# CHAPTER 12

# Air quality

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

# Contents



# Figures

# Tables

# 12. Air quality

## 12.1 Summary

This Air Quality Impact Assessment (AQIA) has considered construction, commissioning, operation and decommissioning phases of the Helidon to Calvert (H2C) Project (the Project).

The AQIA included:

- Review of relevant legislation, historical meteorological data and ambient air quality monitoring data
- Generation of specific meteorology for the air quality study area and Project emission inventories
- Assessment of Project operational air quality impacts (modelling)—including cumulative air quality impacts
- Assessment of Project construction air quality impacts (qualitative risk-based)
- Identification of mitigation and management measures
- Assessment of the residual impact with the inclusion of the identified mitigation and management measures.

The AQIA has been defined as the area within 2 km of the alignment, with the alignment being the centreline of the proposed rail line. For the purposes of the study, the AQIA domain is defined as the regional area surrounding and including the AQIA study area.

Background pollutant concentrations will vary along the Project alignment—largely dependent on the presence of local emission sources. For the AQIA, a conservative background concentration (with a consistent level adopted for dust) has been assumed for each adopted pollutant and averaging period. The conservatively established background concentrations have been based on available air quality monitoring data.

A survey of sensitive receptors (e.g. residential dwellings and agricultural land) in the AQIA study area has been undertaken via desktop review of aerial imagery from Queensland Globe. A total of 5,903 receptors were included in the assessment.

Potential air emissions from the construction of large, linear infrastructure projects are difficult to estimate due to the broad range and transitory nature of construction activities. Construction sites for the Project will also be distributed across a large geographical area. Emissions from the Project during construction were therefore assessed using a qualitative risk-assessment method, through a review of anticipated construction works, plant and equipment.

The results indicate that the unmitigated air emissions from the construction phase of the Project pose a medium risk to human health and a medium risk to impacts from dust deposition. Mitigation measures have been proposed for the construction works to reduce the risk of impacts to a level that is not considered significant.

A quantitative compliance assessment has been undertaken for air quality impacts during the operational phase of the Project. The quantitative assessment considered existing air quality along the Project alignment and dispersion modelling of emissions from expected freight rail movements, locomotives idling at crossing loops, and emissions from passage through the proposed Little Liverpool Range tunnel. The assessment of operational impacts has considered forecast train volumes for the design year 2040. The forecast typical train volume for the year 2040 is 328 trains per week (47 movements per day, northbound and southbound).

The predicted air quality concentrations and deposition rates were compared to adopted Project air quality goals—these were established with consideration to the *Environment Protection Act 1994* (Qld), the *Environmental Protection (Air) Policy 2019* (Qld), National Environment Protection (Ambient Air Quality) measures and guidelines commonly recommended by the Queensland Department of Environment and Science (DES).

The environmental values that are protected by the adopted air quality goals include protecting: health and wellbeing, the health and biodiversity of ecosystems, agriculture uses, and the aesthetics of the environment.

The assessment of the operational phase of the Project determined that, with the inclusion of mitigation to coal services (veneering to wagons for example) compliance is predicted for all pollutant species for the assessed train volume scenarios (at all modelled receptors). Without control (veneering) applied to coal services, the modelled dust concentrations (annual average, with a conservatively adopted background concentration) were slightly above the adopted air quality goal. Predicted Project-only contributions for all modelled pollutants were low.

Based on the assessment and predicted modelling undertaken for the operational AQIA, adopting conservative emission factors and train planning numbers for the year 2040, it is expected that veneering will assist in minimising potential issues associated with particulate matter concentrations.

The assessment of the operational phase of the Project for residual impacts to water quality has determined that compliance with the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018) are predicted to be met by a significant margin at all existing potentially affected receptors.

Odour emissions from the operation of the Project will be minor and have been assessed qualitatively. It is expected that odour impacts on sensitive receptors will not be significant based on the nature of the sources associated with the Project and the receiving environment.

For the construction of the Project, dust sources will be variable and proximity to sensitive receptors and construction mitigation is proposed to address this variability. For a number of emission sources identified, there are multiple available mitigation measures. The final method of mitigation implemented will be determined during construction-phase planning and following confirmation of the availability and suitability of water supply sources.

A number of mitigation and management measures have been proposed to minimise the potential for adverse impacts. Mitigation measures proposed for the Project construction works include:

- An Air Quality Sub-plan will be developed (incorporating particulate (dust) management) as part of the draft Outline Environmental Management Plan (draft Outline EMP)
- Water sprays to reduce dust emissions from the excavation and disturbance of soil and materials, vehicle travel on unsealed roads, and loading and unloading of materials
- Reinstatement and rehabilitation of exposed areas
- Minimum separation distances for the location of any proposed fuel storage tanks.

In addition to mitigation measures, methods for the monitoring, reporting and auditing of compliance with the Project's air quality goals are also proposed for both the construction and operational phases.

## 12.2 Scope of chapter

In this chapter, the potential impacts arising from the Project on air quality are described and mitigation measures to manage the identified potential impacts are established. The assessment of potential impacts has been undertaken considering relevant legislation, historical meteorological data and regional ambient air quality monitoring data, and with reference to the results of Project-specific dispersion modelling outputs for the operational phases of the Project.

This AQIA has been based on the methodologies and guidance presented in the following documents:

- *Application requirements for activities with impacts to air* (DES, 2019a), guideline document under the *Environmental Protection Act 1994* (EP Act) (Qld) to support applications for activities with impacts to air
- *Approved methods for the modelling and assessment of air pollutants in New South Wales* (NSW EPA, 2016), which provides statutory methods for modelling and assessing emissions of air pollutants in New South Wales (NSW) but is relevant and applicable for assessments in Queensland
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for Modelling and Assessment in New South Wales* (Barclay, J., & Scire, J., 2011), which provides detailed guidance on selection of CALPUFF modelling variables. This guidance is written for NSW but is relevant and applicable for Queensland.
- *Guidance on the assessment of dust from demolition and construction*, (United Kingdom Institute of Air Quality Management, 2014). This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving, and construction activities.

The technical report that details the AQIA is provided in Appendix K: Air Quality Technical Report. A detailed description of the Project is provided in Chapter 6: Project description.

## 12.3 Terms of Reference

This chapter addresses the relevant air quality Terms of Reference (ToR) for the Project, as provided in Table 12.1.

Compliance of the Environmental Impact Statement (EIS) against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

**TABLE 12.1: TERMS OF REFERENCE REQUIREMENTS—AIR QUALITY**

| Terms of Reference requirements | | Where addressed |
|---|---|---|
| **Existing environment** | | |
| 11.128. | Describe the existing air quality that may be affected by the Project in the context of environmental values | Sections 12.4.3 and 12.6<br>Appendix K: Air Quality Technical Report—Sections 3 and 5 |
| 11.129. | Discuss the existing local and regional air shed environment | Section 12.6<br>Appendix K: Air Quality Technical Report—Section 5 |
| 11.130. | Provide baseline data on local meteorology and ambient levels of pollutants or modelling of air quality. Parameters should include air temperature, wind speed and directions, atmospheric stability, mixing depth and other parameters necessary for input to the model | Sections 12.6.1 and 12.6.2 Appendix K: Air Quality Technical Report—Section 5 |
| 11.131. | The assessment of environmental values must describe and map at a suitable scale the location of all sensitive air receptors adjacent to all project components. An estimate of typical background air quality levels should be based on surveys at representative sites where data from existing DEHP monitoring stations cannot be reliably extrapolated | Section 12.6 and Table 12.12<br>Appendix K: Air Quality Technical Report—Section 5.6 |
| **Impact assessment** | | |
| 11.132. | Describe the characteristics of any contaminants or materials that may be released as a result of the construction or operations of the Project, including point source and fugitive emissions. Emissions (point source and fugitive) during construction, commissioning and operations are to be listed. | Sections 12.4.2, 12.5.2, 12.5.3 and 12.5.4.<br>Appendix K: Air Quality Technical Report—Section 2.4 |
| 11.133. | The relevant air quality goals or objectives that will be adopted for the assessment should be clearly outlined as a basis of the assessment of impacts on air | Section 12.4.3<br>Appendix K: Air Quality Technical Report—Section 3.6 |
| 11.134. | The assessment of impacts on air will be in accordance with the EP Act, EP Regulation and EPP (Air) 2008 and reference to appropriate to Australian Standards | Section 12.4<br>Appendix K: Air Quality Technical Report—Sections 3 and 4 |
| 11.135. | Predict the impacts of the releases from the activity on environmental values of the receiving environment using recognised quality assured methods. The description of impacts should take into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts. The impact prediction must:<br>a) Address residual impacts on the environmental values (including appropriate indicators and air quality objectives) of the air receiving environment, with reference to the air environment at sensitive receptors. This should include all relevant values potentially impacted by the activity, under the EP Act, EP Regulation and EPP (Air)<br>b) Address the cumulative impact of the release with other known releases of contaminants, materials or wastes associated with existing major projects and/or developments and those which are progressing through planning and approval processes and public information is available<br>c) Predict the human health risk and amenity impacts associated with emissions from the project for all contaminants covered by the National Environmental Protection (Ambient Air Quality) Measure or the EPP (Air) | Sections 12.4, 12.5, 12.7 and 12.9<br>Appendix K: Air Quality Technical Report—Sections 5 to 10 |

| Terms of Reference requirements | | Where addressed |
|---|---|---|
| **Mitigation measures** | | |
| 11.136. | Describe the proposed mitigation measures to manage impacts to air quality, including potential impacts from coal trains, and the predicted level of effectiveness of the mitigation measures | Section 12.8<br>Chapter 23: Draft Outline Environmental Management Plan, Sections 23.13.5<br>Appendix K: Air Quality Technical Report—Sections 4 and 9 |
| 11.137. | Describe how the proposed activity will be consistent with best practice environmental management. Where a government plan is relevant to the activity or site where the activity is proposed, describe the activity's consistency with that plan | Section 12.8<br>Appendix K: Air Quality Technical Report—Section 9 |
| 11.138. | Describe any expected exceedances of air quality goals or criteria following the provision and/or application of mitigation measures, and how any residual impacts would be addressed | Section 12.9<br>Appendix K: Air Quality Technical Report—Sections 10 |
| 11.139. | Describe how the achievement of the objectives would be monitored, audited and reported and how corrective actions would be managed | Section 12.8.4<br>Appendix K: Air Quality Technical Report—Section 9.4 |
| **Climate** | | |
| 11.166. | Describe the climate patterns with particular regard to discharges to water and air and the propagation of noise related to the project | In regard to air quality:<br>Sections 12.6.1 and 12.6.2.5<br>Appendix K: Air Quality Technical Report—Sections 4.4.2.8, 5.2 and 5.3.7 |
| 11.167. | Climate information should be presented in a statistical form including long-term averages and extreme values, as necessary | In regard to air quality:<br>Section 12.6.1<br>Appendix K: Air Quality Technical Report—Section 5.2 |
| 11.168. | Describe the climatic conditions that may affect management of the project. This includes a description of the vulnerability of the project area to seasonal conditions, extremes of climate (for example, cyclones and prolonged rain events) and natural or induced hazards (including bushfire) | Chapter 20: Hazard and risk, Sections 20.8.1 and 20.10.1 |

**Table note:**
The assessment has been undertaken in accordance with the EPP (Air) 2019 (refer Section 12.4).

Early engagement on the draft ToR resulted in the EIS requiring an assessment of potential pollutants in water tanks against Australian Drinking Water Guidelines (NHMRC & NRMMC, 2018). Dust generation during construction and operation have also been key matters raised by stakeholders and the community, which has helped to inform the development of mitigation measures for both construction and operation.

## 12.4 Legislation, policies, standards and guidelines

### 12.4.1 Regulatory context

The legislation, policies, standards and guidelines relevant to air quality in the context of the Project are provided in Table 12.2.

**TABLE 12.2: REGULATORY CONTEXT**

| Legislation, policy or guideline | Relevance to the Project |
|---|---|
| *National Environment Protection (Ambient Air Quality) Measure 2016* (Department of the Environment (DoE, 2016) | Federal measure that sets standards for six major air pollutants in Australia. The standards for these pollutants have been considered in this AQIA and where relevant adopted as Project air quality goals. |
| *National Environment Protection (National Pollutant Inventory) Measure* (National Environment Protection Council, 1998) | The National Pollutant Inventory (NPI), regulated by the Australian Government, tracks pollution across Australia to ensure that the community has access to information about the emission and transfer of toxic substances that may affect them locally. All major polluters are required by the Australian Government to submit annual reports of their emissions to air. Information available from the NPI regarding emission sources near the Project has been considered in this AQIA. |
| Queensland Government, *Environment Protection Act 1994* (EP Act) (Qld) and Environment Protection Regulation 2019 | State legislation and regulation that governs protection of environmental values in Queensland. This regulation has been considered in the Project AQIA. |
| Queensland Government, *Environmental Protection (Air) Policy 2019* (EPP (Air)) | Statutory instrument under the EP Act, to protect the environmental values of air. The air quality objectives in the EPP (Air) for the pollutants of concern have been adopted as Project air quality goals. |
| Queensland Government, *EP Act—Guideline: Application requirements for activities with impacts to air* (Department of Environment and Science (DES), 2019a) | Guideline on information requirements for applications for activities with impacts to air. This guideline has been used to guide the methodology of this AQIA. |
| *Approved methods for the modelling and assessment of air pollutants in NSW* (2016) (NSW Environmental Protection Authority (NSW EPA), 2016) | Statutory methods for modelling and assessing air quality in NSW. Developed for NSW but adopted as technical guidance for the development of dispersion models Australia-wide and is referred to by the EP Act—*Guideline: Application requirements for activities with impacts to air* as the guiding document for the modelling of air pollutants. This document has been used to guide the methodology of this AQIA. |
| *Australian Drinking Water Guidelines* (2018) (NHMRC & NRMMC, 2018) | Provides guidance and criteria to water regulators and suppliers on monitoring and managing drinking water quality. The criteria from this document have been used for the assessment of impacts to drinking water. |
| *Policy for Development on Land Affected by Environmental Emissions from Transport and Transport Infrastructure Version 2*, (Department of Transport and Main Roads, 2013) | Outlines the Department of Transport and Main Roads' (DTMR) policy position on the development of land affected by environmental emissions (noise, vibration, air emissions and particles and light) from linear transport operations and infrastructure. This document has been used to guide the methodology of this AQIA. |
| *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for Modelling and Assessment in New South Wales* (Barclay, J., & Scire, J., 2011) | Document that provides detailed guidance on a selection of CALPUFF modelling variables. Developed for NSW but also applicable for assessment in Queensland. This document has been used to guide the methodology for the dispersion modelling undertaken for this AQIA. |
| *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014) | This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving, and construction activities. The methodology within this document has been used to assess air quality impacts from the construction of the Project. |
| *Air Quality Planning Scheme Policy* (Brisbane City Council (BCC) AQ Planning Scheme Policy) (BCC, 2014) | This document provides guidance on assessment methodologies and air quality goals for air quality assessments undertaken for projects in the BCC local government area (LGA). Air quality goals from this policy have been used in this assessment. |
| *Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013) | The guideline provides recommended separation distances for activities with emissions to air. The guideline is written by EPA Victoria but is referenced in the Queensland *EP Act—Guideline: Application requirements for activities with impacts to air* and is applicable for assessments in Queensland. |

### 12.4.2 Project air emissions

Potential emissions were determined based on the expected Project characteristics, applicable National Pollution Inventory (NPI) emission estimation manuals, and EIS literature for similar rail projects. Air pollutants considered as part of the AQIA are listed in Table 12.3

During the construction phase, particulate matter deposited as total suspended particulates (TSP) and airborne concentrations of particulate matter less than 10 micrometres in diameter ($PM_{10}$) will be of primary concern. These pollutants have the potential for nuisance impacts if not correctly managed (UK IAQM, 2014). For construction activities, particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$) is typically emitted in minor quantities from mechanical sources and is more predominant from combustion point sources (i.e. combustion engines). Point source emissions of combustion gases (e.g. oxides of nitrogen ($NO_x$) and carbon monoxide (CO)) and $PM_{2.5}$ from diesel construction vehicles and mobile plant will be significantly lower than particulate emissions from construction activities. Point-source emissions of combustion gases and $PM_{2.5}$ are unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors. Emissions from combustion sources have not been assessed for Project construction works.

In addition to construction dust, odour and volatile organic compounds (VOCs) will be emitted as fugitive emissions from fuel tanks located at laydown areas.

Air emissions during the commissioning phase of the Project will be minor and are expected to be limited to point source combustion engine emissions from transport vehicles and train locomotives and limited fugitive dust emissions from vehicle travel on unsealed roads.

