

## 6.16 Climate change risk and greenhouse gas

A climate change risk assessment and greenhouse gas (GHG) assessment was carried out for the amended project. This assessment is described below and should be read in conjunction with Section 8.6 of the EIS.

### 6.16.1 Assessment methodology

#### 6.16.1.1 *Climate change risk assessment*

The methodology for the supplementary climate change risk assessment was prepared in accordance with the policy and planning setting detailed in Section 8.6.1 of the EIS.

The approach adopted for the supplementary climate change risk assessment comprises the same five steps as described in Section 8.6.2 of the EIS, as detailed below. It should be noted that the risks identified in the supplementary climate change risk assessment would be the same for option 1 and option 2, as a worst case scenario has been assessed.

#### Climate change risk assessment step 1: Pre-screening

A pre-screening exercise was carried out to determine whether the amended project would continue to be impacted by climate change, and would therefore require a climate change risk assessment to be carried out.

The amended project was considered against each of the issues listed in Section 8.6.2 of the EIS and it was determined that they would not substantially change as a result of the amended project, due to the nature of proposed design changes and construction updates described in **Chapter 3** and **Chapter 4**. It was therefore concluded that the amended project would be consistent with the project as described in the EIS and a climate change risk assessment is required. The amended project would continue to be susceptible to impacts from climate change.

#### Climate change risk assessment Step 2: Risk screening

A screening was carried out to identify the amended project's potential exposure to relevant climate change impacts. Initial direct and indirect climate change risks were identified using the screening matrix described in Section 8.6.2 of the EIS. It was determined that the climate change risks to all project components listed in Section 8.6.2 of the EIS would be unchanged as a result of the amended project.

As a result, the potential variables of climate change risks for the amended project would be consistent with those of the project as described in the EIS, and that the following climate risks would be further investigated:

- Extreme rainfall
- Extreme temperature
- Mean surface temperature
- Wind speed
- Mean rainfall
- Atmospheric carbon dioxide
- Bushfire weather.

### Climate change risk assessment Step 3: Risk assessment

The overall risk rating for the climate risks identified in Step 2 were assessed using the likelihood of the impact occurring and the likely consequence of the impact using the likelihood scale presented in **Table 6-63**, and the likely consequence of the impact (if it occurred) using the consequence scale presented in **Table 6-64**.

By combining the likelihood and consequence levels, an overall risk rating was determined for each risk using the combined risk likelihood and consequence matrix presented in **Table 6-65**. These overall risk ratings present what the risks to the project are before the implementation of any mitigation or adaptation treatments.

Table 6-63 Climate change risk likelihood scale

Likelihood level	Description	Likelihood
Almost certain	Likely to occur frequently in most circumstances within the project lifecycle.	> 81 %
Likely	Likely to occur often in most circumstances within the project lifecycle.	51-80 %
Possible	Likely to occur on occasions within the project lifecycle.	21-50 %
Unlikely	Could occur at some time but not often within the project lifecycle.	11-20 %
Rare	May occur at some time but unusual within the project lifecycle.	1-10 %
Improbable	Could occur but very improbable within the project lifecycle.	< 1 %

Table 6-64 Climate change risk consequence scale

Consequence level	Definition
Catastrophic	<ul style="list-style-type: none"> <li>Irreversible large-scale impact</li> <li>Permanent damage</li> <li>Regulatory intervention maximum fines and penalties and/or</li> </ul>
Severe	<ul style="list-style-type: none"> <li>&gt;5 years and &lt;10 years impact.</li> <li>Irreparable damage of cultural significance and/or</li> <li>Tier 1 prosecution (up to \$5 million)</li> </ul>
Major	<ul style="list-style-type: none"> <li>Long-term (&gt;24 months but &lt; five years)</li> <li>Tier 2 prosecution (up to \$1 Million corporate) and/or</li> <li>Partial impairment of the ecosystem</li> </ul>
Serious	<ul style="list-style-type: none"> <li>Short to mid-term (&lt;24 months) impact Notification to regulator</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>Short term repairable damage or social impact on local population &lt;12 months)</li> </ul>
Minor	<ul style="list-style-type: none"> <li>Localised impacts rectified by on site resources and/or</li> <li>Isolated, easily contained, no lasting effects</li> </ul>

Table 6-65 Climate change risk likelihood and consequence combination matrix

Likelihood	Consequence					
	Minor	Moderate	Serious	Major	Severe	Catastrophic
Frequent	Moderate	High	High	Extreme	Extreme	Extreme
Likely	Moderate	Moderate	High	High	Extreme	Extreme
Possible	Low	Moderate	Moderate	High	High	Extreme
Unlikely	Low	Low	Moderate	Moderate	High	High
Rare	Low	Low	Low	Moderate	Moderate	High
Improbable	Low	Low	Low	Low	Moderate	Moderate

#### Climate change risk assessment Step 4: Risk evaluation

All risks identified as having moderate, high or extreme risk in Step 3 were identified as requiring treatment (see **Section 6.16.3.1**). Risks evaluated as low were determined not to require further consideration.

