospitalisation rates for the municipalities indicates that:

- For Banyule, Boroondara, Manningham, Nillumbik and Whitehorse the prevalence of premature deaths (avoidable, circulatory, respiratory and lung cancer) is significantly lower than that reported for Victoria
- With the exception of Whittlesea, the rate of circulatory system and respiratory system diseases are lower in the identified municipalities than for Victoria as a whole
- The rate of hospital admissions for cancer in the identified municipalities is similar to those reported for Victoria as a whole, with the exception of Nillumbik which is higher.

Overall, the demography and health of the broader community is generally consistent with, or better than the Melbourne Metropolitan area and Victorian population. At a local level there are some existing community concerns relating to air quality and noise impacts on the health of residents and school children in areas located close to existing major roadways. It is expected that, given the general health of this community, at a broad scale, the health of the local community may not be particularly sensitive to changes associated with the project.

18.4 Construction impact assessment

This section discusses the construction impacts associated with North East Link that relate to human health.

The impacts identified for the construction of North East Link that relate to human health are grouped according to four themes:

- Noise and vibration
- Air quality
- Social
- Contaminated land.

The potential for impacts associated with these themes are discussed in the following sections.

18.4.1 Noise and vibration

Sound is a natural phenomenon that only becomes noise when it has some undesirable effect on people or animals. Unlike chemical pollution, noise energy does not accumulate in the body nor the environment but it can have short-term and long-term adverse effects on health.

The key potential health effects from noise and vibration include:

- Sleep disturbance
- Annoyance
- Effects on cardiovascular health
- Hearing impairment and tinnitus
- Cognitive impairment
- Increased mortality (shortening of lifespan).

The assessment of health impacts due to noise and vibration are based on Chapter 11 – Surface noise and vibration and Chapter 12 – Tunnel vibration.

The risk pathway associated with construction noise and vibration is described in Table 18-1 and potential impacts are discussed below.

Table 18-1 Risk table: Construction – noise and vibration

Risk ID	Risk pathway	Risk rating
Risk HE01	Noise and vibration emissions from construction activities affecting the health of the local community	Low

The assessment considered the potential for construction activities to generate noise and vibration that could impact human health (risk HE01).

Noise

During construction, there is potential for an increase in noise to sensitive receptors due to construction activities and spoil haulage.

The majority of construction activities are proposed within the normal working hours from 7am to 6pm, Monday to Friday, and 7am to 1pm on Saturday. Some works would be undertaken outside these hours, when these works are inherently quiet or where they are unavoidable due to the continuous nature of the activities or to manage safety risks and disruption of the traffic network. With the exception of emergency works, activities would not take place outside normal working hours without prior contact with local residents, businesses and EPA Victoria where required.

Assessment of noise impacts associated with the movement of construction-related activities determined there is potential for noise impacts related to:

- The excavation works for the depressed roadway, north of the northern portal
- During the noise wall replacement, when it would not always be possible to erect the new wall ahead of demolition of the existing one. This may be of particular relevance to the Eastern Freeway, where permanent noise walls may not be in place for two to six weeks. This would mean a noticeable increase in traffic noise levels during this time.

The assessment of noise impacts related to the movement of trucks for construction works determined that while the trucks may be identifiable on the roads, they should not lead to a significant increase in noise. Impacts from haul trucks are best minimised through management practices, with a range of measures identified for consideration in the Construction Noise and Vibration Management Plan.

The assessment also considered the potential for tunnelling activities to generate noise which impacts human health. Based on the assessment undertaken the construction of the project's main tunnels, cross passages and portal dive structures would produce perceptible but generally acceptable and manageable levels of noise. Where impacts were potentially unacceptable, mitigation measures would include adjustments to the scale of the works, real time monitoring and community consultation. Where measures could not reduce regenerated noise levels to acceptable values, other measures such as temporary relocation, vibration isolation devices or noise amelioration measures may be required.

Noise and vibration would be managed during the project's construction through a Construction Noise and Vibration Management Plan (EPR NV3 and EPR NV4). Management actions would be implemented if specified guideline targets were not achieved (EPR NV8 and EPR NV9). Management actions would be implemented to protect amenity at residences that would experience exceedance of guideline ground-borne (internal) noise targets (EPR NV10). Any blasting would comply with Australian Standard AS 2187.2-2006 (EPR NV11).