The primary source of air pollution during the operation of the Project will be point-source locomotive engine exhaust. The gaseous pollutants contained in the exhaust are produced as a product of diesel combustion and include $NO_x$, $PM_{10}$, $PM_{2.5}$, VOCs, and polycyclic aromatic hydrocarbons (PAHs). In addition to diesel combustion, fugitive coal dust emissions (TSP, $PM_{10}$, $PM_{2.5}$) are also considered to have the potential to impact sensitive receptors. Potential concentration and deposition impacts have been assessed for Project operations.

Given the uncertainty associated with the timeframe for decommissioning, this phase has not been considered in this AQIA.

A detailed description of each pollutant is provided in Appendix K: Air Quality Technical Report.

**TABLE 12.3: POLLUTANTS CONSIDERED DURING THE AIR QUALITY ASSESSMENT**

| Pollutant | Description[a] |
|---|---|
| TSP | TSP refers to airborne particles ranging from 0.1 micrometres (μm) to 100 μm in diameter. Furthermore, if the particles contain toxic materials (such as lead, cadmium, zinc), toxic effects can occur from inhalation of the dust. Also, dust can cause nuisance impacts by settling on surfaces and possessions, affecting visibility, and potentially contaminating tank water supplies. |
| $PM_{10}$ | Particulate matter less than 10 μm in diameter ($PM_{10}$). |
| $PM_{2.5}$ | Particulate matter less than 2.5 μm in diameter ($PM_{2.5}$). |
| $NO_x$ | $NO_x$ describes a mixture of nitric oxide and $NO_2$. $NO_x$ is colourless at low concentrations but has an odour. Nitrogen dioxide ($NO_2$) is a brownish gas with a detectable odour. |
| Nitrogen dioxide ($NO_2$) | $NO_2$ is a brownish gas with a pungent odour. Nitrogen dioxide can cause damage to the human respiratory tract, increasing a person's susceptibility to respiratory infections and asthma. Sensitive populations, such as the elderly, children, and people with pre-existing health conditions are most susceptible to the adverse effects of $NO_2$ exposure. |
| Carbon monoxide (CO) | CO is a colourless, odourless gas formed when substances containing carbon (such as petrol, gas, coal and wood) are burned with an insufficient supply of air. Concentrations of CO normally present in the atmosphere are unlikely to cause ill effects and therefore have not been considered in the assessment. |
| VOCs | VOCs are carbon-based chemicals that readily evaporate at room temperature, including xylene, toluene and benzene. |
| PAHs | PAHs are a group of over 100 chemicals, which are formed through the incomplete combustion of organic materials, such as petrol or diesel. |
| Trace metals including arsenic, cadmium, lead, nickel and chromium VI | Heavy metals such as cadmium, lead, and mercury are common air pollutants that are typically emitted from industrial activities and fuel combustion. Fugitive coal dust emissions from rail transport along the alignment have potential to be deposited on surfaces that lead to rainwater tanks. Coal may contain many traces of these elements. |
| Odour | Odour emissions can be either a single pollutant species or a mixture of species that have the potential to affect environmental amenity and cause nuisance. |
| Sulphur dioxide ($SO_2$) | Sulphur dioxide is a colourless gas with a sharp, irritating odour. The air quality assessment assumes low sulphur content fuel as per the requirements of Commonwealth legislation (Department of Environment and Energy (DoEE), *Fuel Quality Standards Act 2000*) (DoEE, [*Fuel Standard (Automotive Diesel) Determination]*, 2001 (Cth)). The regulation of low sulphur content fuel in Australia has significantly decreased the generation and concentrations of $SO_2$ near transport sources. Due to the low likelihood of significant impact, $SO_2$ has not been considered in this assessment. |
| Ozone ($O_3$) | Ozone is not emitted directly from fuel combustion, but rather is a secondary pollutant formed via chemical reaction of other pollutant species in the local atmosphere. Assessment of the formation of ozone and other secondary pollutants has not been considered in this assessment. |

**Table note:**

a) The descriptions provided have been derived from the information provided on the Australian Government Department of the Environment, Water, Heritage and the Arts National Pollutant Inventory website and the NSW Department of Planning, Industry and Environment website (**environment.nsw.gov.au**)

### 12.4.3 Environmental values and air quality objectives

The EPP (Air) was prepared by the Queensland Government with the purpose of achieving the objective of the EP Act in relation to the air environment. The air environment in Queensland is enhanced or protected by air quality objectives for environmental values. The EPP (Air) does not apply to workplaces and the air quality objectives are intended to be progressively achieved over the long term. A summary of the air quality objectives relevant to the Project are provided in Table 12.4.

The EPP (Air) achieves the purpose of the EP Act by:

- Identifying environmental values to be enhanced or protected
- Stating indicators and air quality objectives for enhancing or protecting the environmental values
- Providing a framework for making consistent, equitable and informed decisions about the air environment.

The environmental values to be enhanced or protected under the EPP (Air) are the qualities of the air environment that are conducive to:

- human health and wellbeing
- protecting the health and biodiversity of ecosystems
- protecting agricultural use of the environment
- protecting the aesthetics of the environment, including the appearance of buildings, structures and other property.

No dust deposition objectives are prescribed in the EPP (Air); however, the DES commonly sets a guidance deposition rate of 120 milligrams per square metre per day (mg/m²/day) averaged over one month for environmental authorities. This guidance level is based on research into community complaints for coal-related projects. Although this deposition guidance level is not a legislative requirement, it is frequently used in Queensland (DES, 2019a) and is considered to be an appropriate criterion.

Where air quality objectives for identified pollutants are not included in the EPP (Air) and National Environment Protection Measure (NEPM) legislation, criteria have been sourced from NSW EPA (2017) and the *Brisbane City Council Air Quality Planning Scheme Policy* (BCC, 2014).

The environmental values listed in Table 12.4 that are being protected by each proposed air quality objectives are adopted from the EPP (Air) Policy and the NEPM legislation. The environmental values protected through meeting these air quality objectives include:

- Health and wellbeing
- Protection of the aesthetic environment.

The EPP (Air) also includes air quality objectives to protect the environmental values of the health and biodiversity of ecosystems and to protect agriculture. Pollutants which have objectives to protect the health and biodiversity of ecosystems include fluoride, $NO_2$, $O_3$ and $SO_2$. Fluoride, $O_3$ and $SO_2$ also have objectives to protect agriculture.

Fluoride, $O_3$ and $SO_2$ are not pollutants of concern for the assessment (refer Section 12.1.1) and therefore the impact of these pollutants on the health and biodiversity of ecosystems and on agriculture does not require consideration. The EPP (Air) does have an $NO_2$ air quality objective for the health and biodiversity of ecosystems. As discussed in Section 12.6.5, there are no protected areas under the *Nature Conservation Act 1992* (Qld), the *Marine Parks Act 2004* (Qld) or a World Heritage area which is considered sensitive to air quality within 2 km of the alignment, and therefore the impact of $NO_2$ on the health and biodiversity of ecosystems has not been considered.

Although there is no prescribed air quality objective, deposited dust may be a source of potential impact on agricultural crops and livestock, through the potential to inhibit plant growth or impair livestock development.

Research on vegetation response to dust deposition impact (Doley, 2003) has shown that, for sunny conditions, a dust deposition rate of up to 15 g/m²/month (or 500 mg/m²/day) is unlikely to have a detectable effect on crop growth and it is not until a deposition rate of up to 30 g/m²/month (or 1,000 mg/m²/day) occurs that there is a measurable reduction in crop growth under overcast conditions.

Livestock research on dairy cows (Andrews & Skriskandarajah, 1992) has also shown that a dust deposition rate of up to 120 g/m²/month (or 4,000 mg/m²/day) does not influence the amount of feed cattle eat or the amount of milk produced. These dust deposition levels have been considered in the assessment of the operational phase of the Project to assess the potential for impact to agriculture.

A cumulative impact assessment has been undertaken to assess how the Project protects or enhances the environmental values of the air environment through compliance with the air quality goals. Discussion of background air quality for the Project is provided in Section 12.6.2.

#### TABLE 12.4: PROPOSED AIR QUALITY GOALS

| Pollutant | Air quality goal ($\mu g/m^3$) | Averaging period | Environmental value | Source |
|---|---|---|---|---|
| $NO_2$ | 250 | 1-hour[a] | Health and wellbeing | EPP (Air) |
| | 62 | Annual | Health and wellbeing | EPP (Air) |
| TSP | 90 | Annual | Health and wellbeing | EPP (Air) |
| $PM_{10}$ | 50 | 24-hour[b] | Health and wellbeing | EPP (Air) |
| | 25 | Annual | Health and wellbeing | EPP (Air) |
| $PM_{2.5}$ | 25 | 24-hour | Health and wellbeing | EPP (Air) |
| | 8 | Annual | Health and wellbeing | EPP (Air) |
| Arsenic and compounds (measured as the total metal content in $PM_{10}$) | 6 $ng/m^3$ | Annual | Health and wellbeing | EPP (Air) |
| Cadmium and compounds (measured as the total metal content in $PM_{10}$) | 5 $ng/m^3$ | Annual | Health and wellbeing | EPP (Air) |
| Lead and compounds (measured as the total metal content in TSP) | 0.5 | Annual | Health and wellbeing | EPP (Air) |
| Nickel and compounds (measured as the total metal content in $PM_{10}$) | 22 $ng/m^3$ | Annual | Health and wellbeing | EPP (Air) |
| Chromium (III) compounds (as $PM_{10}$) | 9 | 1 hour | n/a | NSW EPA |
| Chromium (VI) compounds (as $PM_{10}$) | 0.1 | 1 hour | Screening health risk assessment | BCC *AQ Planning Scheme Policy* |
| | 0.01 | Annual | Screening health risk assessment | BCC *AQ Planning Scheme Policy* |
| 1,3-butadiene | 2.4 | 1 hour | Health and wellbeing | EPP (Air) |
| Benzene | 5.4 | Annual | Health and wellbeing | EPP (Air) |
| Toluene | 1,100 | 30 minutes | Protecting aesthetic environment | EPP (Air) |
| | 4,100 | 24-hour | Health and wellbeing | EPP (Air) |
| | 400 | Annual | Health and wellbeing | EPP (Air) |
| Xylenes | 1,200 | 24-hour | Health and wellbeing | EPP (Air) |
| | 950 | Annual | Health and wellbeing | EPP (Air) |
| Benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons) | 0.3 $ng/m^3$ | Annual | Health and wellbeing | EPP (Air) |
| Polychlorinated dioxins and furans | $3.0 \times 10^{-8}$ | Annual | Screening health risk assessment | BCC *AQ Planning Scheme Policy* |
| Dust deposition | 120 $mg/m^2/day$ | Monthly[c] | Nuisance | DES recommended |

**Table notes:**

$\mu g/m^3$ microgram per cubic metre

$ng/m^3$ nanogram per cubic metre

mg/m /day milligram per square metre per day

a) Not to be exceeded more than one day per year

b) The 2019 version of the EPP (Air) does not allow for any exceedances of the 24 hour goal for $PM_{10}$. The 2008 version of the EPP (Air) allowed for exceedances for five days per year and therefore air quality assessments previously considered the 6th highest $PM_{10}$ 24-hour average. As there are no exceedances allowed in the 2019 version of the EPP (Air), the maximum predicted $PM_{10}$ 24-hour concentration has been considered in the assessment rather than the 6th highest.

c) Not legislative, but adopted for the Project

n/a No environmental value listed for this goal

## 12.5 Methodology

The AQIA methodology for the construction, commissioning, operation and decommissioning phases of the Project included:

- Qualitative risk-based assessment for the construction phase to estimate potential air quality impacts
- Consideration of potential commissioning phase sources and emissions
- Quantitative impact assessment for the operation phase to estimate potential impacts, including cumulative air quality issues (it is noted that some minor emissions sources are assessed qualitatively)
- Identification of mitigation and management measures
- Assessment of the residual impact with the inclusion of the identified mitigations.

Following engagement and subsequent stakeholder feedback on the draft ToR, assessment of potential pollutants in water tanks (based on potential deposited levels) has been undertaken, with potential concentrations compared to adopted *Drinking Water Quality Guidelines* (NHMRC & NRMMC, 2018). Dust generation has also been a key matter raised by stakeholders and the community, which has helped inform the development of mitigation measures. Dust generation during construction works have considered both onsite construction activities and the movement of construction plant to and within the works areas.

The methodology used to assess air impacts during each phase of the Project are described in this section. Further information about the impact assessment methodology is available in Appendix K: Air Quality Technical Report.

### 12.5.1 AQIA study area and assessment domain

The AQIA study area is defined as the area within 2 km of the proposed rail centreline. The assessment domain is defined as the regional area surrounding, including the AQIA study area, and has been adopted as the area within approximately 100 km of the alignment. Air quality and meteorological monitoring data from locations outside the AQIA study area, but within the assessment domain, have been considered in this assessment.

Figure 12.1 illustrates the AQIA study area for this assessment and the locations of referenced meteorological and air quality monitoring stations. As there are no monitoring stations within the AQIA study area, monitoring data from stations located outside the study area have been extrapolated and adopted for the purposes of this assessment.

### 12.5.2 Construction phase impact assessment

Construction emissions for large linear infrastructure projects are complex due to the number of construction works, the distribution of sites across a large geographical area, the transitory nature of many individual construction works at particular locations and the typical, short time-scale of emissions. The varying averaging periods for air quality goals also add an additional level of complexity. As such, air quality impacts from the construction phase of the Project have been assessed via a qualitative risk assessment.

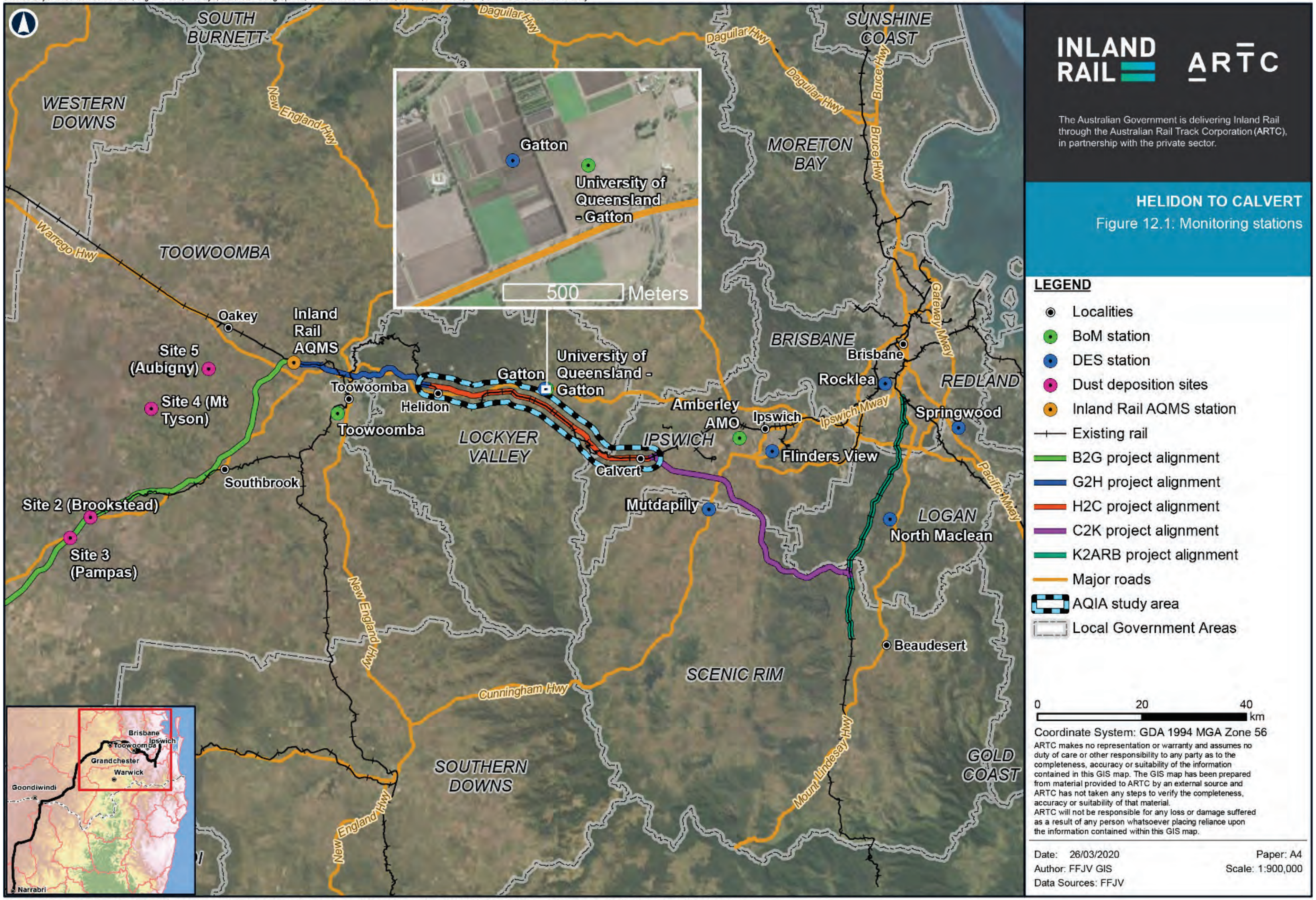
As discussed in Section 12.1.1 the highest proportion of construction emissions is generated by mechanical activity, e.g. material movement or mobile equipment travel, which typically generate coarser particulate emissions ($PM_{10}$ and TSP). Airborne concentrations and deposited dust are the key indicators for construction works. $PM_{10}$ and TSP are the primary pollutants of concern and are the focus of the assessment for construction dust. Point-source gaseous emissions from diesel construction vehicles will be significantly lower than particulate emissions from construction works and are unlikely to result in exceedance of air quality goals and so have not been assessed in detail. Notwithstanding this, mitigation measures for these sources have been proposed.