#### Climate change risk assessment Step 5: Risk treatment/adaptation

Mitigation or adaptation treatment was identified for all moderate, high and extreme risks with the aim of reducing the original unmitigated risk ratings (see **Section 6.16.3.1**).

#### 6.16.1.2 Greenhouse gas assessment

A greenhouse gas assessment was carried out for the project as described in the EIS in accordance with the methodology outlined in the Greenhouse Gas Assessment Workbook for Road Projects (the Workbook) (Transport Authorities Greenhouse Group, 2013). This supplementary greenhouse gas assessment for the amended project was not prepared in accordance with the workbook, as the amended project comprises a combination of concept and strategic designs that would be further developed through detailed design. The sections of the amended project that have been designed to strategic level only do not contain all relevant information required to be input into the methodology outlined in the workbook.

This supplementary assessment therefore focuses on changes in quantities of greenhouse gases associated with the amended project compared to the project as described in the EIS. It consists of two steps as follows.

#### Greenhouse gas step 1: Define the assessment boundary

The assessment boundary of the GHG assessment, which is defined as the emission scopes and sources and the types of GHG considered for the assessment, was described in Section 8.6.2 of the EIS. The assessment boundary of the supplementary GHG assessment would not change from that described in the EIS.

The following six GHGs were considered for the assessment carried out in the EIS and the amendment report:

- Carbon dioxide
- Methane
- Nitrous oxide
- Sulphur hexafluoride
- Hydro fluorocarbons
- Perfluorocarbons.

Each GHG behaves differently in the atmosphere with respect to its ability to trap outgoing radiation and in respect to their lifespan in the atmosphere. Each GHG was compared to the global warming potential of carbon dioxide over a 100-year period in order to achieve a single unit of measurement. The global warming potential of each GHG was determined based on the latest NGA Factors. The resulting aggregated emissions are referred to in terms of tonnes of carbon dioxide equivalent emissions (tCO<sub>2</sub>-e).

## Greenhouse gas step 2: Determine the quantity of GHG emissions generated by each emissions source

### Construction

The GHG emissions from construction of the project as described in the EIS were estimated using the Carbon Gauge GHG Calculator for Roads Project Version 01.130612 (Carbon Gauge) as described in Section 8.6.2 of the EIS.

The amended project comprises a combination of concept and strategic designs that would be further developed through detailed design. As such, the Carbon Gauge could not be utilised. In order to calculate the GHG emissions for the amended project, the changes in construction (see **Chapter 4**) were therefore quantified, and then added to the quantities identified in the EIS, resulting in the amended project quantify as presented in **Table 6-66**.

As described in **Table 6-66**, several key construction elements, including the total number of bridges constructed, the area of the construction footprint and the total quantity of pavement required would be increased by about 26 per cent for the amended project compared with the project as described in the EIS. Increases associated with other key construction elements, including traffic movements and water use, would be less. This assessment adopted a conservative approach with the application of a 26 per cent increase to the total construction GHG emissions as described in the EIS, which is considered a conservative scenario.

It should be noted that the construction greenhouse gas assessment covers both option 1 and option 2, as a worst case scenario has been adopted for each of the construction elements described in **Table 6-66**.

Table 6-66 Percentage changes in construction elements for the amended project compared to the project as described in the EIS

Construction element	Quantity as per in the EIS	Amended project quantity	Percentage increase between the project as per the EIS and the amended project (%)
Total number of construction traffic movements (see <b>Table 4-7</b> )	164,002 movements	165,079 movements	0.7
Number of bridges constructed (see <b>Section 4.1</b> )	19 bridges	24 bridges	26
Quantity of water used in construction (see <b>Section 4.2.7</b> )	676 ML	822 ML	22
Area of construction footprint <sup>1</sup> (see <b>Section 4.3</b> )	354 ha	441 ha	25
Total pavement quantity (see <b>Table 4-3</b> )	231,000 m <sup>3</sup>	290,000 m <sup>3</sup>	26

<sup>1</sup> Inclusive of all vegetation cleared

## Operation

Operational GHG emissions would result from:

- Operational electricity use, including powering of street lighting, variable message signs and traffic signals
- Ongoing maintenance, including use of diesel fuel for the operation of maintenance vehicles and machinery and embodied energy within materials for maintaining the road
- Use of the road by vehicles.