Vibration

The assessment considered the potential for tunnelling activities to generate vibration from surface works and tunnelling, which impacts human health.

For surface works, the most significant potential for vibration impacts would be during the use of vibratory rollers, rockbreakers and driven piling. Vibration from these activities would likely be intermittent during the project's construction.

For tunnelling works, there is potential for vibration impacts related to the use of a tunnel boring machine (TBM), a road header or an excavator with a hydraulic hammer attachment. Vibration from these activities would likely be continuous or at least semi-continuous throughout the project's construction.

Overall, the assessment indicates that construction activities are expected to produce relatively minor levels of vibration and audible regenerated noise. At locations where works would be close to sensitive receptors, or where the depth of the tunnel beneath the surface level would be shallower, it is anticipated there would be some perceptible levels of vibration and audible regenerated noise. However, this is not anticipated to result in significant health impacts in the community.

Noise and vibration would be managed during construction through the Construction Noise and Vibration Management Plan (EPR NV3 and NV4). Management actions would be implemented if specified guideline targets were not met for construction vibration in relation to protection of amenity (EPR NV8).

18.4.2 Air quality

Construction activities can cause the emission of dust, vehicle and equipment fumes and odours which have the potential to impact human health. Potential air quality impacts to human health associated with the project's construction primarily relate to:

- Dust emissions from construction activities which have the potential to pose:
 - A nuisance, where the larger particles settle out and deposit on surfaces in the community
 - A potential health issue, where particles that are small enough enter the respiratory system
- Odorous emissions due to asphalt sealing of constructed roads
- Emissions from diesel-fuelled construction vehicles and earth moving machinery.

The assessment of health impacts related to changes in air quality is based on the assessment presented in Chapter 10 – Air quality.

The risk pathway associated with air quality is described in Table 18-2 and potential impacts are discussed below.

Table 18-2 Risk table: Construction – air quality

Risk ID	Risk pathway	Risk rating
Risk HE02	Dust generated and emissions to air from construction equipment and construction activities affecting the health of local community	Low

The assessment considered the potential for construction related dust and air emissions to impact the health of the local community (risk HE02).

The main impacts identified related to the generation of airborne dust, including deposited dust, total suspended particulates and the finer dust fractions of PM₁₀ and PM_{2.5}.

The assessment determined that emissions to air from the project’s construction are not anticipated to significantly impact the health of communities provided the EPRs are implemented as discussed below. Implementing these measures would prevent significant emissions of dust and odours to surrounding communities. Air emissions would be intermittent over the duration of construction and spread over a large area. Odours may also be generated during some activities but these would be close to the source of particular materials.

The implementation of appropriate EPRs would minimise the potential for health impacts due to air emissions as presented in Technical report B – Air quality. The implementation of the Construction Environment Management Plan (CEMP) (EPR EMF2) together with a Dust and Air Quality Management and Monitoring Plan would assist in managing air quality impacts during the project’s construction by addressing the emissions of smoke, dust, fumes and other air pollutions (EPR AQ1). A Spoil Management Plan would be developed and implemented to identify measures to manage spoil (EPR CL1). Communication with the community and stakeholders would be managed during construction with a Communications and Community Engagement Plan (EPR SC2).

18.4.3 Contaminated land

Locations in the vicinity of the project where land contamination is known to exist are limited. Nevertheless past commercial, industrial and quarrying activities combined with historically poor environmental management and waste disposal may potentially have caused contamination, posing potential impacts to human health.

The assessment of the potential health impacts related to contamination is based on the assessment presented in Chapter 23 – Contamination and soil.

The risk pathway associated with contaminated land is described in Table 18-3 and potential impacts are discussed below.

Table 18-3 Risk table: Construction – contaminated land

Risk ID	Risk pathway	Risk rating
Risk HE03	Inappropriate handling, stockpiling, transport and treatment/disposal of contaminated soil and groundwater resulting in exposure and potential health impacts to the local community	Low

The assessment considered the potential for contaminated soil and groundwater to impact the local community during the project’s construction (risk HE03).