The assessment methodology used for the assessment of construction dust is the 2014 United Kingdom (UK) Institute of Air Quality Management (IAQM) *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The IAQM process is a four-step, risk-based assessment of dust emissions associated with demolition, including land clearing and earth moving, and construction activities.

The method includes:

- Step 1—screening assessment: assess distance from receptors to active construction areas
- Step 2—dust risk assessment: assess the dust emission magnitude (scale of activity) of the identified sources, determine the sensitivity of the surrounding area, and determine the risk of impacts if no mitigation is implemented
- Step 3—management strategies: identify the mitigation measures required to minimise the risk of impacts to sensitive receptors
- Step 4—reassessment: review the potential for residual impacts post mitigation.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




**HELIDON TO CALVERT**

Figure 12.1: Monitoring stations

Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:900,000

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.1_Monitoring_stations_v5.mxd Date: 27/03/2020 15:15

The emission sources considered were demolition, earthworks, construction and trackout, which are defined as follows:

- Demolition: any activity involved with the removal of an existing structure (or structures)
- Earthworks: the processes of soil-stripping, ground-levelling, excavation and landscaping
- Construction: any activity involved with the provision of a new or upgrade of a structure (or structures), its modification or refurbishment
- Trackout: the transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network.

The assessment of construction dust impacts is presented in Section 12.7.

In addition to construction dust, odour and VOCs will be emitted from fuel tanks located at laydown areas. Impacts from fuel storage have been assessed in Section 12.7.1.2. This assessment of fuel storage tanks has followed guidance from the BCC *Air Quality Planning Scheme Policy* (BCC, 2014) and EPA Victoria *Recommended separation distances for industrial residual air emissions* (2013), which is referenced in the *EP Act—Guideline: Application requirements for activities with impacts to air* as being applicable for assessments in Queensland.

Detailed dispersion modelling of construction is not typically undertaken because construction activity is difficult to forecast accurately due to the transient nature of construction work and variations to the spatial location and intensity of construction activities. The qualitative risk-based approach applied to assess potential Project construction phase impacts is consistent with industry standard methodology.

A breakdown of each step and the associated findings of the dust impact assessment are detailed in Appendix K: Air Quality Technical Report.

### 12.5.3 Commissioning phase impact assessment

The Project commissioning phase will involve testing and checking the rail line and communication and signalling systems.

Air emissions during the commissioning phase of the Project are anticipated to be minor and will be limited to combustion engine emissions from transport vehicles and train locomotives, and limited dust emissions from vehicle travel on unsealed roads.

Emissions associated with train passage during the Project commissioning phase will be significantly lower than emissions during the operational phase.

Air emissions from the commissioning phase of the Project are expected to be insignificant and are unlikely to generate nuisance or result in potential exceedances of the Project's air quality goals. Assessment has not been carried out.

### 12.5.4 Operations phase impact assessment

#### 12.5.4.1 Overview

Dispersion modelling addressing line source emissions (i.e. emissions from freight trains travelling along the track and through the Little Liverpool Range tunnel) was undertaken. The dispersion modelling assessed Project compliance, or otherwise, with the adopted air quality goals. Assessment was undertaken at potentially affected sensitive-receptor locations.

The air dispersion modelling was undertaken using the CALPUFF and GRAL modelling suites. The GRAL model was developed to assess the dispersion of pollutants from roadways and tunnel portals and has been used to model emissions from the Little Liverpool Range tunnel. The CALPUFF model was used to model all other open-air sections of the alignment (e.g. outside the tunnel).

Meteorological data was prepared using The Air Pollution Model (TAPM) and data from nearby monitoring stations. The data available for this Project and a discussion of the methodologies followed for the dispersion modelling is overviewed in Section 12.5.4.3, with further detailed discussion provided in Appendix K: Air Quality Technical Report.

Modelling of emissions from the tunnel considered the length and cross-sectional area of the tunnel, the emissions that would occur inside the tunnel, and the proposed ventilation design. For typical operations, the tunnel will be naturally ventilated. The tunnel is sized so that fans are not required for general operation and train emissions will exit the portals via natural ventilation (with the movement of each freight train within the tunnel causing a piston effect). As there is no mechanical venting of train emissions from the tunnel, there will be minimal plume uplift.

Cumulative assessment of air quality impacts was undertaken by considering background air quality, NPI-listed facilities, other nearby 'State significant' or 'strategic' projects and modelling emissions from existing rail network traffic, the Project and 1 kilometre of the adjoining Gowrie to Helidon (G2H) and Calvert to Kagaru (C2K) projects.

The contribution from other local sources is represented by the adopted background concentrations for relevant pollutants assessed.

#### 12.5.4.2 Emissions inventory

To quantify potential emissions from Project operations, an emissions inventory was developed. The key pollutants of interest included TSP, $PM_{10}$, $PM_{2.5}$, and $NO_X$. However, emissions have been calculated for all pollutants that have air quality goals (refer Table 12.4)

Stationary trains were modelled for the crossing loops planned at Helidon, Gatton, Laidley and Calvert. Concentrations at sensitive receptors from trains idling at crossing loops are likely to be higher than for trains travelling along the alignment. This is due to the potential residence time at the crossing loop. Emissions from crossing loops have been modelled specifically to address this scenario and the potential impacts that may result.

Estimated emissions also included fugitive dust from rail transport of coal along the alignment. The potential for contamination to water tanks from deposition of pollutants has been investigated in the assessment.

**Train volumes**

The train and wagon information presented in this section has been used as a basis for the operational impact assessment. The Project alignment is located adjacent to the existing Queensland Rail (QR) West Moreton System rail corridor. For the purpose of the assessment it has been assumed that all trains, including those existing services that currently use the West Moreton System rail corridor, will travel along the Project alignment.

Typical weekly train movements (2040) are provided in Table 12.5.The forecast typical train volume for 2040 is 328 trains per week. The typical train volumes are based on the *Inland Rail Program Business Case* (ARTC, 2015a) and assume Inland Rail will be at freight capacity in the year 2040. It is important to note that the typical train volumes are expected to be worst case for the Project—based on ARTCs operational train planning.

The engineering design train volumes (peak) are higher than the business case 2040 freight capacity train volumes (typical) to ensure the design has a suitable factor of safety when making infrastructure related decisions. For the year 2040, the adopted engineering design train volumes (up to 402 trains per week) are approximately 23 per cent higher than typical train volumes (328 trains per week). The engineering reference design train volumes (peak) are unlikely to be realised during operations. However, both typical and peak train volumes have been assessed and reported, along with potential impacts for all contaminants (at all assessed receptors), in full within Appendix K: Air Quality Technical Report. The assessment has been conservatively undertaken for 1,800 m long train sets.

**TABLE 12.5: WEEKLY TRAIN MOVEMENTS BY SERVICE**

| Train type/description | Volume of trains/week Typical[a] | Locomotive type NR Class[b] | SCT Class[c] | Class 82[d] | PR22L[e] |
|---|---|---|---|---|---|
| MB Express (Bromelton) | 11 | X | - | - | - |
| MB Express (Acacia Ridge) | 11 | X | - | - | - |
| MB Superfreighter (Bromelton) | 33 | - | X | - | - |
| MB Superfreighter (Acacia Ridge) | 6 | - | X | - | - |
| GB Superfreighter (Bromelton) | 18 | - | X | - | - |
| GB Superfreighter (Acacia Ridge) | 8 | - | X | - | - |
| New Acland Coal[f] | 46 | - | - | - | X |
| Cameby Downs/Rywung Coal[f] | 46 | - | - | - | X |
| Kogan Creek Coal[f] | 34 | - | - | - | X |
| Wilkie Creek Coal[f] | 23 | - | - | - | X |
| Narrabri—PoB Grain | 20 | - | - | X | - |
| Yelarbon—PoB Grain | 20 | - | - | X | - |
| Oakey—PoB Grain[f] | 19 | - | - | X | - |
| Narrabri— PoB Export Cont | 10 | - | - | X | - |
| Yelarbon—PoB Cotton | 5 | - | - | X | - |
| Toowoomba Export Containers[f] | 10 | - | - | - | X |
| Westlander[f] | 3 | - | - | - | X |
| Oakey—Rosewood Livestock[f] | 5 | - | - | X | - |
| **Total** | **328** | | | | |

**Table notes:**

a) Train volumes, have been rounded to the nearest whole number

b) National Rail class locomotives

c) Downer EDI SCT/LDP Class locomotive

d) Downer EDI 82 Class locomotive

e) Downer EDI/Progress Rail Services PR22L locomotive

f) Indicates that this train service is an existing service which currently uses the West Moreton System rail corridor.

MB = Melbourne to Brisbane, X = This locomotive operates the listed train type, '-' = This locomotive is not on this train type, PoB = Port of Brisbane

### Diesel locomotive emissions

Emissions factors have been sourced from emissions testing completed on locomotives by the NSW EPA and rated emission standards published by the United States Environmental Protection Agency (US EPA) and European Union. The US EPA and European Union (EU) emission factors are the most accurate source of emissions data available for the locomotives. Table 12.6 presents the referenced emissions factors on a grams per kilowatt per hour basis (g/kWhr).

**TABLE 12.6: LOCOMOTIVE EMISSIONS FACTORS**

| Locomotive | NR Class Cycle weighted | NR Class Idling | SCT/LDP | 82 Class | PR22L |
|---|---|---|---|---|---|
| Locomotive max power (kW) | 2,917 | | 3,350 | 2,425 | 1,640 |
| Rated emission standard | US EPA—Tier 0 | - | US EPA—Tier 1 | US EPA—Tier 0 | EURO IIIA |
| Total particulates (g/kWhr) | 0.101 | 1.09 | 0.60 | 0.8 | 0.20 |
| $NO_x$ (g/kWhr) | 16.6 | 43.7 | 9.92 | 12.74 | 6.00 |
| Total Hydrocarbons (THC)[a] (g/kWhr) | 0.519 | 4.66 | 0.74 | 1.34 | 0.50 |
| Source | US EPA Emissions Limits—Line Haul Locomotives | *Diesel Locomotive Fuel Efficiency & Emission Testing Report* Nov 2016 by ABMARC for NSW EPA (NR121 & 93 Class) | US EPA Emissions Limits —Line Haul Locomotives | | EU Emissions Standards—Nonroad Engines |

**Table note:**

a) VOCs are a subset of THC. For this assessment 100 per cent of THC emissions are assumed to be VOCs.

Table 12.7 summarises the operating mode percentages of maximum engine power used for each engine notch setting to calculate average duty-cycle power ratings.

To determine the time spent at each engine notch setting, data from US rail operations was used to provide a basis for average duty cycle power ratings. Table 12.8 presents US EPA data from Ireson, Germer, and Schmid (2005), which represents duty-cycle data for line haul diesel locomotives in the US. The line haul data presented is the result of analysis of 63 line-haul trains and 2,475 operational hours.

#### TABLE 12.7: ADOPTED NOTCH SETTING AND OPERATING MODE POWER RATING PERCENTAGES

| Notch setting or operating mode | Adopted percentage of maximum engine power (per cent) | Source |
|---|---|---|
| Idle | 2.3 | Casadei & Maggioni (2016) |
| Dynamic braking | 3.6 | StarCrest Consulting Group (2008) |
| Notch 1 | 4.8 | Spiryagin et al. (2015) |
| Notch 2 | 10.7 | |
| Notch 3 | 24.1 | |
| Notch 4 | 34.3 | |
| Notch 5 | 45.4 | |
| Notch 6 | 66.0 | |
| Notch 7 | 87.1 | |
| Notch 8 | 100 | |

#### TABLE 12.8: DUTY-CYCLES FOR LINE HAUL AND PASSENGER LOCOMOTIVES IN THE US (PERCENTAGE TIME IN NOTCH)

| Notch setting/operating mode | Line haul |
|---|---|
| Idle | 38.0 |
| Dynamic braking | 12.5 |
| Notch 1 | 6.5 |
| Notch 2 | 6.5 |
| Notch 3 | 5.2 |
| Notch 4 | 4.4 |
| Notch 5 | 3.8 |
| Notch 6 | 3.9 |
| Notch 7 | 3.0 |
| Notch 8 | 16.2 |

Average hourly (duty-cycle) power consumption rates have been calculated for each locomotive type using the adopted notch power ratings and duty-cycle information presented in Table 12.7 and Table 12.8. The calculated average hourly power consumption rates in addition to the maximum and idling power consumption rates for each locomotive are presented in Table 12.9.

#### TABLE 12.9: LOCOMOTIVE POWER USAGE

| Power | NR Class | SCT/LDP | Class 82 | PR22L |
|---|---|---|---|---|
| Maximum power (kWhr) | 2,917 | 3,350 | 2,425 | 1,640 |
| Calculated average duty cycle (kWhr) | 823 | 945 | 684 | 463 |
| Idle (kWhr) | 68 | 78 | 56 | 38 |

Table 12.10 presents the adopted maximum design line speeds along the Project alignment. Class 82 trains speeds were not known at the time of the assessment and have been assumed to travel at the same speed of the PR22L locomotives. For the purposes of the AQIA, average line speeds were estimated to be 75 per cent of the maximum line speeds along the alignment.

**TABLE 12.10: AQIA ADOPTED LOCOMOTIVE LINE SPEEDS**

| Assumption | Direction of travel | NR Class | SCT/LDP | Class 82 | PR22L |
|---|---|---|---|---|---|
| Maximum line speed (km/hr) | North | 115 | 115 | 80 | 100 |
| | South | 115 | 115 | 80 | 80 |
| Average line speed (km/hr) | North | 86 | 86 | 60 | 60 |
| | South | 86 | 86 | 60 | 60 |

The following equation represents the calculation method used to determine the total locomotive power per hour for the entire alignment:

$$P_{total} = \sum_{n}^{loco} (P_{loco} \times d \times v_{loco} \times n_{loco})$$

Where:

- $P_{total}$ is the total locomotive calculated power per hour for entire alignment (kWhr)
- $P_{loco}$ is the calculated average duty cycle power for each locomotive type (kWhr)
- *d* is the rail track length of the Project alignment (km)
- $v_{loco}$ is the average line speed of each locomotive type (km/hr)
- $n_{loco}$ is the total number of locomotives of each train type. Pollutant emission rates were then calculated using the following parameters:
- For the typical scenario, emissions have been calculated based on a total of 328 trains per week (approximately 47 trains per day) (refer Table 12.5)
- Locomotive power usage has been adopted as presented in Table 12.9
- 75 per cent of journey time was assumed to consist of travel time, with 25 per cent of journey time assumed to consist of trains being stationary and idling in crossing loops.

The following equation represents the calculation method used to determine pollutant emissions from locomotive traffic along the entire alignment:

$$ER_{pollutant} = \frac{EF_{pollutant} \times P_{total}}{d}$$

Where:

- $ER_{pollutant}$ is the calculated pollutant emission rate for $NO_x$, TSP, $PM_{10}$, $PM_{2.5}$ and Total VOCs (as THC) grams per metre per second (g/m/s)
- $EF_{pollutant}$ is the pollutant emission factor as per (g/kWhr)
- $P_{total}$ is the total locomotive calculated power per hour for entire alignment (kWhr)
- *d* is the rail track length of the Project alignment (m).

The following equation represents the calculation method to determine emissions from idling locomotives during normal assumed operation:

$$ER_{idle} = \left[\sum_{n}^{loco} \left(\frac{t_{loco}}{3} \times n_{loco} \times P_{loco}\right)\right] \times EF_{pollutant}$$

Where:

- $ER_{idle}$ is the calculated pollutant emission rate for $NO_x$, TSP, $PM_{10}$, $PM_{2.5}$, CO, and total VOCs (g/s)
- $t_{loco}$ is the locomotive travel time along the alignment without stopping. Idling time is assumed to be 25 per cent of the total travel time along the alignment.
- $n_{loco}$ is the total number of locomotives of each train type
- $P_{loco}$ is the total locomotive calculated power per hour for entire alignment from idling (kWhr)
- $EF_{pollutant}$ is the pollutant emission factor as per Table 12.6 (g/kWhr).