The methodology for determining the increase in each operational GHG emission is discussed below. The GHG assessment carried out for the construction and operation of the amended project was based on the design as set out in this document and construction activities outlined in **Chapter 3** and **Chapter 4**. It is noted that the operational greenhouse gas assessment would be the same for option 1 and option 2, as a worst case scenario has been assessed.

### ***Operational electricity use and ongoing maintenance***

Operational electricity use and emissions associated with the ongoing maintenance of the project as described in the EIS were estimated using the Carbon Gauge assessment method (see Section 8.6 of the EIS). As described above, information required to input into the Carbon Gauge is not available for the amended project. As a result, Carbon Gauge could not be used to assess the operational maintenance GHG emissions of the amended project.

In order to estimate operational electricity and ongoing maintenance GHG emissions, an 11 per cent increase was applied to operational electricity and operational maintenance GHG emissions from the project as described in the EIS. This was determined by assessing the key changes in the operation of the amended project as described in **Table 6-67**. The operational footprint is inclusive of all operational design components of the amended project, including areas requiring ongoing maintenance, street lighting, variable message signs and traffic signals. As a result, it was determined that this would represent a conservative approach.

Table 6-67 Percentage changes in the amended project operational footprint compared to the operational footprint of the project as described in the EIS

Size of operational footprint as per the EIS	Size of amended project operational footprint	Percentage increase between the project as per the EIS and the amended project
285 hectares	317 hectares	11 per cent

### **Road use by vehicles**

For emissions generated by road users of the project as described in the EIS the Tools for Roadside Air Quality (TRAQ) tool was used (see Section 8.6 of the EIS). TRAQ was used to determine emissions associated with current and future operational road use, both with and without the amended project. The methodology of which is consistent with that described in Section 8.6.5 of the EIS.

As described in **Section 6.3**, traffic forecasts for western Sydney have been refined, resulting in a substantial reduction in future trips to the South West Growth Area and the Western Sydney Employment Area. As a result, the forecast future traffic movements without the project, and therefore the estimated GHG emissions without the project that were fed into the TRAQ assessment to determine future background concentrations, have been reduced from those described in the EIS. GHG emissions modelled using TRAQ took account of:

- The expected mix of road users (vehicle types)
- Average number of vehicles
- Length of road
- Average and peak traffic speeds
- Surface roughness
- Road gradient.

Changes to these components from the project as described in the EIS are considered to be minor.

## **6.16.2 Existing environment**

### **Climate change**

The existing climate change environment, including climate change considerations for road projects and climate change projections, was described in Section 8.6.3 of the EIS and is still applicable to this assessment.

### **Greenhouse gases**

The existing greenhouse gas environment, including an inventory of greenhouse gases, was described in Section 8.6.3 of the EIS and is still applicable to this assessment.

## 6.16.3 Impact assessment

### 6.16.3.1 *Climate change risk assessment*

#### Construction

Three potential climate change scenarios were identified as having moderate to high unmitigated risk rating for the amended project, which is consistent with the project as described in the EIS. The risks identified during construction are listed in **Table 6-68**. The ratings assume the incorporation of standard construction controls but otherwise were identified for the project before the identification and inclusion of mitigation measures into the design as set out in this document.

A residual risk assessment was carried out in accordance with the methods outlined in **Section 6.16.1.1** to consider the climate change risks following the implementation of adaptation measures. The construction adaptation measures and residual likelihood, consequence and risk are consistent with those for the project as described in the EIS and are presented in **Table 6-68**. It is noted that the residual risk assessment took into account changes to Australia's climate since the time of writing the EIS.

In summary, three risks to construction were identified as having a moderate residual risk. This is an increase from the two low and one moderate risks identified for the project as described in the EIS. This is considered to be a result of increased likelihood and/or consequence of climate change in Australia, rather than an increased risk of the amended project.