The assessment identified no significant areas of soil contamination in the immediate vicinity of the project. Some specific areas of contamination were identified as a result of historical activities. These include soil and fill materials beneath Bulleen Oval and potentially contaminated groundwater in the Bulleen area.

In the context of the health assessment, where contaminated soil and groundwater is appropriately assessed and managed as proposed, no health impacts are expected in relation to the management of these materials.

EPRs would be implemented to manage contamination, soil and groundwater as presented in Technical report O – Contamination and soil (EPR CL1, EPR CL2, EPR CL3, EPR CL4 and EPR CL5) and Technical report N – Groundwater (EPR GW2, EPR GW3 and EPR GW4).

18.4.4 Social

As described in the above sections, noise and vibration and air quality have the potential to directly affect health. Changes to a range of social conditions have the potential to affect the health and wellbeing of the community in a more indirect way.

During the construction of North East Link, it is anticipated there would be changes to access and connectivity that may have implications for the wellbeing of individuals in the community. In addition, loss of access to green space during construction may impact health and wellbeing.

The risk pathways associated with these potential changes during the project’s construction are described in Table 18-4 and potential impacts are summarised below in Table 18-5.

These risk pathways represent the key potential impacts of social changes to human health with a more holistic discussion presented in Technical report J – Human health.

Table 18-4 Risk table: Construction – social

Risk ID	Risk pathway	Risk rating
Risk HE05	Changes within the community such as the altered access or connectivity to/between recreational areas, community facilities, commercial premises and active transport infrastructure resulting in potential implications to public safety and wellbeing of individuals during construction	Low
Risk HE06	Changes within the community from the temporary use of some green space areas for construction resulting in impacts on the health and wellbeing of the community and permanent loss of some green space during operations.	Low

This section of the chapter evaluates the health implications of construction-related changes based on other assessments as presented in Chapter 9 – Traffic and transport, Chapter 13 – Land use planning, Chapter 16 – Landscape and visual and Chapter 17 – Social.

Table 18-5 Health impacts due to social changes during construction

Key issues	Findings	Proposed management measures
Altered access and connectivity		
<p>The potential for changes to access and connectivity during construction (due to the temporary disruption of roads, walking and cycling routes and public transport routes) that would impact public safety and wellbeing (risk HE05).</p>	<ul style="list-style-type: none"> • Changes to the local road network, active and public transport routes, increased traffic on connector roads, and property acquisitions could lead to impacts on social ties and connections. This reduced connectivity may deter people from participating in community activities or active transport, potentially reducing the connection to an environment and feeling of community cohesion. • Impacts to car parking at Watsonia railway station and the Doncaster Park and Ride may result in additional time walking from alternative parking to the station. • Impacts to walking and cycling routes have the potential to deter people from participating in active transport modes. New alternative routes would need to maintain safety to prevent an increase in accidents or a perception of unsafe travel routes. • The construction works are not expected to impact community access to existing health and emergency services. 	<ul style="list-style-type: none"> • Impacts to community feelings of severance and disconnection would be minimised through ongoing engagement and consultation with the community to discuss progress of construction activities and operation (EPR SC2). Relevant local councils and Victorian Government authorities would be consulted to identify alternative local facilities for formal recreational users displaced from recreational facilities due to the project works (EPR SC4). North East Link Project (NELP) and the relevant local councils are undertaking an assessment of current facilities and usage at each site so that sporting clubs and user groups can be accommodated within another local site. Following consultation with the managers, operators and users of the facilities, it was noted that generally people travel a fair distance to use these facilities and that users would continue to use the facilities at a new location, even if it may be further away. • Impacts to car parking would be minimised through EPR T1 – Optimise design performance, which requires the contractor to minimise loss of car parking in consultation with relevant councils. • Impacts to existing vehicle, cycling and walking routes would be minimised by providing suitable alternatives, with advance notice of changes. This would be managed by the development and implementation of Transport Management Plan(s) in consultation with relevant road authorities for works in all locations that affect pedestrian, bicycle, public transport or road users (EPRs T2-T5).