To determine continuous idling emissions from crossing loops, it was assumed that NR class locomotives would idle for periods up to or greater than 1 hour depending on the scenario modelled. The idling emission rates were derived from the hourly idling locomotive power usage presented in Table 12.9, and the locomotive emission factors presented in Table 12.6. The idling emission rates were applied to all modelled hours, which is a conservative assumption that locomotives are idling at the crossing loops continuously for a whole year.

The derived pollutant locomotive diesel emission rates for primary modelled pollutants of concern are presented in Table 12.11. The locomotive idling emission rates for each crossing loop are also presented, which are cumulative emissions from the four proposed crossing loops. The methodology for the assessment of emissions from the crossing loops is explained in Section 12.5.4.3.

#### TABLE 12.11: DERIVED POLLUTANT DIESEL COMBUSTION EMISSION RATES

| Pollutant | Total Project emissions (g/m/s) | Long-term average Project idling emissions per crossing loop (g/s)[1] | Short-term continuous Project idling emissions per crossing loop (g/s)[1] |
|---|---|---|---|
| $NO_x$ | $1.84 \times 10^{-4}$ | 0.222 | 4.944 |
| TSP | $5.94 \times 10^{-5}$ | 0.0055 | 0.123 |
| $PM_{10}$ | $3.42 \times 10^{-5}$ | 0.0054 | 0.120 |
| $PM_{2.5}$ | $1.26 \times 10^{-5}$ | 0.0052 | 0.116 |
| Total VOCs | $2.81 \times 10^{-5}$ | 0.024 | 0.527 |

**Table notes:**

1. Scenarios modelled (long-term and short-term) for crossing loops are discussed and provided in Section 12.5.4.3

g/m/s = grams per metre per second, g/s = grams per second

Where emissions factors for specific pollutants of concern were not available, emission factors from the *Emission estimation technique manual for railway yard operations.* (NPI, 2008) and the *European Monitoring and Evaluation Program/European Environmental Authority (EMEP/EEA) air pollutant emission inventory guidebook 2016* (EMEP/EEA, 2016a) were used. The referenced and speciated locomotive emissions factors are presented in Table 12.12.

#### TABLE 12.12: LOCOMOTIVE EMISSION FACTORS AND SPECIATION

| Pollutant | Emission factor | Units | Speciation percentage (per cent) | Source |
|---|---|---|---|---|
| **Total suspended particulates** | | | | |
| $PM_{10}$ | 3.53 | kg/kL | 97.6 | (NPI, 2008) |
| $PM_{2.5}$ | 3.39 | kg/kL | 93.7 | (NPI, 2008) |
| Cadmium | 0.01 | g/tonne of fuel | 0.0007 | (EMEP/EEA, 2016a) |
| Chromium | 0.05 | g/tonne of fuel | 0.0033 | (EMEP/EEA, 2016a) |
| Copper | 1.7 | g/tonne of fuel | 0.1118 | (EMEP/EEA, 2016a) |
| Nickel | 0.07 | g/tonne of fuel | 0.0046 | (EMEP/EEA, 2016a) |
| Selenium | 0.01 | g/tonne of fuel | 0.0007 | (EMEP/EEA, 2016a) |
| Zinc | 0.03 | g/tonne of fuel | 0.0658 | (EMEP/EEA, 2016a) |
| Lead | 0.0005 | mg/kg of fuel | 0.00003 | (EMEP/EEA, 2016b) |
| Arsenic | 0.0001 | mg/kg of fuel | 0.00001 | (EMEP/EEA, 2016b) |

| Pollutant | Emission factor | Units | Speciation percentage (per cent) | Source |
|---|---|---|---|---|
| **Total hydrocarbons** | | | | |
| Non-methane VOCs | 4.65 | kg/tonne of fuel | 100 | (EMEP/EEA, 2016a) |
| Benzo(a)pyrene (PAH) | 0.03 | g/tonne of fuel | 0.0006 | (EMEP/EEA, 2016a) |
| Toluene | - | - | 0.01 | (EMEP/EEA, 2016b) |
| m,p-xylenes | - | - | 0.98 | (EMEP/EEA, 2016b) |
| o-xylenes | - | - | 0.40 | (EMEP/EEA, 2016b) |
| Benzene | - | - | 0.07 | (EMEP/EEA, 2016b) |
| Polychlorinated dioxins and furans (toxic equivalents quotient) | $8.35 \times 10^{-11}$ | kg/kL | | (NPI, 2008) |

**Fugitive coal dust**

The nature of the emissions from the coal wagons (laden and unladen) is fugitive, i.e. the emissions are not released through an easily quantifiable source, such as a vent or stack. The primary mechanism for coal dust lift-off from coal wagons is the movement of air over uncovered laden wagons; therefore, the surface area open to the wind plays a pivotal role in the amount of fugitive coal dust emitted.

For the purposes of the AQIA, it has been assumed that all coal trains operating on Inland Rail will use veneering to control coal dust emissions. Veneering is a best-practice management measure currently applied to trains that use the Bowen Basin coal rail lines and the West Moreton System rail corridor.

A detailed study into the surface-wind speed across loaded wagons and their associated dust emissions has been carried out in *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008).The study also presents an equation to calculate the mass emission rate of coal dust from a moving laden wagon at a particular site, using the average wind speed at each modelling location, together with the train speed data for that site:

$$m = (k_1 \times v^2) + (k_2 \times v) + k_3$$

Where:

- *m* is the mass emission rate of coal dust (as TSP) from the wagon surface in g/km/tonne of coal transported
- $k_1$ is a constant with a value of 0.0000378
- $k_2$ is a constant with a value of -0.000126
- $k_3$ is a constant with a value of 0.000063
- *v* is the air velocity over the surface of the train in km/hr.

This veneer acts as a binding agent to reduce the amount of surface lift-off of particulates from the laden wagons. *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008) suggested that a reduction in surface lift-off of up to 85 per cent was achievable through its application. Trials completed by the BNSF Railway Company and Union Pacific Railroad Company investigated the effectiveness of coal dust suppressants in the Powder River Basin. The trials looked at seven different chemical agents in suppressing coal dust emissions from 1633 loaded trains. The trials found that *'… coal dust reductions ranged from 75 to 93 percent depending on the topical treatment used in the test'* (BNSF & UP, 2010). A conservative assumption of 75 per cent reduction in the coal dust emission rates has been adopted in this assessment for the laden coal trains.

*Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008) also detailed that following unloading of the coal at the port or terminals, a small amount of residual coal typically remained in the wagon (approximately 0.13 tonnes (t) per wagon), which was transported back to the mines. In addition, parasitic loads were found to be located on the wagon sills, shear plates and bogies, which resulted in further fugitive emissions.

Although wagon washing is undertaken at some coal-handling facilities (such as at the Jondaryn Load Out Facility), wagon washing is not undertaken at the Port of Brisbane and therefore it is expected that residual coal will remain in the wagons following unloading at the port. An additional 0.13 t of coal per wagon was added to the proposed coal train payload of 85.9 t per wagon to account for residual coal in the wagons on return trips.

Modelled coal dust emission rates assumed:

- Travel speed of 80 km/h for a laden coal train travelling along the alignment (maximum laden coal train speed for alignment). The travel speed was used as the wind speed when calculating the mass emission rate of coal dust.

- Reduction of emissions from between 75–85 per cent from the application of direct control to coal wagons (veneering). It has been conservatively assumed that fugitive coal dust emissions will be reduced by 75 per cent (Connell Hatch, 2008).
- Coal payload (average) per train of 5,592 t (inclusive of 0.13 t residual coal per wagon).
- Conversion factor of 0.5 from TSP to $PM_{10}$ (US EPA, 1998).
- Conversion factor of 0.15 from $PM_{10}$ to $PM_{2.5}$ (US EPA, 1998) based on the particle size distributions for mechanically generated emissions from aggregate and unprocessed ores published in the US EPA AP42 *Compilation of Air Pollutant Emission Factors* (US EPA, 1998). Particle size distribution data is not provided for coal, but size distributions for aggregate and unprocessed ores (15 per cent for $PM_{2.5}$) is considered acceptable in lieu of specific data for coal.

Modelling of coal dust emissions assumes that all coal trains travel at speed (80 km/hr) along the alignment, and do not slow down to access the crossing loops. Fugitive emissions of coal dust from trains at the crossing loops has not been modelled specifically. However, at lower wind speeds across the coal wagons, emissions are estimated to be considerably lower than the modelled travel speed of 80 km/hr. For example, fugitive coal dust emissions from a stationary coal train, with an average 10 km/hr cross wind, represent 1.1 per cent of emissions from a coal train travelling at 80 km/hr. Coupled with the assumption that the coal trains travel at 80 km/hr for the entire alignment results in an conservative estimate of coal dust emissions, which adequately represents fugitive coal dust emissions from the crossing loops proposed in the Project.

The derived coal dust emission rates for the Project are presented in Table 12.13.

**TABLE 12.13: DERIVED COAL DUST EMISSION RATES**

| Pollutant[a] | Uncontrolled coal dust emissions (g/m/s) per train | Controlled coal dust emissions (g/m/s) per train | Total H2C alignment controlled coal dust emissions (g/m/s) |
|---|---|---|---|
| TSP | $2.14 \times 10^{-6}$ | $5.36 \times 10^{-7}$ | $4.99 \times 10^{-5}$ |
| $PM_{10}$ | $1.07 \times 10^{-6}$ | $2.68 \times 10^{-7}$ | $2.49 \times 10^{-5}$ |
| $PM_{2.5}$ | $1.61 \times 10^{-7}$ | $4.02 \times 10^{-8}$ | $3.74 \times 10^{-6}$ |

**Table note:**

a) $PM_{10}$ has been assumed to represent 50 per cent of TSP emissions, with $PM_{2.5}$ assumed to represent 15 per cent of $PM_{10}$ emissions.

### Tunnel portal emissions

Emissions from the Little Liverpool Range tunnel portals were calculated using specific parameters relevant to the tunnel, and are summarised as follows:

- Total tunnel length of 850 m
- Portal area of 100 m at each end
- Laden coal trains travelling only in the west-to east-tunnel direction.

Table 12.14 presents the average train speeds for each of the groups of expected locomotive type, which is a result of the locomotive number and type per train, weight of trailing wagons, and gradient of the tunnel rail track. A weighted average was calculated based on the percentage of rail traffic expected to travel through the tunnel. The average speeds are broken into 'stopping' and 'non-stopping' speeds, based on operational modelling of rail traffic.

**TABLE 12.14: LITTLE LIVERPOOL RANGE TUNNEL AVERAGE LOCOMOTIVE SPEEDS (KM/HR)**

| | Non-stopping | | Stopping | |
|---|---|---|---|---|
| **Train type** | **Eastbound** | **Westbound** | **Eastbound** | **Westbound** |
| Superfreighter | 43.7 | 24.4 | 39.7 | 24.0 |
| Express | 54.6 | 34.6 | 47.1 | 31.1 |
| Coal | 37.3 | 44.3 | 37.7 | 43.4 |
| Agriculture-steel-containers | 51.3 | 49.0 | 50.8 | 48.8 |
| **Weighted average** | **43.5** | **55.6** | **31.5** | **54.4** |

**Table note:**

The weighted average speed has been calculated by multiplying the speed for each train by the ratio of that train type over the total number of trains travelling in that direction.

Average duty-cycle calculations from operational modelling of Little Liverpool Range tunnel rail traffic are presented for each train type in Table 12.15.

#### TABLE 12.15: LITTLE LIVERPOOL RANGE TUNNEL AVERAGE POWER (KW) PER TRAIN

| | Non-stopping | | Stopping | |
|---|---|---|---|---|
| **Train type** | **Eastbound** | **Westbound** | **Eastbound** | **Westbound** |
| Superfreighter | 5,377 | 4,713 | 5,444 | 5,524 |
| Express | 6,603 | 7,494 | 7,729 | 7,478 |
| Coal | 4,454 | 4,399 | 4,458 | 4,405 |
| Agriculture-steel-containers | 3,594 | 4,308 | 3,700 | 4,275 |

Table 12.16 summarises the tunnel portal emissions used in the dispersion modelling, which include the cumulative sources of locomotive diesel combustion emissions and fugitive dust emissions from coal train wagons.

#### TABLE 12.16: DERIVED PORTAL EMISSIONS

| | Northbound emission rate (kg/hr) | | Southbound emission rate (kg/hr) | |
|---|---|---|---|---|
| **Pollutant** | **Non-stopping** | **Stopping** | **Non-stopping** | **Stopping** |
| $NO_x$ | 1.45 | **1.50** | 1.51 | **1.56** |
| TSP | 0.136 | **0.137** | 0.084 | **0.088** |
| $PM_{10}$ | 0.105 | **0.107** | 0.082 | **0.085** |
| $PM_{2.5}$ | 0.077 | **0.080** | 0.079 | **0.082** |
| CO | 0.716 | **0.734** | 0.694 | **0.720** |
| THC | 0.214 | **0.219** | 0.212 | **0.219** |

**Table note:**
The highest emission rate for each travel direction and the emission rate used for the modelling is shown in bold.

The calculated stopping emission rates are higher than the non-stopping due to the longer in-tunnel durations (generally lower average speeds and higher average power) and, as such, were used in modelling as a conservative assumption.

#### Adjoining Inland Rail projects

To assess the cumulative impact of the Inland Rail Program (Inland Rail), the adjoining sections of Inland Rail adjacent to the Project, namely the G2H and C2K projects, have been included in the AQIA dispersion modelling.

One kilometre of the adjoining G2H and C2K projects has been modelled at either end of the Project alignment and background air quality considered in a cumulative impact assessment.

The emission rates used for the modelling of the G2H and C2K projects were assumed to be equivalent to that calculated for the Project.

No other projects required detailed modelling, and the contribution from other local sources is represented by the conservatively adopted background concentrations for the pollutants assessed.

#### Existing rail network traffic

The Project alignment is located adjacent to the existing West Moreton System rail corridor for approximately 24 km. Emissions from trains operating on the existing West Moreton System rail corridor will currently be influencing the background air quality in the AQIA study area. However, emissions from existing train travel along the West Moreton System rail corridor have not been included in the assumed background concentrations as they have been assumed for the operational modelling scenarios that all trains, including those existing services that currently use the QR alignment, will travel along the Project alignment. The existing services are therefore included in the Project contribution to cumulative concentrations.

It is highlighted that veneering is currently applied to coal trains that use the Bowen Basin coal rail lines and the West Moreton System rail corridor. Therefore, existing coal trains that currently use the West Moreton System rail corridor are assumed for this AQIA to already have implemented veneering.

#### 12.5.4.4 Dispersion modelling

The air dispersion modelling conducted for the AQIA used TAPM as a meteorological pre-processor to the CALPUFF and GRAL models. The CALPUFF model was used primarily for the modelling assessment; however, for potential impacts from the Little Liverpool Range tunnel portals, the GRAL model was used.

The data available for this Project and a discussion of the data-processing methodologies required to implement both CALPUFF and GRAL are discussed in the following sections, with further details provided in Appendix K: Air Quality Technical Report. All modelling was undertaken in accordance with relevant guidance documents and appropriate literature (DEC, 2005; Barclay & Scire, 2011).

Figure 12.2 presents the modelling methodology undertaken for the AQIA.

**Selection of meteorological year**

For Australia, the El Niño-Southern Oscillation (ENSO) has the strongest effect on year-to-year climate variability, mostly affecting rainfall and temperature. El Niño incidences represent periods of unusually warm Pacific Ocean conditions along the western coast of South America, which frequently presents as high rainfall events in South America and drought conditions for Australia. Conversely, La Niña periods represent cooler ocean surface temperatures along the western coast of South America and increase the likelihood of drought conditions locally and high rainfall periods in Australia.

The Southern Oscillation Index (SOI), Oceanic Niño Index (ONI), and Multivariate ENSO Index (MEI) are measures that can indicate episodes of El Niño and La Niña. Using the SEI, ONI, and MEI measures for ENSO, agreeance in which years represent periods of El Niño or La Niña can be determined. The three indices show that the year 2013 was relatively neutral in terms of ENSO. The year 2013 was adopted for the AQIA.

Further discussion on the selection of the meteorological year is provided in Appendix K: Air Quality Technical Report.