#### Operation

The 12 potential climate change risk scenarios that were identified for the operation of the project as having moderate or high unmitigated risk rating, and their comparison to the project as described in the EIS, are listed in **Table 6-69**. The ratings assume the incorporation of standard construction controls but otherwise were identified for the project before the identification and inclusion of mitigation measures into the design as set out in this document. Three risks to operation were identified as having a rating of high, and nine risks to operation were identified as having a rating of moderate. This is consistent with the project as described in the EIS. Consistent with Section 8.6.4 of the EIS, unmitigated risks that were identified as having a low rating have not been described in **Table 6-69** as they were not considered to require any additional risk treatment, as these risks are considered tolerable.

A residual risk assessment was carried out in accordance with the methods outlined in **Section 6.16.1.1** to consider the risks following the implementation of adaptation measures. The operational adaptation measures and residual likelihood, consequence and risk are presented in **Table 6-69**. 18 risks identified during the climate change assessment for the project as described in the EIS as having a low unmitigated risk rating are not repeated here. It is noted that the residual risk assessment took into account changes to Australia's climate since the time of writing the EIS.

In summary, the following residual risks were identified:

- Nineteen low risks. This is a decrease of three from the 22 moderate risks identified for the project as described in the EIS.
- Nine moderate risks. This is consistent with the nine moderate risks identified for the project as described in the EIS.
- Four high risks. This is an increase of three from the one high risk identified for the project as described in the EIS.

These changes to climate change risks are considered to be a result of increased likelihood and/or consequence of climate change in Australia, rather than an increased risk of the amended project.

Table 6-68 Unmitigated and residual risks to the amended project, compared to the project as described in the EIS (construction)

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Extreme heat							
Increased frequency, severity and duration of extreme temperatures (days exceeding 35°C) leading to adverse health impacts for construction workers and potential health and safety incidents.	Moderate	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of TfNSW Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.	Unlikely	Serious	Moderate	Low
Extreme precipitation							
Increased frequency, severity and duration of extreme precipitation events leading to unsuitable and unsafe conditions for construction to proceed, resulting in an increase in 'stop work' days and subsequent delays to the construction program.	Moderate	Moderate	The location of temporary construction ancillary facilities has considered the risk of flood and strong winds associated with severe storm events, with site uses more vulnerable to the impacts of severe storms located away from the areas of highest risk to minimise impact.	Unlikely	Serious	Moderate	Moderate

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
<b>Bushfires</b>							
Increased frequency and severity of bushfires leading to smoke generation, resulting in potential health effects for construction workers and health and safety incidents, potential increase in 'stop work' days, and subsequent delays to construction program.	Moderate	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of TfNSW Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.  Variable messaging signs to be used to display messages warning drivers of changes in conditions. Variable messaging signs are proposed as part of the project.	Unlikely	Major	Moderate	Low

Table 6-69 Unmitigated and residual risks to the amended project, compared to the project as described in the EIS (operation)

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Extreme heat							
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to increased stress of carriageway to bridge connections resulting in structural failure of carriageway.	High	High	Detailed design to consider the full range of potential temperature extremes on the project (particularly bridge structures) which may occur as a result of climate change and choose materials able to withstand heat where feasible, to minimise the likelihood of infrastructure failures.	Unlikely	Catastrophic	High	Moderate
Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to adverse health impacts for maintenance workers and potential health and safety incidents for road users.	Moderate	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of TfNSW Work Health and Safety Procedures. Examples of potential work health safety practices may include stop work protocols for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.	Unlikely	Serious	Moderate	Low

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Extreme rainfall							
Increased rainfall from severe storm events resulting in increased scour of embankments and cuttings, leading to increased likelihood of landslips causing damage to infrastructure.	Moderate	Moderate	Detailed design to consider inclusion of measures to reduce velocity and volume of stormwater flows to reduce potential impact of scour. All roads and bridges to be sealed, cleared areas to be landscaped and scour protection to be installed.	Rare	Major	Low	Low
Increased rainfall from severe storm events leading to a higher frequency of floods resulting in overtopping of the road and complete loss of infrastructure service.	Moderate	Moderate	Stormwater infrastructure was designed to ensure flood immunity for the motorway up to and including the one in 100-year storm event.	Unlikely	Major	Moderate	Moderate
Increased rainfall from severe storm events leading to higher velocity runoff flows through creeks, resulting in increased scour and damage to the asset.	Moderate	Moderate	Detailed design to consider energy dissipation at culvert outlets when velocities exceed existing magnitudes. Stormwater infrastructure was designed to ensure suitable conveyance to minimise change in flow velocities and has considered future conditions under climate change. No substantial change in velocity is anticipated.	Unlikely	Serious	Moderate	Moderate