Key issues	Findings	Proposed management measures
Loss of green space		
<p>The potential for temporary use of green space (including green corridors, grassland, parks and gardens, outdoor sporting facilities, playing fields and children play areas) to impact the health and wellbeing of the community (risk HE06).</p>	<ul style="list-style-type: none"> Where a full or partial area of open space would be subject to occupation during construction or permanent acquisition, it is highly likely the neighbouring community would experience reduced access to and availability of open spaces for active or passive recreation over a short to medium term. This would be felt most significantly in locations where more than 90 per cent of the open space area or park would be affected, and also at spaces which are highly valued by the community. The project would also require temporary occupation and/or permanent acquisition of a number of community facilities, particularly around the southern extent of Bulleen Road and the area surrounding the Eastern Freeway. Construction works would also impact the visual amenity of green spaces which may discourage community members from using the spaces that are only partially impacted during construction. In the short term this may affect active lifestyle access and use of these areas, however it is expected that people would adapt to these changes and/or find alternatives. The loss of green spaces would also involve the removal of trees. It is estimated that approximately 26,000 planted trees are at risk of being removed during construction. 	<ul style="list-style-type: none"> Where recreation facilities are displaced by the construction or operation of the project, work in collaboration with local councils and relevant Victorian Government authorities to identify relocation opportunities with the objective of accommodating displaced facilities and maintaining the continuity of those recreational activities, where practicable (EPR SC4). Where construction or operation activities directly impacted on community infrastructure facilities such as schools, child care centres, and aged care centres, consultation must occur with managers, owners and user groups of the facilities to understand if any practical measures can be taken to avoid or minimise impacts (EPRs SC1 and EPR SC4). The long-term loss of trees and canopy cover during construction could be mitigated through replanting, which would include the development of a Tree Canopy Replacement Plan (EPR AR3).

Overall, the project would impact community cohesion, car parking and walking and cycling routes during construction. This could lead to community feelings of disconnection and isolation. Furthermore, the project construction sites and activities would affect visual amenity, some long term loss of trees and canopy cover, and a temporary loss of access to some existing passive green space areas. This could deter people from participating in community activities, potentially reducing the connection to an environment and feeling of community cohesion. However, with the implementation of project EPRs described above, including ongoing engagement with the community and the development and implementation of Transport Management Plan(s), the potential for significant impacts on the health of the local community during construction are not anticipated.

18.5 Operation impact assessment

This section discusses the operational impacts associated with North East Link that relate to human health.

The impacts identified for the operation of North East Link that relate to human health are grouped according to four themes:

- Noise and vibration
- Air quality in surrounding communities
- In-tunnel air quality
- Social.

18.5.1 Noise and vibration

The risk pathway associated with noise and vibration is described in Table 18-6 and potential impacts are discussed below.

North East Link is expected to redistribute traffic and change travel patterns in Melbourne’s north-east and across the broader metropolitan area. The change in traffic patterns would change the existing noise environment as presented in Chapter 11 – Surface noise and vibration. Changes in noise and vibration have the potential to impact human health as described in Section 18.4.1 of this chapter.

Table 18-6 Risk table: Operation – noise and vibration

Risk ID	Risk pathway	Risk rating
Risk HE07	Noise generated by the redistribution of traffic due to operation causes an increase in noise potentially affecting the health and amenity of the local community. In particular these impacts may increase annoyance affecting cognitive function in schools and workplaces, or increase sleep disturbance causing an increase in hypertension and increased risks of cardiovascular morbidity or premature mortality	Medium

The assessment considered the potential for noise and vibration from the redistribution of traffic during North East Link's to impact population and localised health (risk HE07).

For population health risks, the assessment determined that risk and health incidence values were negative. This indicates that for the population (ie all receptors) evaluated, there would be an overall reduction in noise during operation. As such, there may be some health benefits related to this reduction, although these would be generally small and unlikely to be measurable within the community.

While there are some localised areas where increases in noise levels have been identified, additional noise mitigation has already been identified for these properties as presented in Technical report C – Surface noise and vibration. Where these additional noise mitigation measures are considered, the maximum localised changes in noise related to the project are not considered to be of significance in relation to impacts on the health of the community.