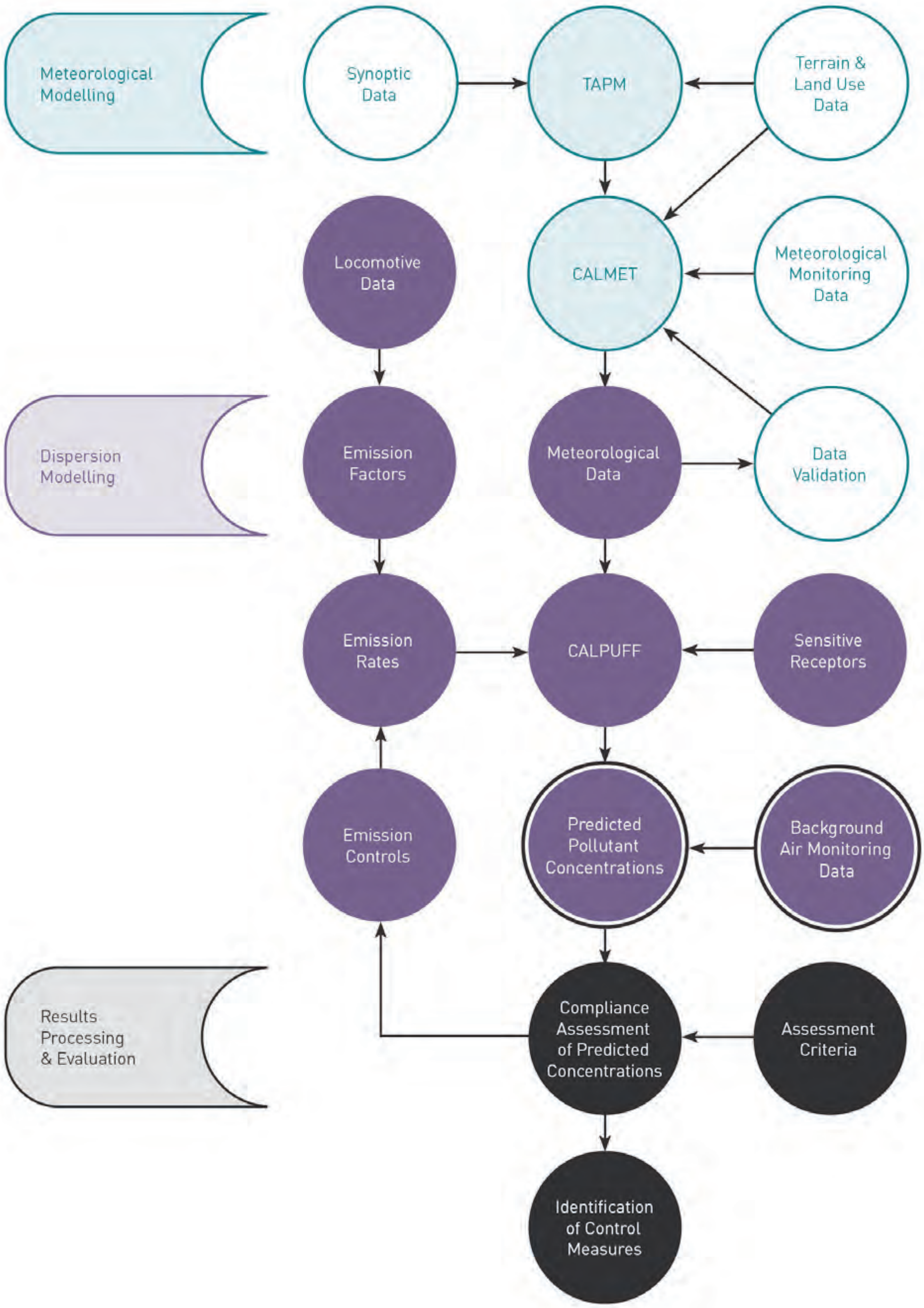



**FIGURE 12.2: DIAGRAMMATIC REPRESENTATION OF THE CALPUFF MODELLING METHODOLOGY**

### TAPM and meteorological data

Meteorological data used in the dispersion model is of fundamental importance as it drives the atmospheric transport, dispersion and predictions of the air pollutants. Key parameters include:

- Wind direction, which determines the initial direction, and changes, of transport of pollutants from their sources
- Wind speed, which dilutes the plume in the direction of transport and determines the travel time from source to receiver
- Atmospheric turbulence, which indicates the dispersive ability of the atmosphere.

Meteorological data from the Bureau of Meteorology (BoM) and DES meteorological stations, in addition to prognostic meteorological data generated by TAPM, has been used in the assessment. Pseudo upper air stations were generated from TAPM model runs for the AQIA study area. The use of pseudo upper air stations allows the CALMET modelling to be driven primarily by surface observations.

A total of four pseudo upper air stations were generated from TAPM, with individual runs undertaken for each station. The model setup for TAPM for each of the runs undertaken is presented in Table 12.17.

**TABLE 12.17: TAPM INPUT PARAMETERS**

| Parameter | Input |
|---|---|
| TAPM version | 4.0.4 |
| Number of grids (spacing) | 5 (30 km, 10 km, 3 km, 1 km, 0.3 km) |
| Number of grid points | 41 |
| Number of vertical levels | 25 |
| Terrain height database | 9-second DEM |
| Year of analysis | January to December 2013 |
| Grid centre point | Refer Table 12.18 for each station |

BoM meteorological data was sourced from The University of Queensland's (UQ) Gatton station. A summary of the meteorological stations considered, including the prognostic stations, is presented in Table 12.18.

**TABLE 12.18: METEOROLOGICAL STATIONS INCLUDED IN MODELLING**

| Station | Coordinates (GDA zone 56) | Variables | Source |
|---|---|---|---|
| UQ Gatton | 434,588m; 6,953,179m | Wind direction; wind speed; temperature; rainfall; pressure; relative humidity | BoM |
| UA1 | 410,300m; 6,955,085m | Upper air | TAPM |
| UA2 | 424,290m; 6,955,180m | Upper air | |
| UA3 | 438,916m; 6,941,834m | Upper air | |
| UA4 | 455,636m; 6,935,025m | Upper air | |

### CALPUFF

The CALPUFF suite of programs, including meteorological (CALMET), dispersion (CALPUFF) and post-processing modules (CALPOST), is a non-steady state modelling system designed for meteorological and air quality modelling. DES does not require the use of any particular dispersion model (e.g. CALPUFF or AERMOD models); however, within the DES *Guideline Application requirements for activities with impacts to air* (DES, 2019a) reference is made to the NSW EPA guidance document *Approved methods and guidance for the modelling and assessment of air pollutants in NSW* (NSW EPA, 2016. CALPUFF is appropriate in applications involving complex terrain, non-steady-state conditions, in areas where coastal effects may occur, and/or when there are high frequencies of stable or calm meteorological conditions (Barclay & Scire, 2011). As many of these features are present in the AQIA study area, the CALPUFF model is preferred over the more commonly used Gaussian models of AERMOD or AUSPLUME, which are less reliable in the aforementioned conditions.

### GRAL

To investigate the air quality impacts from the railway tunnel portal emissions, the GRAL dispersion model has been used. GRAL is a Lagrangian Particle model developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria (Oettl et al. 2002; Oettl et al., 2003; Oettl et al., 2005). GRAL has been evaluated against experimental data from five different tunnel portals, both in flat and complex terrain, with high- and low-traffic volumes, namely the Enrei, Hitachi and Ninomiya tunnels in Japan (Oettl et al., 2003), and the Kaisermuehlen (Oettl et al., 2004) and Enrentalerberg tunnels in Austria (Oettl et al., 2002). The GRAL model was specifically used to assess emissions from the Little Liverpool Range tunnel portals.

The results from the GRAL modelling have been combined with the results from the CALPUFF modelling to predict the total potential impacts at modelled receptors.

### Crossing loops

Locomotive diesel emissions from crossing loops have been modelled as follows:

- Emissions from locomotives idling directly at the crossing loops have been modelled. Emissions from the stopping and starting of trains at each crossing loops has not been modelled
- Locomotives have been modelled at each end of each crossing loop as three separate point sources, resulting in six emission source points per loop
- Two different approaches (hereafter referred to as versions) have been assessed for crossing loops to accurately consider emissions and allow for assessment against both short and long-term averaging periods:
  - Short-term (one-hour average): continuous idling of NR Class locomotives assumed throughout the year
  - Long-term (24-hour and annual averages): idling assumed to occur 25 per cent of the travel time, e.g. 15 minutes per hour or 6 hours per day
- For the short-term version, the six point sources represent two Express trains with six NR Class locomotives. The long-term version represents emissions from a calculated composite emission of all trains travelling along the alignment
- No split of idling time has been assumed for each end of the loop to allow for a worst-case assessment of idling, for both the north-bound and south-bound travel directions
- The locomotive point sources have been located on the top and in the centre of 'buildings' included in the model. This accounts for the influence of downwash caused by the structure of the locomotives.

### Modelling scenarios

Modelling of emissions from train travel along the Project alignment has been undertaken, assuming an even volume of train travel per day, e.g. daily train volumes and train emissions from travel along the alignment have been modelled based on the weekly train volumes divided by seven.

In addition to the train volumes, two different versions of each scenario (short-term and long-term) have been run to assess emissions from the crossing loops against both short-term and long-term air quality goals (refer Section 12.4.3). The modelled scenarios and crossing loop versions assessed are summarised in Table 12.19.

The model predictions from the short-term version have been used to assess compliance against the short-term goals (30 minute, 1 hour, 24-hour and monthly), with the model predictions from the long-term version used to assess compliance against annual average goals.

In addition to the short- and long-term versions, the requirement for veneering has also been investigated by modelling particulate emissions from coal trains with and without the inclusion of veneering (75 per cent reduction to fugitive coal dust emissions). In total, four modelling scenarios are presented in this chapter and have been run as part of the Project AQIA. Additional modelling scenarios are provided in Appendix K: Air Quality Technical Report.

**TABLE 12.19: DISPERSION MODELLING SCENARIOS**

| Scenario | Crossing loop version | Crossing loop idling description | Air quality goal averaging periods assessed |
|---|---|---|---|
| Typical train volumes 2040 | Short-term | Continuous idling emissions from crossing loops | 30 minute, 1 hour, 24-hour and monthly dust deposition |
| | Long-term | Idling at loops assumed to occur 25 per cent of the travel time | Annual |

**Table note:**
For each of the scenarios listed in Table 12.19 two variations have been run, one with the inclusion of veneering and one without veneering.

All the data and parameters used as input parameters for the dispersion modelling, including additional scenarios and model outputs, have been provided in Appendix K: Air Quality Technical Report.

**Influence of climate change on meteorological modelling data**

The meteorological modelling undertaken for the AQIA study area has been undertaken using prognostic meteorological data generated by TAPM and observational data from BoM stations for the year 2013. The purpose of meteorological modelling is to develop representative dispersion modelling inputs based on long-term historical meteorological data.

Changing climatic conditions due to climate change has the potential to influence wind conditions, atmospheric stability, mixing height and other meteorological factors important to the dispersion of ground-released pollution. However, as described in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2017) (which is the referred to guidance for air quality modelling in the Queensland *Guideline: Application requirements for activities with impacts to air* (within the EP Act) the site-representative meteorological data is to be based on long-term historical representative meteorological data (presented in Section 12.6.1). The potential influence of future changing climatic conditions has not been considered in this assessment.

**Limitations**

The atmosphere is a complex, physical system, and the movement of air in a given location is dependent on several variables, including temperature, topography and land use, as well as larger-scale synoptic processes. Dispersion modelling is a method of simulating the movement of air pollutants in the atmosphere using mathematical equations, based on our understanding of the processes involved, their interactions and available input data.

Simulating complex atmospheric processes can come at the expense of accuracy, which particularly affects model predictions during certain meteorological conditions and source emission types. For example, the prediction of pollutant dispersion under low wind-speed conditions (typically defined as those wind speeds less than 1 m/s), or for low-level, non-buoyant sources, tend to over-estimate pollutant concentrations.

While the models contain a large number of variables that can be modified to improve precision, a range of default values are typically adopted for model variables that are applicable under most modelling circumstances. These default values are recommended for use unless there is sufficient evidence to support their modification.

The results of dispersion modelling, therefore, provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with appropriate input data, can provide very good indications of the scale of pollutant concentrations and the likely locations of the maximum concentrations occurring, their outputs should not be considered to be representative of exact pollutant concentrations at any given location or point in time.

The model predictions are also typically conservative and tend to over-predict maximum pollutant concentrations at receiver locations.

### 12.5.4.5 Conversion of $NO_x$ to $NO_2$

Nitrogen oxides are produced in most combustion processes and are formed during the oxidation of nitrogen in fuel and nitrogen in the air. During high-temperature processes, a variety of oxides are formed including NO and $NO_X$. NO will generally comprise 95 per cent of the volume of $NO_X$ at the point of emission. The remaining $NO_X$ will primarily consist of $NO_2$. The conversion of NO to $NO_2$ requires ozone ($O_3$) to be present in the air, as ozone is the catalyst for the conversion. Ultimately, however, all NO emitted into the atmosphere is oxidised to $NO_2$ and then further to other higher oxides of nitrogen.

The USEPA's Ozone Limiting Method (OLM) was used to predict ground-level concentrations of $NO_2$. The OLM assumes that approximately 10 per cent of the initial $NO_X$ emissions are emitted as $NO_2$. If the ozone ($O_3$) concentration is greater than 90 per cent of the predicted $NO_X$ concentrations, all the $NO_X$ is assumed to be converted to $NO_2$, otherwise $NO_2$ concentrations are predicted using the equation:

$$NO_2 = 46/48 \text{ x } O_3 + 0.1 \text{ x } NO_x$$

This method assumes instant conversion of NO to $NO_2$ in the plume, which can lead to overestimation of concentrations close to the source, since conversion would usually occur over a period of hours. This method is described in detail in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2017). The OLM is a conservative approach as outlined in Appendix K: Air Quality Technical Report (Appendix D). Due to its proximity to the Project alignment, background ozone data from the Mutdapilly monitoring station was used to convert the modelled $NO_2$ concentrations in accordance with the OLM methodology.

### 12.5.4.7 Tank water quality

**Potential impacts**

In rural and remote Australia where reticulated water supply is not always available, the use of domestic rainwater tanks is common practice. Rainfall is collected from roof run-off and, where installed, is most commonly used as the primary source of household drinking water (enHealth, 2010). Rainwater stored in tanks has the potential to be contaminated by chemical, physical and microbial sources, and become a hazard to human health. Industrial and traffic emissions have the potential to be a source of chemical contamination through their atmospheric deposition onto rooves where water is collected (Gunawardena, 2012).

**Fugitive coal dust deposition**

Fugitive coal dust emissions from rail transport along the Project rail corridor have potential to be deposited on surfaces that lead to rainwater tanks. Coal may contain many trace elements, some of which include: sulfur (S), chlorine (Cl), arsenic (As), boron (B), cadmium (Cd), lead (Pb), mercury (Hg), molybdenum (Mo), selenium (Se), chromium (Cr), copper (Cu), fluorine (F), nickel (Ni), vanadium (V), and zinc (Zn). Several of these compounds can have toxic and chronic health effects, which are dependent on exposure length, concentration, and path of ingestion. A leaching test study completed by Lucas et al. (2009) showed, through experimentation, that even though these compounds exist within coal and coal dust, they leach negligible amounts into receiving water, and measured concentrations were well below the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018). Therefore, it is expected that coal dust will not pose significant health impacts from exposure to toxic trace elements and its health impacts will be primarily related to exposure to particulate matter in the form of $PM_{10}$ and $PM_{2.5}$.

**Assessing impacts to water tank quality**

The potential for the operation of the Project to impact tank water quality collected via roof catchment has been investigated. Using the emissions inventory developed for the AQIA, dust deposition modelling was undertaken using CALPUFF to determine the potential impact of diesel and fugitive coal dust emissions on tank water quality. Dust deposition was predicted for all receptors within the AQIA study area. The methodology for predicting the potential impact to water tank quality includes:

- Rain water collection systems can have first-flush devices, which take the first water captured by roofs and divert it for disposal rather than collection in a water tank. It was assumed that no first-flush systems were installed for any of the modelled receptors.
- Annual average dust deposition rates were predicted for every receptor in the AQIA study area. Every receptor was assumed to have a water tank, and the roof area (collection area) for each receptor was assumed to be 200 $m^2$.
- It was assumed that all deposited dust at each receptor (200 $m^2$ roof area) was collected by a 10,000 litre (L) rainwater tank, which was 10 per cent full, resulting in a receiving water volume of 1,000 L. This conservative assumption allows for prolonged periods of drought and short rainfall events that wash deposited pollutants into rainwater tanks.
- The goals used for the assessment of impacts to water quality were taken from the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018), which provides guideline water concentrations for arsenic, cadmium, lead, nickel and chromium VI, which are all metals.
- The concentration of metals in water tanks was determined by taking the predicted annual average dust deposition level (e.g. 2 mg/$m^2$), multiplying it by the assumed roof area (200 $m^2$) to determine total mass (e.g. 400 mg), and then speciating the predicted dust deposition level into metal concentrations using the diesel locomotive emission factors and fugitive coal emission factors (refer Section 12.5.4.2).
- The predicted water concentrations for each species were then assessed against the goals prescribed by NHMRC.

The methodology applied is described for water tanks; however, it is also applicable for assessment of impacts to water quality for dams, assuming that the surface area (roof area) and receiving water volumes (1,000 L) are comparable.