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Extreme rainfall event leading to accident/s resulting in potential health and safety incidents for road user or active transport users.	High	High	Variable messaging signs to be used to display messages warning drivers of changes in weather and traffic conditions. Variable messaging signs are proposed as part of the project	Unlikely	Severe	High	High
<b>Bushfires</b>							
Increased frequency and severity of bushfires leading to reduced visibility due to smoke, resulting in road users being unable to view signs, signals and other vehicles, and potential health and safety incidents.	Moderate	Moderate	Variable messaging signs to be used to display messages warning drivers of changes in weather and traffic conditions. Variable messaging signs are proposed as part of the project.	Unlikely	Major	Moderate	Moderate
Increased frequency and severity of bushfires leading to smoke generation, resulting in health effects for maintenance workers and road users, and potential health and safety incidents.	Moderate	Moderate	Adaptive management approach to be applied to workplace health and safety planning. This includes use of TfNSW Work Health and Safety Procedures. Variable messaging signs can display messages warning drivers of changes in conditions. Variable messaging signs are proposed as part of the project.	Unlikely	Major	Moderate	Moderate

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Increased frequency and severity of bushfires resulting in increased maintenance and damage to landscaping	Moderate	Moderate	Detailed design to consider the use of native species which are typically more fire tolerant and can more rapidly regenerate after fire events.	Unlikely	Serious	Moderate	Moderate
Increased frequency and severity of bushfires resulting in impact on trucks carrying dangerous goods, leading to explosions and associated risk to life.	High	High	Median crossovers and heavy vehicle emergency stopping bays proposed as part of the project. Variable messaging signs can display messages notifying trucks carrying dangerous goods to cease travel in that direction and direct them to the nearest stopping bay or median crossover. Variable messaging signs are proposed as part of the project.	Rare	Catastrophic	High	Moderate
Increased frequency and severity of bushfires leading to increased fauna movement onto the motorway, resulting in increased accidents.	Moderate	Moderate	Detailed design to maintain fauna passage along main creek lines under bridge structures	Possible	Serious	Moderate	Moderate

Risk scenario	Unmitigated risk rating for the project as described in the EIS	Unmitigated risk rating for the amended project	Adaptation/mitigation options	Likelihood	Consequence	Residual risk rating for the amended project	Residual risk rating for the project as described in the EIS
Increased frequency and severity of bushfires leading to road closures, resulting in restricted access and increased congestion for road users and emergency vehicles	Moderate	Moderate	Median crossovers and heavy vehicle emergency stopping bays proposed as part of the project. Variable messaging signs can display messages notifying trucks carrying dangerous goods to cease travel in that direction and direct them to the nearest stopping bay or median crossover. Variable messaging signs are proposed as part of the project.	Unlikely	Serious	Moderate	Low
<b>Droughts</b>							
Long periods of dry weather leading to a build-up of fuel, rubber and brake dust on road surfaces, resulting in a decrease in skid resistance and increase in accidents in wet weather events.	Moderate	Moderate	Variable messaging signs can post changes to speed limits and alert drivers to changes in conditions. Variable messaging signs are proposed as part of the project.	Possible	Major	High	Moderate
Long periods of dry weather leading to a build-up of rubber and brake dust on road surfaces, resulting in increased runoff of pollutants from the carriageway.	Moderate	Moderate	Water quality treatment features are proposed as part of the project, consisting of grassed swales and water quality basins. Water quality treatment features will be further considered within detailed design.	Possible	Moderate	Moderate	Low

### 6.16.3.2 Greenhouse gas assessment

#### Construction

Construction emissions for the amended project were calculated using the methodology described in **Section 6.16.1.2**. The scope 1, scope 2 and scope 3 emissions that would be generated by the amended project based on the emissions source are presented in **Table 6-70**.

It is estimated that the amended project would generate about 342,225 tCO<sub>2</sub>-e of total construction GHG emissions over the entire duration of construction. As described in **Section 6.16.1.2**, this represents a 26 per cent increase from the emissions of the project as described in the EIS and is considered to be a worst case scenario. This is comprised of 148,441 tCO<sub>2</sub>-e of scope 1 emissions and 193,774 tCO<sub>2</sub>-e of scope 3 emissions. No material scope 2 emissions sources were identified for the construction of the project as described in the EIS, and consequently no scope 2 GHG emissions were quantified for the amended project.