Changes in noise levels due to the operation of North East Link are expected to comply with traffic noise objectives (EPR NV1) as presented in Technical report C – Surface noise and vibration. Traffic noise monitoring would be undertaken within six months of the project opening and again after 10 years to verify conformance with the proposed traffic noise limit (EPR NV2). The tunnel ventilation system would be designed to meet EPA requirements for noise. Monitoring would be undertaken of the tunnel ventilation system and contingency measures implemented if noise level targets are not met (EPR NV7).

18.5.2 Air quality in surrounding communities

Changes to traffic volumes and distribution related to North East Link would change the local and regional air quality. Vehicle exhaust emissions are known to result in health effects when populations are exposed to high levels.

Key components of vehicle exhaust emissions that could cause health effects are:

- Air toxicity (that is, volatile organic compounds, polycyclic aromatic hydrocarbons) and diesel particulate matter (DPM)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO₂)
- Particulate matter (measured as PM₁₀ and PM_{2.5}).

The risk pathway associated with air quality is described in Table 18-7 and potential impacts are discussed below.

Table 18-7 Risk table: Operation – air quality in surrounding community

Risk ID	Risk pathway	Risk rating
Risk HE09	Redistribution of traffic on surface roads during operation changes ambient pollutant levels (particulate matter, nitrogen dioxide, carbon monoxide, volatile organic compounds and polycyclic aromatic hydrocarbons) and emissions from tunnel ventilation structures potentially impacting on the health of the surrounding the community. Health effects may include respiratory and cardiovascular effects morbidity or premature mortality	Medium

The assessment considered the potential for changes to pollutant levels due to emissions from traffic and tunnel ventilation structures to impact human health (risk HE09).

Air toxics and diesel particulate matter (DPM)

The assessment considered emissions of air toxics including polycyclic aromatic hydrocarbons (PAH), volatile organic compounds (VOCs) and exposure to DPM. The assessment considered the potential for acute or chronic exposures related to the project to cause health effects. Chemicals known to be genotoxic carcinogens have also been assessed in relation to carcinogenic (cancer) risks.

For the assessment of acute and chronic exposures to VOCs, the hazard index was found to be below one, indicating that maximum predicted concentrations are below the applicable health based guideline. The calculated lifetime cancer risks related to the maximum change in VOCs are less than 1×10^{-6} , which is considered to be acceptable.

The calculated lifetime cancer risk related to the maximum change in PAHs was found to be less than 1×10^{-6} , which is considered acceptable.

The calculated lifetime cancer risks related to the exposure to DPM is equal to 1×10^{-6} , which is considered acceptable.

Carbon monoxide

Motor vehicles are the dominant source of carbon monoxide in air. Adverse health effects of exposure to carbon monoxide are linked with carboxyhaemoglobin (COHb) in blood. In addition, an association between exposure to carbon monoxide and cardiovascular hospital admissions and mortality, especially in the elderly for cardiac failure, myocardial infarction and ischemic heart disease. Some birth outcomes (such as low birth weights) have also been identified.

The maximum predicted cumulative one-hour average and eight-hour average concentrations of carbon monoxide for the years 2026 and 2036 were assessed.

All estimated acute and chronic concentrations of carbon monoxide are predicted to be below the relevant health-based guidelines.

Nitrogen dioxide

Nitrogen dioxide can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of nitrogen dioxide has also been associated with increased mortality, particularly related to respiratory disease, and with increased hospital admissions for asthma and heart disease patients. Asthmatics, the elderly and people with existing cardiovascular and respiratory disease are particularly susceptible to the effects of nitrogen dioxide. The health effects related to exposure to nitrogen dioxide depend on the duration of exposure as well as the concentration.

Potential health effects related to exposure to nitrogen dioxide would be undertaken for the project using comparison with guidelines (assessing total exposures – background plus the project) and an assessment of incremental impacts on health (related to changes in air quality from the project).

Conservative assessment

For the conservative assessment, it was determined the maximum total one-hour average and maximum annual average concentrations of nitrogen dioxide are predicted to be below the relevant acute and chronic guidelines.

All calculated population risks relevant to the assessment of nitrogen dioxide impacts from the ventilation facilities and changes from the redistribution of traffic on surface roads are less than 1×10^{-5} and are considered to be acceptable. In addition, all calculated changes in population incidence are considered to be negligible.