The outcome of this method was pollutant concentrations in tank water which could be compared against the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

Detailed dispersion modelling is not typically undertaken for construction activity and has not been undertaken for the construction phase assessment for the Project. Construction dust has therefore not been considered for the assessment of tank water quality.

Similarly, fugitive emissions from fuel storage tanks required for the construction phase have not been considered for the assessment of tank water quality. Fugitive emissions from fuel storage tanks will be gaseous and will not be a significant issue with respect to deposition and tank water quality.

**Drinking water quality goals**

The *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018) present guideline values on allowable contaminants within drinking water, such as for water tanks. Table 12.20 presents the drinking water criteria for the pollutants of interest. Calculated water pollutant concentrations from dispersion modelling have been assessed against these guideline values in Section 12.7.3.

**TABLE 12.20: DRINKING WATER QUALITY GUIDELINES**

| Pollutant | Guideline value (mg/L) | Environmental value | Source |
|---|---|---|---|
| **Arsenic** | 0.01 | Health | (NHMRC & NRMMC, 2018) |
| **Cadmium** | 0.002 | Health | |
| **Lead** | 0.01 | Health | |
| **Nickel** | 0.02 | Health | |
| **Chromium as Cr(VI)** | 0.05 | Health | |

### 12.5.4.8 Agricultural freight odour

To assess the nuisance impacts that may arise from agricultural freight trains, a qualitative assessment using FIDOL factors has been undertaken to determine the likelihood of odour nuisance. The following factors, described using the acronym FIDOL, are accepted as being important dimensions of odour nuisance:

- Frequency (F): how often an individual is exposed to the odour
- Intensity (I): strength of the odour
- Duration (D): length of exposure
- Offensiveness (O): offensiveness or intrinsic character, known as the hedonic tone of the odour, may be pleasant, neutral, or unpleasant
- Location (L): type of land use and nature of human activities in the vicinity of an odour source.

In addition, sensitivity of the receiving community and offensiveness of the odours likely to be emitted was considered in the qualitative odour analysis.

### 12.5.5 Cumulative impact risk assessment

AQIAs are inherently cumulative assessments as they are required to consider background air quality when assessing against air quality goals.

Further to the adopted background air quality (refer Section 12.6.2) the AQIA has also considered cumulative impacts to sensitive receptors in the operational phase of the Project. This was undertaken by assessing emissions from the adjoining Inland Rail projects (C2K and G2H) as discussed in Section 12.5.4.2. The results of the operational phase assessment are discussed in Section 12.7.3.

Key existing emission sources in the AQIA study area are discussed in Section 12.6.3. Based on publicly reported emissions, none of the existing emission sources require detailed assessment as part of the Project's operational phase.

A qualitative cumulative impact assessment (CIA) has also been undertaken through review of other State significant or strategic projects. The assessment of cumulative impacts has considered the assessable State significant or strategic projects individually, with the assessment results provided in Section 12.7.4. A summary of the assessable projects' cumulative impacts is provided in Chapter 22: Cumulative impacts.

### 12.5.6 Decommissioning phase

Given the uncertainty associated with timeframe for decommissioning, this phase has not been considered in this AQIA.

## 12.6 Existing environment

The existing values of the air environment that may be affected by the Project are discussed in Section 12.4.3. To assess the impact of the Project on environmental values, the existing environment must be considered. Aspects of the existing environment relevant to this assessment include:

- Meteorological conditions and climate
- Existing air quality due to regional and local sources of air pollution (natural and anthropogenic) that emit similar air pollutants as those assessed
- Terrain and land use.

This section presents the locations of sensitive receptors that have been included in the Project AQIA.

### 12.6.1 Meteorology and climate

The Project is located in South East Queensland (SEQ) and spans the Lockyer Valley and Ipswich LGAs. SEQ generally experiences a sub-tropical climate with distinct wet and dry seasons.

BoM operates a network of meteorological monitoring stations around Australia that have long-term climatic data available for analysis. As the Project alignment spans a relatively significant distance laterally, local meteorological conditions may differ across this distance, especially at areas further inland and/or away from notable terrain features. Three BoM monitoring stations provide a suitable regional coverage of climatic conditions and have been reviewed for the AQIA. Details of the monitoring stations provided in Table 12.21. The locations of the stations are shown in Figure 12.1.

The monitoring station considered to be the most representative of the AQIA study area is the UQ Gatton station, which is located in between Helidon and Calvert. Meteorological monitoring data from the UQ Gatton station has been used to develop the dispersion model for the assessment.

**TABLE 12.21: DETAILS OF BOM METEOROLOGICAL MONITORING STATIONS CONSIDERED IN THE ASSESSMENT**

| Station name | Coordinates | Location relative to alignment | Period operational | Elevation |
|---|---|---|---|---|
| UQ Gatton | -27.5436, 152.3375 | 3 km N | 1897–Present | 89 m |
| Amberley Approved Maintenance Organisation (AMO) | -27.6297, 152.7111 | 16 km E | 1941–Present | 24 m |
| Toowoomba | -27.5836, 151.9317 | 18 km W | 1869–2007 | 691 m |

In addition to the measured meteorological data from the BoM stations, output data from CALMET (refer Section 12.5.4.3) has also been analysed and presented in this section to describe atmospheric stability and mixing height.

### 12.6.1.1 Temperature

Mean minimum and maximum temperatures have been collected from the UQ Gatton, Amberley AMO, and Toowoomba BoM stations and are displayed in Table 12.22.

Temperatures for UQ Gatton and Amberley AMO are very similar, with a 0.1 °C difference between the mean minimum and mean maximum annual average temperatures at the two locations. However, the Toowoomba monitoring station records a mean maximum annual temperature of 22.6 °C, which is approximately 4 °C lower than the UQ Gatton and Amberley AMO BoM locations. The mean minimum annual temperature at Toowoomba is also lower than these stations.

The difference in temperature is likely attributable to the difference in monitoring station elevation, with the Toowoomba station located at 691 metres (m) above sea level, compared to the other two monitoring stations that are much closer to sea level, each at elevations less than 90 m.

**TABLE 12.22: MEAN MINIMUM (BLUE) AND MAXIMUM (RED) MONTHLY TEMPERATURES FOR BOM STATIONS**

| | Mean minimum and maximum temperature (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
| UQ Gatton[a] | 19.1 | 19.0 | 17.3 | 13.7 | 10.2 | 7.6 | 6.2 | 6.7 | 9.5 | 13.2 | 16.0 | 18.1 | 13.0 |
| | 31.6 | 30.8 | 29.6 | 27.2 | 23.8 | 21.1 | 20.8 | 22.5 | 25.6 | 28.2 | 30.2 | 31.3 | 26.9 |
| Amberley AMO[b] | 19.6 | 19.5 | 17.8 | 14.0 | 10.0 | 7.1 | 5.4 | 6.2 | 9.5 | 13.3 | 16.3 | 18.4 | 13.1 |
| | 31.2 | 30.4 | 29.4 | 27.2 | 24.1 | 21.6 | 21.3 | 22.8 | 25.6 | 27.8 | 29.6 | 30.8 | 26.8 |
| Toowoomba[c] | 16.7 | 16.6 | 15.4 | 12.3 | 9.1 | 6.3 | 5.3 | 6.0 | 8.5 | 11.5 | 13.8 | 15.7 | 11.4 |
| | 27.6 | 26.6 | 25.5 | 22.9 | 19.6 | 16.9 | 16.3 | 17.9 | 20.9 | 23.7 | 26.0 | 27.5 | 22.6 |

**Table notes:**

a) Mean maximum and minimum temperature values have been calculated based on 106 years of data (1913 to 2019)

b) Mean maximum and minimum temperature values have been calculated based on 77 years of data (1941 to 2018)

c) Mean maximum and minimum temperature values have been calculated based on 67 years of data (1931 to 1998)

**Rainfall**

Mean rainfall values have been collected from the UQ Gatton, Amberley AMO, and Toowoomba BoM stations and are presented in Table 12.23.

Table 12.23 shows that a distinct wet (summer) and dry (winter) season is experienced at each of the monitoring locations. Over 39 per cent of average annual rainfall occurs during the three months of summer for each of the stations. The months of winter are the driest at Gatton and Amberley, with rainfall over winter accounting for approximately 14 per cent of annual average rainfall in Gatton (104.8 millimetres (mm)) and 13 per cent in Amberley (113.4 mm). August is, on average, the driest month in Toowoomba, with 39.5 mm.

Of the three stations referenced, Toowoomba receives the highest amount of rainfall annually (952.4 mm), followed by Amberley AMO (864.0 mm) and UQ Gatton (770.2 mm).

**TABLE 12.23: MEAN MONTHLY AND ANNUAL RAINFALL FOR SELECTED MONITORING STATIONS**

| | Mean rainfall (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
| UQ Gatton[a] | 110.1 | 99.4 | 79.3 | 48.6 | 45.4 | 41.7 | 36.4 | 26.7 | 34.8 | 65.0 | 78.5 | 99.2 | 770.2 |
| Amberley AMO[b] | 116.9 | 121.2 | 85.5 | 54.5 | 52.8 | 46.9 | 37.6 | 28.9 | 33.6 | 73.3 | 81.5 | 119.4 | 864.0 |
| Toowoomba[c] | 132.1 | 121.1 | 94.6 | 61.9 | 58.4 | 56.8 | 52.0 | 39.5 | 46.7 | 72.2 | 89.5 | 120.0 | 952.4 |

**Table notes:**

a) Mean rainfall values have been calculated based on 122 years of data (1897 to 2019)

b) Mean rainfall values have been calculated based on 69 years of data (1941 to 2010)

c) Mean rainfall values have been calculated based on 138 years of data (1869 to 2007)

### 12.6.1.2 Wind speed and direction

Long-term annual wind speed and direction data was requested from BoM for the UQ Gatton, Toowoomba, and Amberley AMO stations. Wind roses for each of these stations for the most recent years with available data are presented in Figure 12.3, Figure 12.4 and Figure 12.5. The wind roses show that the predominant wind directions at:

- Amberley AMO over the period 2008 to 2017 is easterly and east-north-easterly (Figure 12.3). The proportion of calm conditions is 5 per cent.
- UQ Gatton is westerly; however, easterly winds are more prevalent during warmer seasons (Figure 12.4). The proportion of calm conditions is 5 per cent.
- Toowoomba are easterly, with very little variation recorded in different seasons (Figure 12.5). The proportion of calm conditions is 0.2 per cent.

Analysis of the annual wind roses for the three stations indicates that wind speed and direction is influenced on the local scale by terrain and land use. Terrain and land use are discussed further in Section 12.6.4.

### 12.6.1.3 Atmospheric stability

Stability is a measure of the convective properties of a parcel of air. Stable conditions occur when convective processes are low, while unstable conditions are associated with stronger convective processes, which are associated with potentially rapid changes in temperature. Stable atmospheres occur when a parcel of air is cooler than the surrounding environment, so the parcel of air (and any pollution within it) sinks. Conversely, unstable atmospheres occur when a parcel of air is warmer than the surrounding environment, making the parcel of air buoyant and, subsequently, leading to the parcel of air rising.

Stability is commonly explained using Pasquill-Gifford A–F stability class designations. Classes A, B and C represent unstable conditions, with class A representing very unstable conditions and C representing slightly unstable conditions. Class D stability corresponds to neutral conditions, which are typical during overcast days and nights. Classes E and F correspond to slightly stable and stable conditions respectively, which occur at night.

Stability class data extracted from the CALMET files for locations representing the BoM UQ Gatton station and the western and eastern portals of the Little Liverpool Range tunnel are presented in Figure 12.6, Figure 12.7 and Figure 12.8. The figures show the prevalence of stable conditions during the night hours and neutral and unstable conditions during the day.

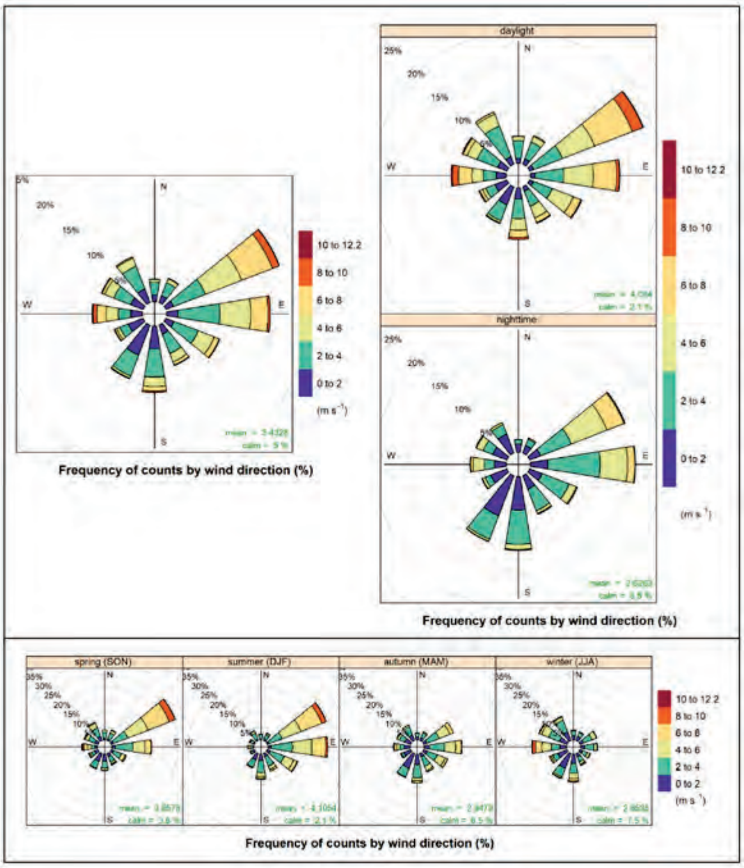



**FIGURE 12.3: BOM AMBERLEY AMO STATION WIND ROSES FOR 2008 TO 2017**
**Figure notes:** all hours (top left); daylight and night-time hours (top right); and seasons (bottom)

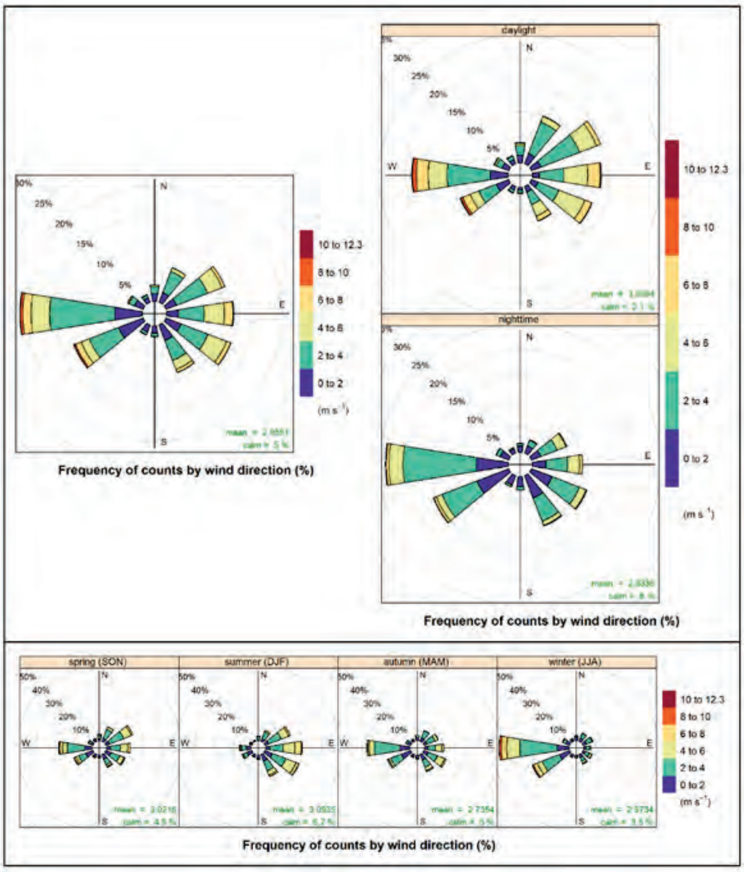



**FIGURE 12.4: BOM UQ GATTON STATION WIND ROSES FOR 2010 TO 2017**
**Figure notes:** all hours (top left); daylight and night-time hours (top right); and seasons (bottom)