Table 6-70 Construction GHG emissions of the amended project compared to the project as described in the EIS

Emissions type	Percentage of total emissions (%) <sup>1</sup>	Emissions of the project as per the EIS (tCO <sub>2</sub> -e)	Emissions of the amended project (tCO <sub>2</sub> -e)	Change in emissions between the project as described in the EIS and amended project (tCO <sub>2</sub> -e)
Scope 1 emissions	43	117,810	148,441	30,631
Scope 2	0	0	0	0
Scope 3	57	153,789	193,774	39,985
<b>Total</b>	<b>100</b>	<b>271,607</b>	<b>342,225</b>	<b>70,618</b>

<sup>1</sup> Given the method used to calculate GHG emissions for the amended project (see **Section 6.16.1.2**), the percentage distribution of scope 1, scope 2 and scope 3 emissions would not change as a result of the amended project

#### Operation

Activities that would generate GHG emission during operation of the amended project are consistent with those of the project as described in the EIS. These are listed in **Table 6-71**. Operational emissions for the amended project were calculated using the methodology described in **Section 6.16.1.2**.

**Table 6-71** lists the total GHG emissions associated with each emission source for both the amended project and compares this to that of the project as described in the EIS. The use of the road by vehicles is further broken down to the year of opening (2026) and 10 years into operation (2036). In summary, the GHG emissions increases for electricity use and road maintenance but decreases for vehicle road use. This decrease is due to the changes in traffic movements described in **Section 6.1.6** and represents a positive change.

Table 6-71 GHG emissions during operation of the amended project as compared to the project as described in the EIS

Emission source	Project as per EIS (tCO <sub>2</sub> -e per annum)	Amended project (tCO <sub>2</sub> -e per annum)	Difference (tCO <sub>2</sub> -e per annum)	Difference (%)
Electricity use <sup>1</sup>	20,399	22,643	+ 2,244	11
Road maintenance <sup>2</sup>	25,996	28,865	+ 2,860	11
Use of road by vehicles 2026	93,194	86,248	-6,946	Reduction of 7
Use of road by vehicles 2036	144,006	126,749	-17,257	Reduction of 12

<sup>1</sup>namely the use of diesel fuel for the operation of maintenance vehicles and machinery and embodied energy within materials for maintaining the road

<sup>2</sup>eg for powering street lighting, variable message signs and traffic signals

The total GHG emissions associated with vehicle contributions fuel combustion from traffic using the road network and the M12 Motorway was assessed further and is summarised in **Table 6-72**. A comparison was made of GHG emissions that would be produced by the project against a 'no build' scenario where vehicles use the existing road network (ie the 'without project' scenario).

**Table 6-72** shows that an increase in GHG emissions from fuel consumption is expected from the year of opening, and a further increase in GHG emissions is expected from the future year scenario. This is consistent with the project as described in the EIS, and is directly associated with the substantial increase in traffic using the road network and the M12 Motorway.

Table 6-72 GHG emissions from fuel consumption for the amended project as compared to the project as described in the EIS (tCO<sub>2</sub>-e)

Year	Without project*	With project as per the EIS	With amended project	Difference between without project and with project as per the EIS	Difference between without project and with amended project
2026	50,140	93,194	86,248	43,054	36,108
2036	62,056	144,006	126,749	81,950	64,693

\*This was described in Table 8-68 of the EIS as being 51,948 for the 2026 and 144,006 for 2036. This has been revised for this assessment as a result of the updated traffic forecasts for western Sydney described in **Section 6.16.1.2**.

\*\*This was described in Table 8-68 of the EIS as being 41,246 tCO<sub>2</sub>-e for 2026 and 60,557 for 2036. This has been revised in this assessment as a result of the updated 'without project' GHG emissions described above.

## 6.16.4 Cumulative impacts

### 6.16.4.1 *Climate change risks*

#### Construction

The climate change risk assessment identified the same three potential risks with a risk rating of moderate or greater associated with the amended project construction. As per the project as described in the EIS, these relate to increase in extreme heat, extreme precipitation and bushfire. The risks identified for the amended project during construction would not be altered by the presence of multiple projects being constructed near one another.