Localised changes in nitrogen dioxide as a result of emissions from the project's tunnel ventilation facilities result in maximum risks that are below 1×10^{-5} and are not considered to require any further consideration of risk management.

Assessment of localised changes in nitrogen dioxide due to the redistribution of surface road traffic identified some locations where the maximum risks were equal to the adopted risk management level. The assessment undertaken is conservative and further assessment of more realistic exposures is required to determine if risk management measures need to be further considered in these areas as discussed below.

Realistic assessment

For the realistic assessment, changes in nitrogen dioxide due to the project are lower than for the conservative assessment.

It was determined the maximum total one-hour average and maximum annual average concentrations of nitrogen dioxide are predicted to be below the relevant acute and chronic guidelines.

All calculated population risks relevant to the assessment of nitrogen dioxide impacts from the project's tunnel ventilation facilities and changes from the redistribution of traffic on surface roads are less than 1×10^{-5} and are considered to be acceptable. In addition, all calculated changes in population incidence are considered to be negligible.

Localised changes in nitrogen dioxide due to emissions from the ventilation facilities result in maximum risks that are below the adopted risk management level. The refinement of risks related to the redistribution of surface road traffic indicates the maximum risks are below the adopted risk management level.

As this relates to a more realistic assessment of the impact of vehicle emissions relevant to 2026 and 2036, no risk management measures need to be further considered in relation to localised changes in nitrogen dioxide.

Particulates

Particulate matter is a widespread air pollutant with a mixture of physical and chemical characteristics that vary by location (and source). Unlike many other pollutants, particulates comprise a broad class of diverse materials and substances, with varying morphological, chemical, physical and thermodynamic properties, with sizes that vary from less than 0.005 microns to greater than 100 microns.

Particulates can be derived from natural sources such as crustal dust (soil), pollen and moulds, and other sources that include combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The gases that are the most significant contributors to secondary particulates include nitrogen oxides, ammonia, sulphur oxides, and certain organic gases (from vehicle exhausts, combustion sources and agricultural, industrial and biogenic emissions).

Numerous epidemiological studies have reported significant positive associations between particulate air pollution and adverse health outcomes, particularly mortality as well as a range of adverse cardiovascular and respiratory effects.

The assessment of particulates considered cumulative exposures (maximum 24-hour average concentration and maximum annual average concentration) and incremental exposures (population health risk and population incidence for 2026 and 2036).

Conservative assessment

The assessment of total exposure (that is, background plus the project) of particulates determined maximum total/cumulative concentrations of PM_{2.5} from the project are above the relevant guideline for the 24-hour and annual average, regardless of the project. This is due to existing levels (background levels) of PM_{2.5} in the urban environment. The maximum cumulative 24-hour average and annual average concentrations of PM₁₀ from the project are below the relevant guideline. The contribution of emissions from the tunnel ventilation facilities is minor and does not change existing air quality in the area. Larger changes in PM_{2.5} and PM₁₀ relate to localised impacts near surface roads.

All calculated population risks relevant to the assessment of particulate matter impacts from the ventilation facilities and changes from the redistribution of traffic on surface roads are less than 1×10^{-5} and are considered to be acceptable. In addition, all calculated changes in population incidence are considered negligible.

Localised changes in particulate matter due to emissions from the tunnel ventilation facilities and changes from the redistribution of traffic on surface roads result in maximum risks that are not considered to require any further consideration of risk management.

Realistic assessment

For the realistic assessment, changes in particulate matter due to the project are lower than for the conservative assessment.

Assessment of total exposures to particulate matter for the realistic scenario is unchanged from the conservative assessment as the key contributor to total exposures is background.

All calculated population risks relevant to the assessment of particulate matter impacts from the ventilation facilities and changes from the redistribution of traffic on surface roads are less than 1×10^{-5} and are considered to be acceptable. In addition all calculated changes in population incidence are considered to be negligible.

Localised changes in particulate matter due to emissions from the tunnel ventilation facilities and changes from the redistribution of traffic on surface roads result in maximum risks that are not considered to require any further consideration of risk management.