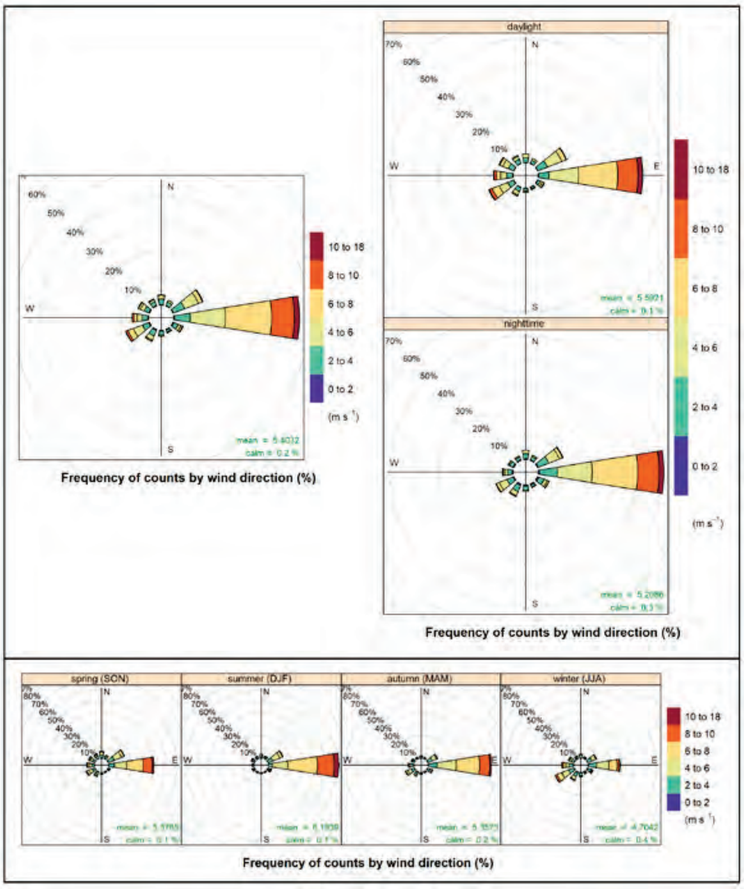



**FIGURE 12.5: BOM TOOWOOMBA STATION WIND ROSES FOR 2010 TO 2017**

**Figure notes:** all hours (top left); daylight and night-time hours (top right); and seasons (bottom)

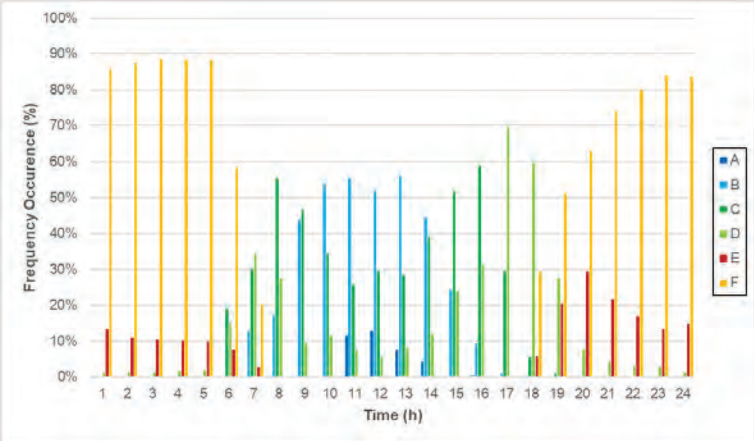



**FIGURE 12.6: HOURLY STABILITY CLASS FREQUENCY FOR BOM UQ GATTON**
**Figure notes:** CALMET-generated

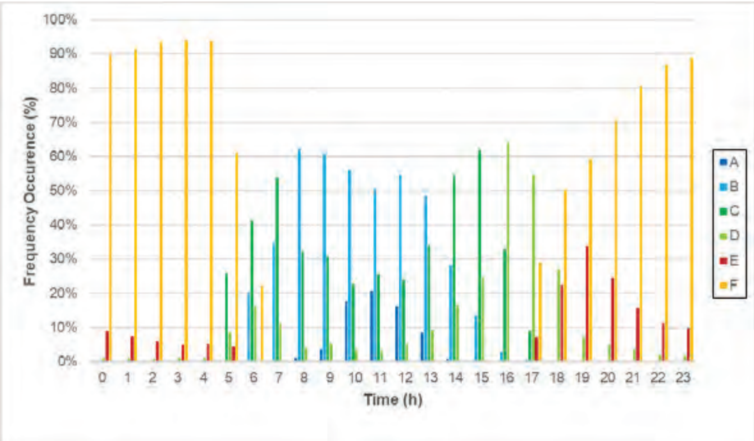



**FIGURE 12.7: HOURLY STABILITY CLASS FREQUENCY FOR LITTLE LIVERPOOL RANGE TUNNEL WESTERN PORTAL**
**Figure notes:** CALMET-generated

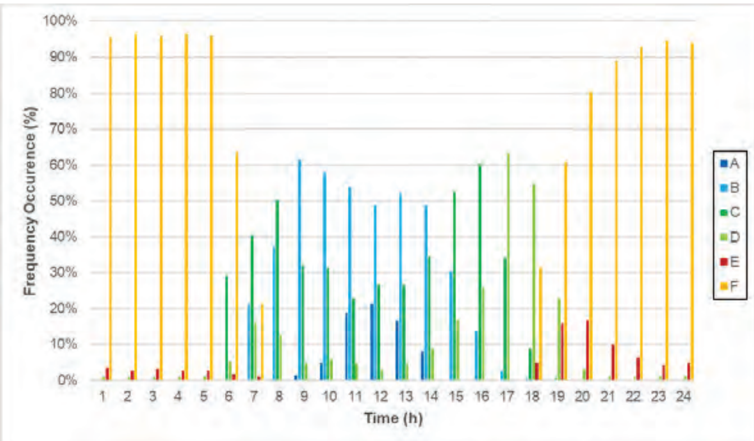



**FIGURE 12.8: HOURLY STABILITY CLASS FREQUENCY FOR LITTLE LIVERPOOL RANGE TUNNEL EASTERN PORTAL**
**Figure notes:** CALMET-generated

### 12.6.1.4 Mixing height

Mixing height is estimated within CALMET for stable and convective conditions with a minimum mixing height of 50 m. Figure 12.9, Figure 12.10 and Figure 12.11 present mixing height statistics by hour of day across the meteorological dataset (2013) as generated by CALMET for the BoM UQ Gatton station and at the western and eastern portals of the Little Liverpool Range tunnel. The mixing heights calculated are consistent with general atmospheric processes and show increased vertical mixing with the progression of the day, as well as lower mixing heights during night time. In addition, peak mixing heights are consistent with typical ranges.

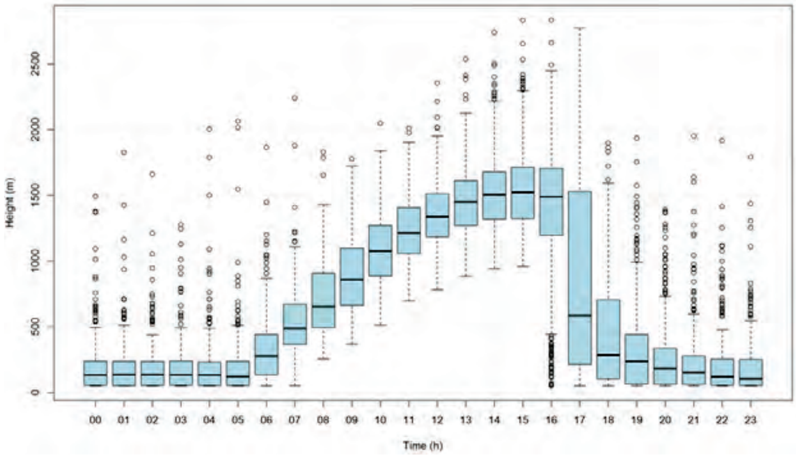



**FIGURE 12.9: MIXING HEIGHT STATISTICS FOR BOM UQ GATTON**
**Figure notes**: CALMET-generated

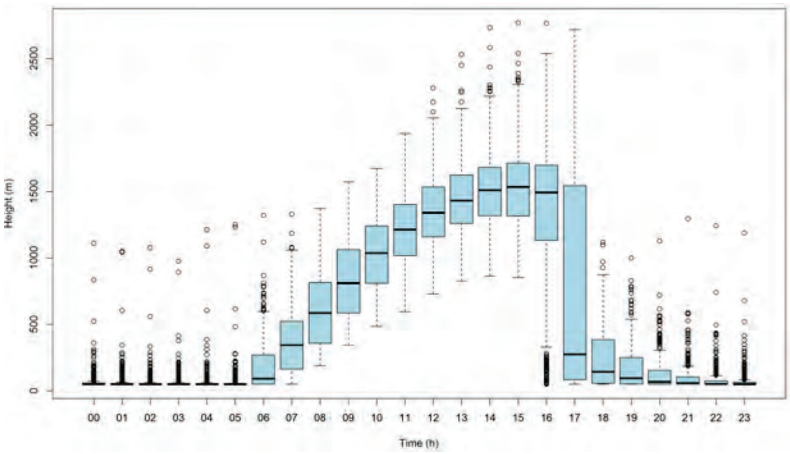



**FIGURE 12.10: MIXING HEIGHT STATISTICS FOR THE WESTERN PORTAL OF LITTLE LIVERPOOL RANGE TUNNEL**
**Figure notes**: CALMET-generated

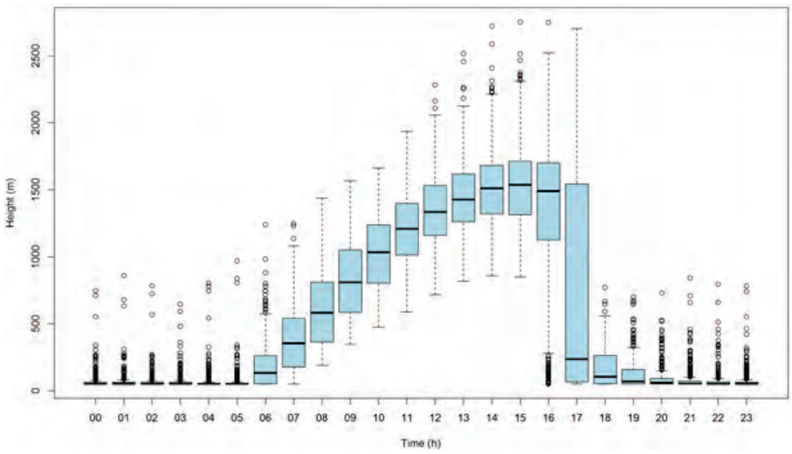



**FIGURE 12.11: MIXING HEIGHT STATISTICS FOR THE EASTERN PORTAL OF LITTLE LIVERPOOL RANGE TUNNEL**

**Figure notes**: CALMET-generated

## 12.6.2 Background air quality

### 12.6.2.1 Sources of available monitoring data

To characterise the existing air quality in the AQIA study area, a review of available air quality monitoring data was conducted considering the following sources:

- Publicly available air quality monitoring data from DES monitoring stations
- Monitoring data available from the Inland Rail air quality monitoring station (AQMS) ($PM_{10}$ and $PM_{2.5}$), located at a residential dwelling located off Draper Road, Charlton (Lot 29, SP294200), west of Gowrie
- Dust deposition monitoring data from monitoring undertaken for Inland Rail in 2016 (AECOM, 2017).

The locations of the monitoring stations are shown in Figure 12.1, with the details for each station presented in Table 12.24.

DES has an ambient monitoring network across Queensland that monitors airborne pollutant concentrations in areas with large population bases or heavy industry adjacent to residential areas. There are no DES monitoring stations in the AQIA study area. However, due to the length of the Project, there are five DES monitoring stations located in the surrounding regional area. These stations are Flinders View, Mutdapilly, North Maclean, Rocklea and Springwood; all of which are situated to the east of Toowoomba. Based on the characteristics of each station, including station type, absence of local emission sources and surrounding land uses, these stations are considered either representative of the AQIA study area or appropriate for the assessment (e.g. a conservative representation of the existing air environment in the AQIA study area) and have been used for the assessment for airborne pollutant concentrations.

Monitoring data from DES stations from 2010 to 2017 has been reviewed. The details of the DES stations considered in the assessment, including the pollutants monitored, are presented in Table 12.24.

**TABLE 12.24: DETAILS OF MONITORING STATIONS CONSIDERED IN THE ASSESSMENT**

| Station name | Operator | Coordinates | Location relative to alignment | Pollutants monitored | Years of data referenced |
|---|---|---|---|---|---|
| Gatton | DES | 27.5434, 152.3343 | 3 km NW | Meteorology only | 2010 to 2017 |
| Flinders View | DES | 27.6528, 152.7741 | 23 km E | $NO_x$, $O_3$, $SO_2$, $PM_{10}$ | 2010 to 2017 |
| Mutdapilly | DES | 27.7528, 152.6509 | 15 km SE | $NO_x$, $O_3$ | 2010 to 2017 |
| North Maclean | DES | 27.7708, 153.0030 | 50 km ESE | $NO_x$, $O_3$ | 2010 to 2017 |
| Rocklea | DES | 27.5358, 152.9934 | 50 km ENE | $NO_x$, $O_3$, $PM_{10}$, $PM_{2.5}$ and visibility-reducing particles | 2010 to 2017 |
| Springwood | DES | 27.6125, 153.1356 | 60 km E | $NO_x$, $O_3$, $SO_2$, $PM_{10}$, $PM_{2.5}$ and air toxics (organic pollutants) | 2010 to 2017 |
| Inland Rail AQMS | ARTC | 27.4948, 151.8479 | 26 km W | $PM_{10}$, $PM_{2.5}$ | 2018 to 2019 |
| Site 2 (Brookstead) | ARTC Dust Deposition Monitoring | 27.7583, 151.4499 | 69.5 SW | Dust deposition | May 2016 to July 2016 |
| Site 3 (Pampas) | | 27.7936, 151.4102 | 74.5 SW | | |
| Site 4 (Mt Tyson) | | 27.5721, 151.5709 | 53 km W | | |
| Site 5 (Aubigny) | | 27.5046, 151.6825 | 42 km W | | |

**Table notes:**
a) East (E), east south-east (ESE), south-west (SW), west (W)

Table 12.24 shows that the pollutant species of interest which are monitored at the DES monitoring stations include $NO_x$, $PM_{10}$, $PM_{2.5}$ and VOCs. When selecting background concentrations, preference was given to the stations closest to the alignment and in a similar environment; however, not all pollutants species of interest are measured at each monitoring station.

The Rocklea and Springwood stations are located a significant distance (35 km) from the alignment but have been considered as they are both neighbourhood-type monitoring stations and provide a suitable indication of the potential background air quality in the AQIA study area. The Springwood monitoring station is the only suitable monitoring station which monitors VOCs, and therefore it has been referenced for the AQIA for these pollutants.

Monitoring of metals (e.g. arsenic, cadmium) is not undertaken at any of the identified DES stations, but is undertaken at stations located in Townsville (Townsville Coast Guard) and Mt Isa (The Gap). However, the monitoring stations are located in these areas due to the presence of heavy industrial activities that emit metals. Therefore, these monitoring stations are not considered representative of background air quality and the monitoring data from these stations has not been referenced.

VOC monitoring at Springwood is undertaken specifically for benzene, toluene, xylene and formaldehyde. Monitoring of PAHs, 1,3-butadiene, dioxins and furans is not undertaken at Springwood or at any other DES monitoring stations in Queensland, and therefore no background air quality data is available for these species. The Project is not expected to emit significant quantities of metals, PAHs, 1,3-butadiene, dioxins and furans and the risk of exceeding the air quality goals for these species is low. Monitoring of these pollutants has not been undertaken.

A three-month deposited dust monitoring program was conducted for the Project in 2016, as part of the *Yelarbon to Gowrie (Y2G) Preliminary Environmental Assessment Report* (AECOM, 2017). The monitoring was conducted at four sites in accordance with AS/NZS 3580.10.1:2003 (Standards Australia, 2003). The highest measured rate of 50 mg/m²/day (measured at Site 3 during May/June 2016) has been adopted as the background concentration for the assessment.

The Inland Rail AQMS is located within the G2H project. The DES air quality monitoring stations described in Table 12.24 are located at a similar distance to the Project as the Inland Rail AQMS and have a larger dataset. The monitoring data from the Inland Rail AQMS has not been used in the assessment against the Project's air quality goals.

### 12.6.2.2 Adopted background air quality

Table 12.25 summarises the existing environment background concentrations adopted for the air quality assessment. Where appropriate, the 70th percentile concentration was selected as the adopted background concentration.