As per the project as described in the EIS, other risks with identified lower risk ratings for the project may increase in conjunction with other projects being constructed nearby. However, the likelihood, and therefore overall risk of cumulative climate change risks resulting in serious consequences is generally considered low and would be consistent with those described in Section 8.6.5 of the EIS.

#### Operation

The nature of the proposed changes presented in **Chapter 3** and **Chapter 4** are not considered to substantially impact the climate change risks considered for the amended project. As a result, potential risks that may result from the operation of the amended project with consideration of other projects being carried out in the area are consistent with those described in Section 8.6.5 of the EIS.

The adaptation measures identified in Table 8-64 of the EIS would increase the amended project's resilience to climate change and reduce the cumulative impact of any climate change risks on the amended project or surrounding environment.

### 6.16.4.2 *Greenhouse gases*

#### Construction

The cumulative impacts of greenhouse gases for the amended project compared to the project as described in the EIS during construction are listed in **Table 6-73**. The combined estimated scope 1, scope 2 and scope 3 GHG emissions for the construction of the amended project are about 342,225 tCO<sub>2</sub>-e per annum (see **Section 6.16.3.2**). When compared to the most recent Australia inventory (532.9 megatonnes of CO<sub>2</sub>-e) and NSW inventory (130.3 megatonnes of CO<sub>2</sub>-e) of GHG emissions the construction of the amended project would contribute about 0.06 per cent of Australia's total annual GHG emissions and 0.26 per cent of NSW's total annual GHG emissions. This is not substantially increased from the contributions of the project as described in the EIS which would contribute 0.05 per cent and 0.21 per cent respectively (see **Table 6-73**).

The total contribution of the construction of the amended project to the effects of climate change would therefore be considered minor and consistent with those of the project as described in the EIS.

Table 6-73 Comparison of cumulative impacts of greenhouse gases for the amended project compared to the project as described in the EIS (construction)

Greenhouse gas emissions	Emissions of the project as described in the EIS	Emissions of the amended project	Change in emissions between the project as described in the EIS and the amended project
Volume of combined emissions (tCO <sub>2</sub> -e per annum)	271,607	342,225	+ 70,618
Contribution to total NSW emissions (%)	0.21	0.26	+ 0.05
Contribution to total Australia emissions (%)	0.05	0.06	+ 0.01

## Operation

The cumulative impacts of greenhouse gases for the amended project have been compared to the project as described in the EIS during construction and are listed in **Table 6-74**. The estimated total emissions for the operation and maintenance of the amended project are about 109,468 tCO<sub>2</sub>-e per annum at year of opening (see **Section 6.16.3.2**). When compared to the most recent Australia inventory (532.9 megatonnes of CO<sub>2</sub>-e) of GHG emissions the amended project would contribute about 0.02 per cent of Australia's total annual GHG emissions in its year of opening, which is consistent to those of the project as described in the EIS.

When compared to the most recent NSW inventory (130.3 megatonnes of CO<sub>2</sub>-e) of GHG emissions the amended project would contribute about 0.08 per cent of NSW's total annual GHG emissions in its year of opening, which represents a decrease in emissions when compared to the project as described in the EIS which would contribute 0.09 per cent of NSW's total annual GHG emissions in its year of opening.

In its year of opening the amended project would contribute about 0.5 per cent of a total of 23.1 megatonnes of CO<sub>2</sub>-e GHG emissions generated by the road transportation in NSW. This is consistent with the contributions of the project as described in the EIS.

The total contribution of the operation and maintenance of the amended project to the effects of climate change would therefore be either consistent with or improved from the project as described in the EIS.

Table 6-74 Comparison of cumulative impacts of greenhouse gases for the amended project compared to the project as described in the EIS (operation)

Greenhouse gas emissions	Emissions of the project as described in the EIS	Emissions of the amended project	Change in emissions between the project as described in the EIS and the amended project
Volume of combined emissions (tCO <sub>2</sub> -e per annum)	114,006	109,468	-4,538 (decrease in emissions)
Contribution to total NSW emissions (%)	0.09	0.08	-0.01 (decrease in emissions)
Contribution to total Australia emissions (%)	0.02	0.02	No change
Contribution to total NSW road transportation emissions	0.5	0.5	No change

### 6.16.5 Environmental management measures

The environmental management measures identified in Section 8.6.6 of the EIS are considered appropriate to minimise the climate change and greenhouse gas impacts of the amended project. No additional or amended environmental management measures are required for the amended project.