18.5.3 In-tunnel air quality

The risk pathway associated with in-tunnel air quality is described in Table 18-8 and potential impacts are discussed below.

Table 18-8 Risk table: Operation – in-tunnel air quality

Risk ID	Risk pathway	Risk rating
Risk HE08	Tunnel operation leading to higher in car pollutant concentrations and exposures by occupants using the tunnel	Low

The assessment considered the potential for car pollutants to impact the health of tunnel users (risk HE08).

Exposures to pollutants within tunnels vary depending on time of day, location within the tunnel and time spent within the tunnel.

For motorists, the amount of time spent in the North East Link tunnel is expected to be limited. The length of the tunnels is approximately six kilometres, which would take approximately 4.5 minutes to travel at 80 kilometres per hour. At highly congested times, or during traffic incidences, the time spent in the tunnel may double to approximately nine minutes.

The proposed in-tunnel air quality limits for carbon monoxide and nitrogen dioxide are considered adequately protective of the health of users of North East Link tunnels. In relation to exposures to particulates in the tunnel, there are no guidelines currently available to evaluate health effects of very short-duration exposures to particulates. Short-duration exposures to higher levels of particulates should be minimised by advising motorists to keep windows closed and switch ventilation to recirculation, as is currently being implemented in New South Wales.

18.5.4 Social

As described in Section 18.4.4 above, changes to access and connectivity may have implications for the wellbeing of individuals in the community. In addition, loss of access to green space may impact health and wellbeing.

The risk pathways associated with these potential changes during the project’s operation are described in Table 18-9 and potential impacts are summarised below in Table 18-10. These risk pathways represent the key potential impacts of social changes to human health with a more holistic discussion presented in Technical report J – Human health.

Table 18-9 Risk table: Operation – social

Risk ID	Risk pathway	Risk rating
Risk HE10	Changes within the community, such as altered access or connectivity to/ between recreational areas and community facilities and active transport infrastructure may have implications to public safety and the wellbeing of individuals from the operation of the project	Low
Risk HE11	Changes within the community from the permanent loss of green space and tree canopy areas resulting in impacts on the health and wellbeing of the community.	Planned (moderate consequence)

This section of the chapter evaluates the health implications of impacts during operation based on other assessments as presented in Chapter 9 – Traffic and transport, Chapter 16 – Landscape and visual, and Chapter 17 – Social.

Table 18-10 Human health impacts due to social changes during operation

Key issues	Findings	Proposed management measures
Altered access and connectivity		
The potential for changes to access and connectivity during operation that would impact public safety and wellbeing (risk HE10).	<ul style="list-style-type: none"> Once completed and operating in 2036, North East Link would significantly redistribute medium and longer cross city trips away from the local and arterial roads. Travel times are expected to improve, with savings up to 35 minutes between the M80 Ring Road and the Eastern Freeway. The project would also generally reduce traffic and truck volumes on local roads. Some increases in traffic are expected in some feeder routes. This would provide a ‘lower stress’ environment for pedestrians and cyclists and increase time available to spend on healthy behaviours such as exercise or social interactions. North East Link is also forecast to reduce the total number of crashes across the north-east despite an overall projected increase in vehicle kilometres travelled. Improved active transport routes would also reduce the need for cyclists to mix with general traffic and provide improved linkages to the existing network of trails and paths. This would reduce the likelihood of incidents along the corridor and would improve the overall amenity and comfort of these trips. New and widened road and freeway infrastructure for North East Link could divide residential communities during operation due to the perceived and actual reduced public safety related to heavy traffic. This 	<ul style="list-style-type: none"> The mitigation measures identified in the construction section above (Section 18.4.4) are relevant to relocation and access to facilities. To manage impacts related to severance due to reduced public safety, the design of the project would be required to provide safe vehicle movements. This would be managed through independent road safety audits during design and after construction. Impacts to community feelings of severance and disconnection would be minimised through engagement and consultation with the community to discuss operation (EPR SC2). Impacts associated with community connectedness would also be mitigated

Key issues	Findings	Proposed management measures
	<p>could hinder social contact and the independent mobility of children, which has been linked to adverse health outcomes. However, it is noted these communities are already divided by the arterial road network (Rosanna, Greensborough Road and Greensborough Bypass and the Eastern Freeway).</p> <ul style="list-style-type: none"> • New emergency lanes and stopping bays on the outer carriageways would enable access for emergency services and maintenance vehicles. Emergency response plans and incident management procedures would be implemented from the new operations centre utilising the Freeway Management System infrastructure. This would enable ease of access for emergency services and continued safe operation to other users of the freeway. • Upgrades to public transport including the Doncaster Busway would improve travel times and so increased patronage is anticipated. 	<p>through the project’s Urban Design Strategy (EES Attachment II) which prioritises performance requirements to maintain and enhance community connectedness, health and wellbeing and pride of place (EPR LV1). This could occur by providing regular crossing points and land bridges connecting the residential area to the east of North East Link to the western residential area.</p>
Loss of green space		
<p>The assessment considered the potential for the permanent loss of green space to impact the health and wellbeing of the community (risk HE11).</p>	<ul style="list-style-type: none"> • Once the project was complete a number of open space or park areas would be changed. In the short term this may affect active lifestyle access and use of these areas, but it is expected that people would adapt to these changes and/or find alternatives. • The visual amenity of green spaces would be impacted by the presence of new and amended infrastructure (including new roadways, ventilation facilities, substations, bridges and drainage channels). These impacts, however, are typically of short duration as most people adapt to changes in the visual landscape, particularly within an already urbanised area. As a result, most changes in visual impacts are not expected to have a significant impact on the health of the community. • During operation it is not expected that availability of sporting facilities and clubs would be reduced. Depending on where the facilities are relocated, it is possible that if facilities were located further from their existing location that some users from the immediate surrounding area may not be prepared to travel the additional distance to access other facilities. 	<ul style="list-style-type: none"> • Where recreation facilities are displaced, local councils and relevant Victorian Government authorities would be consulted to identify relocation opportunities with the objective of accommodating displaced facilities and maintaining the continuity of those recreational activities, where practicable (EPR SC4). • The project’s Urban Design Strategy (EES Attachment II) looks to maximise opportunities to enhance public amenity, open space and facilities, and to avoid or minimise landscape and visual impacts. The project would be required to develop Urban Design and Landscape Plans to demonstrate the design is in accordance with the Urban Design Strategy (EPR LV1).

Once open, North East Link is anticipated to improve access and connectivity as well as public safety on the roads, freeway and shared use paths. This would improve human health by providing a lower stress transport environment. While the project is anticipated to have long term impacts on green space due to land acquisition for its construction, it is expected that people would adapt to these changes in green space or find alternatives. Furthermore, it is anticipated that public amenity, open space and facilities would be enhanced through the development and implementation of Urban Design and Landscape Plans that are in accordance with Attachment II – Urban Design Strategy. Where these relevant EPRs are implemented, potential permanent changes to green spaces are not anticipated to significantly adversely impact health and wellbeing.

18.6 Conclusion

This chapter has identified and assessed existing conditions, impacts and associated risks to human health from North East Link.

The assessment considered changes in emissions to air and noise and vibration resulting from the project's construction and operation. In addition, the assessment considered impacts on health related to social changes associated with the project.

The key findings of the assessment are:

- During the project's construction it was determined the implementation of EPRs would manage risks so that impacts to human health are not anticipated. There may however be some changes to access arrangements for traffic, pedestrian and cycling routes. In addition, there would be some temporary loss of green space during construction, but these are not considered to significantly affect community access to existing sporting fixtures or alternate facilities.
- There are anticipated to be overall reductions in noise impacts from road traffic during operation, potentially resulting in some health benefits. Where noise has potential to exceed the North East Link project noise objectives, noise mitigations would be implemented so there would not be significant impacts.
- Changes in air quality due to the project are not considered to be related to any significant or measurable impacts on the health of the community.
- A range of other changes related to the project may result in social benefits due to improved travel times and greater connectivity.

Application of the project EPRs would minimise impacts related to air quality, noise and vibration, contamination and social impacts.

In response to the EES evaluation objective described at the beginning of this chapter, effects of the project on human health have been assessed and EPRs have been identified to minimise or avoid impacts to surrounding communities.