**TABLE 12.25: SUMMARY OF ADOPTED EXISTING POLLUTANT CONCENTRATIONS**

| Pollutant | Averaging time and statistic | Adopted air quality goal (µg/m³) | Adopted background concentration (µg/m³) | Monitoring location |
|---|---|---|---|---|
| Deposited dust | 30-day, maximum | 120 mg/m²/day | 50 mg/m²/day | 4 locations west of Toowoomba (Y2G Preliminary Environmental Assessment) |
| Nitrogen dioxide ($NO_2$) | 1-hour, maximum | 250 | 57.5 | Mutdapilly |
| | Annual average | 62 | 7.8 | |
| TSP | Annual average | 90 | 40.5 | Flinders View |
| $PM_{10}$ | 24-hour, 70th percentile | 50 | 18.7 | |
| | Annual average | 25 | 16.2 | |
| $PM_{2.5}$ | 24-hour, 70th percentile | 25 | 6.4 | Springwood |
| | Annual average | 8 | 5.7 | |
| Benzene | Annual average | 5.4 | 5.2 | |
| Toluene | 1-hour, 70th percentile | 1,100 | 23.0 | |
| | 24-hour, 70th percentile | 4,100 | 21.7 | |
| | Annual average | 400 | 18.5 | |
| Xylenes | 24-hour, 70th percentile | 1,200 | 31.5 | |
| | Annual average | 950 | 26.0 | |

### 12.6.2.3 Assimilative capacity of the receiving environment

The assimilative capacity of the receiving air environment can be quantified through the difference between the adopted background concentrations and the air quality goals. For most pollutants and averaging times, the background concentrations represent less than half of the criteria, indicating a moderate assimilative capacity of the receiving environment. Pollutants that show lower levels of assimilative capacity include the following:

- $PM_{10}$ 16.2 µg/m$^3$ annual average, representing 65 per cent of the 25 µg/m$^3$ annual goal
- $PM_{2.5}$ 5.7 µg/m$^3$ annual average, representing 71 per cent of the 8 µg/m$^3$ annual goal
- Benzene 5.2 µg/m$^3$ annual average, representing 96 per cent of the 5.4 µg/m$^3$ annual goal.

### 12.6.2.4 Data validation

The DES datasets are sourced as validated datasets; however, the data does contain gaps that are either missing monitoring data or subsequently invalidated by DES. The referenced data sets are representative of actual pollutant concentrations in the air at the time of monitoring. The datasets consist of hourly averages that have been summarised and analysed for the required averaging periods. Where there was less than 75 per cent available valid data for an averaging period, then that averaging period was not calculated. Annual averages were considered valid when at least three of the year's quarterly periods had a data availability threshold of at least 75 per cent, as per guidance from the NEPC *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5: Data Collection and Handling* (NEPC, 2001).

### 12.6.2.5 Influence of climate change on background air quality

Changing climatic conditions can influence ambient air quality via increased frequency of atypical events such as bushfires and dust storms. However, confidently predicting the influence of climate change on the duration, frequency and magnitude of extreme air quality events is challenging. It is also highlighted that in comparative terms, emissions from the operation of the Project are not significant in comparison to major regional air quality events such as bushfires and dust storms. Due to the uncertainty present in assessing the influence of changing climatic conditions on the background air quality, climate change has not been considered beyond the bushfires and dust storms that are already present in the adopted background datasets.

## 12.6.3 Existing emission sources

The NPI regulated by the Australian Government is responsible for tracking pollution across Australia and ensuring that the community has access to information about the emission and transfer of toxic substances. Facilities that exceed NPI reporting thresholds are required by the Australian Government to submit annual reports of their emissions to air. The NPI has emission estimates for 93 toxic substances, along with details of the source and location of these emissions. These substances have been identified as being important due to their possible effect on human health and the environment.

An NPI search conducted within the assessment domain shows three nearby facilities (within 4.0 km) that are required to report emissions annually:

- Valley Beef, Grantham
- Gatton Wastewater Treatment Plant
- Laidley Wastewater Treatment Plant.

Other facilities listed on the NPI have not been considered due to their distance from the AQIA study area.

A description of each existing emission source is identified and its approximate distance and location from the alignment is described in Table 12.26.

**TABLE 12.26: NEAREST NATIONAL POLLUTANT INVENTORY LISTED FACILITIES IN THE ASSESSMENT DOMAIN**

| Facility name | Industry | Pollutants emitted | Distance and location relative to alignment (km) |
|---|---|---|---|
| Valley Beef, Grantham | Meat and meat production manufacturing | $NH_3$ (21,000 kg/yr), CO (1,700 kg/yr), $NO_x$ (9,400 kg/yr), $PM_{10}$ (4,600 kg/yr), $PM_{2.5}$ (440 kg/yr), $SO_2$ (51 kg/yr), total VOCs (410 kg/yr) and trace metals (<1 kg/yr) | 4.0 south |
| Gatton Wastewater Treatment Plant | Wastewater treatment plant | $NH_3$ (110 kg/yr) and Cl (100 kg/yr) | 1.2 north-east |
| Laidley Wastewater Treatment Plant | Wastewater treatment plant | $NH_3$ (6,500 kg/yr) and Cl (2,300 kg/yr) | 1.0 north-east |

The Gatton and Laidley wastewater treatment plants are located within 1.2 km of the alignment and primarily emit ammonia ($NH_3$) and chlorine (Cl) as listed in their NPI reports. These pollutants are not emitted by Project sources and therefore are not required to be considered further.

The Valley Beef meat and meat production facility is located 4 km south of the alignment in Grantham and emits some common pollutants to those anticipated to be emitted by the Project. Queensland does not have State-specific guidance on recommended separation distances to industrial uses, however, the Victorian EPA (2013) does prescribe guideline separation distances that are commonly applied in Queensland. The recommended separation distance for abattoirs that process greater than 200 tonnes per year is 1 km. The Valley Beef meat and meat production facility is located 3 km further than the recommended separation distance. Emissions from the facility will be adequately represented by the assumed background concentrations and do not require site-specific modelling.

In addition to the NPI sources listed in Table 12.26, other local emission sources will include environmentally relevant activities (ERAs) and vehicle traffic. It is expected that emissions from local ERAs and vehicle traffic will be adequately represented by the assumed background concentrations, as sites with ERAs emit lower quantities of pollutants than the major polluters that report to the NPI.

The Project alignment is located adjacent to the existing West Moreton System rail corridor for approximately 24 km. Emissions from trains operating on the existing West Moreton System rail corridor will currently be influencing the background air quality in the AQIA study area. However, emissions from existing train travel along the West Moreton System rail corridor have not been included in the assumed background concentrations as it has been assumed for the operational modelling scenarios that all trains, including those existing services which currently use the QR alignment, will travel along the Project alignment.

### 12.6.4 Terrain and land use

Terrain features and land use can influence meteorological conditions on both a local and regional scale. The terrain along the Project alignment running west to east begins at an elevation of 150 m at Helidon at the base of the range and gradually increases as it crosses through the Little Liverpool Range. Approximately 3 km east of Laidley, elevation increases to 250 m at the point where the proposed tunnel will be constructed. After the tunnel, elevation slowly drops as the alignment moves east finishing at Calvert.

The land use in the AQIA study area is predominately grazing land, combined with other agricultural uses including irrigated seasonal horticulture and cropping. Other land uses include residential, other minimal use and services. Several small townships exist within 5 km of the Project alignment, these include Helidon, Grantham, Placid Hills, Gatton, Forest Hill, Laidley, Grandchester, and Calvert.

The influence of terrain on wind flows and dispersion has been considered in the meteorological modelling undertaken for the assessment as discussed in Section 12.5.4.3. The effect of land use on surface roughness and dispersion has also been included in the meteorological model developed for the AQIA study area. The height of the train emission source included in the model was based on the proposed Project vertical alignment.

### 12.6.6 Sensitive receptors

Sensitive air quality receptors within the AQIA study area were identified as per the DES guideline *Application requirements for activities with impacts to air* (DES, 2019a). As per the DES guideline, a sensitive receptor can include:

- Dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises
- Motel, hotel or hostel
- Kindergarten, school, university or other educational institution
- Medical centre or hospital
- Protected area under the *Nature Conservation Act 1992* (Qld), the *Marine Parks Act 2004* (Qld) or a world heritage area
- Public park or garden
- Place used as a workplace including an office for business or commercial purposes.

The Project is situated within a rural setting, and the majority of the alignment is located at a significant distance from major population centres. The alignment does travel through the township of Gatton and Forest Hill, and near the townships of Helidon, Laidley, Grandchester and Calvert. Residential dwellings near the alignment and in these townships have been included in the AQIA.

There are no World Heritage Areas or areas protected by the *Marine Parks Act 2004* (Qld) located within the AQIA study area. There is one area protected under the *Nature Conservation Act 1992* (Qld) located within the AQIA study area, being the Lockyer Resources Reserve located approximately 1.9 km from the alignment at its nearest point. Resource reserves are permitted to be used for controlled levels of resource extraction such as mining and quarrying (DES, 2016c) and therefore this protected area is not expected to be sensitive to air quality and has not been considered in the assessment.

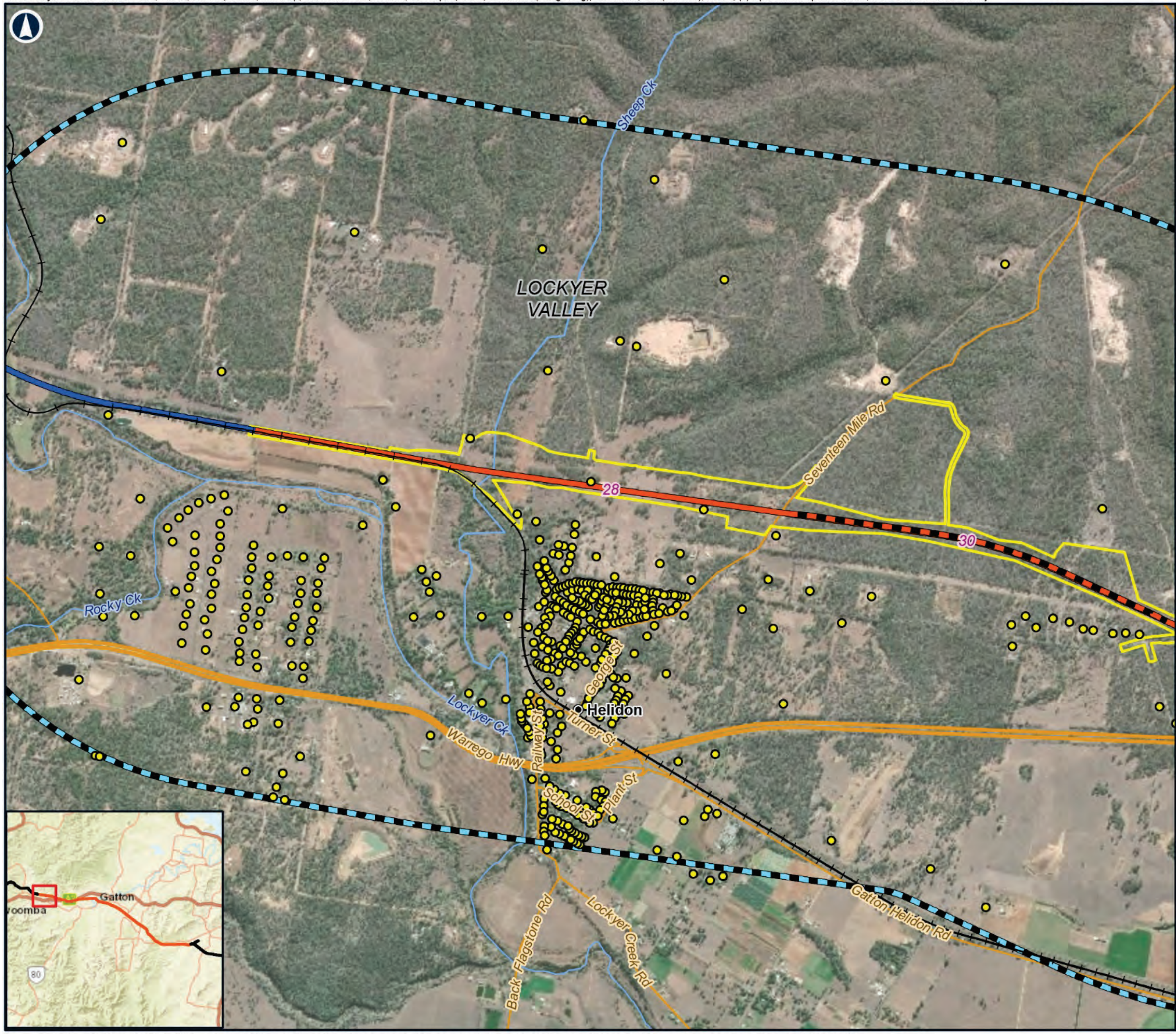
The primary sensitive receptor types in the AQIA study area are residential dwellings. As per the ToR, surfaces that lead to potable water tanks in the vicinity of the Project are also considered sensitive receptors and have been considered in the assessment.

There are no pollutant species in this AQIA that strictly require assessment of impacts to agricultural uses based on the air quality goals specified in the EEP Air 2019. However, impacts to agricultural uses within the AQIA study area as a result of dust deposition have been considered—with the predicted maximum dust deposition level for all modelled receptors in the AQIA study area (operational phase) assessed against the dust deposition levels at which crop growth and livestock impact may occur (refer Section 12.4.3.

Figure 12.12 (a–i) shows the location of identified sensitive receptors adopted for the AQIA. The number of identified sensitive receptors in the AQIA study area is 5,903.

Discrete receptors point have been included for sensitive receptors and have been modelled at ground level (0 m above ground). In addition to the discrete receptors, grids of receptors have been included in the modelling (at a height of 0 m above ground) to facilitate the generation of contour plots.

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.12a: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

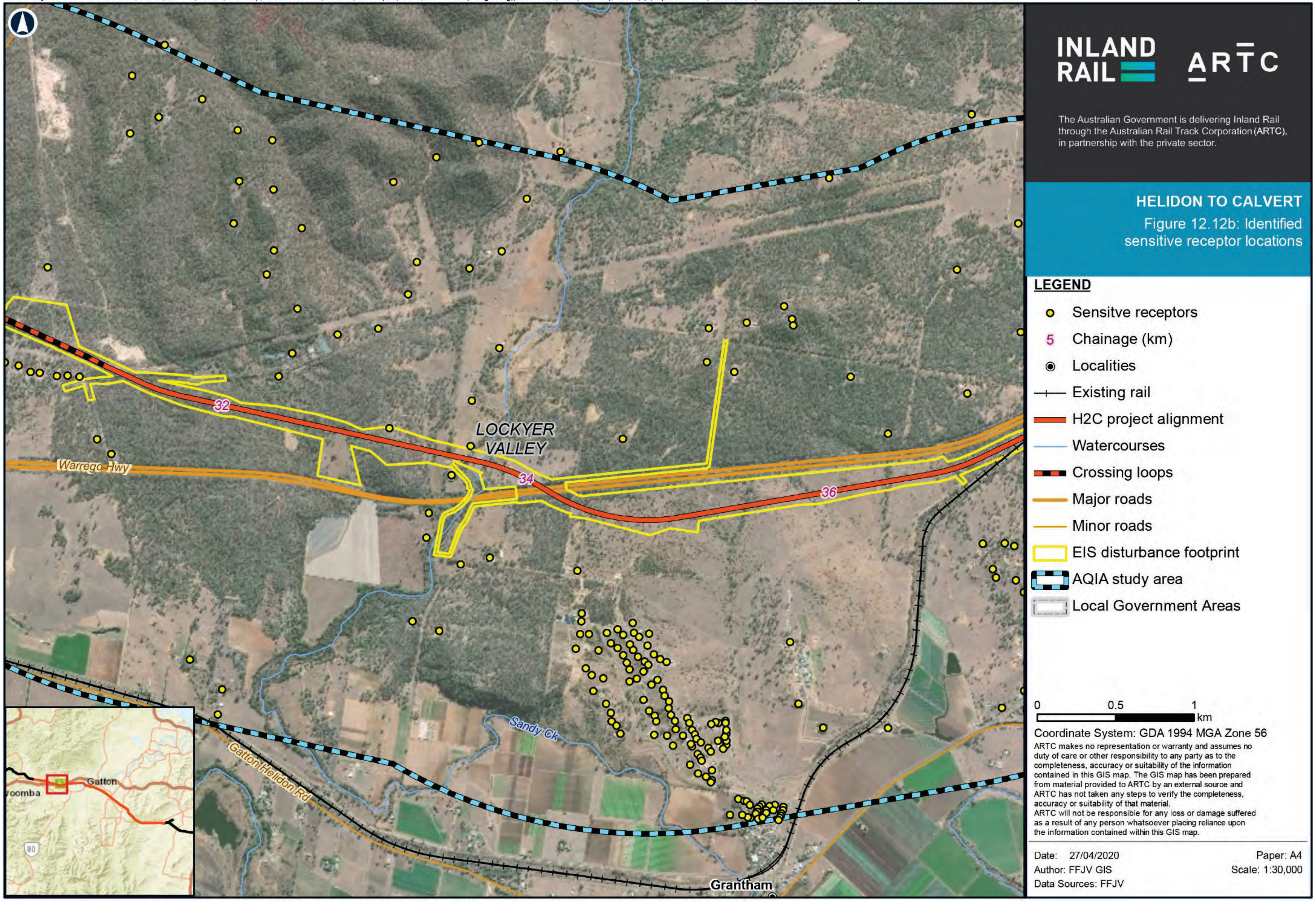
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

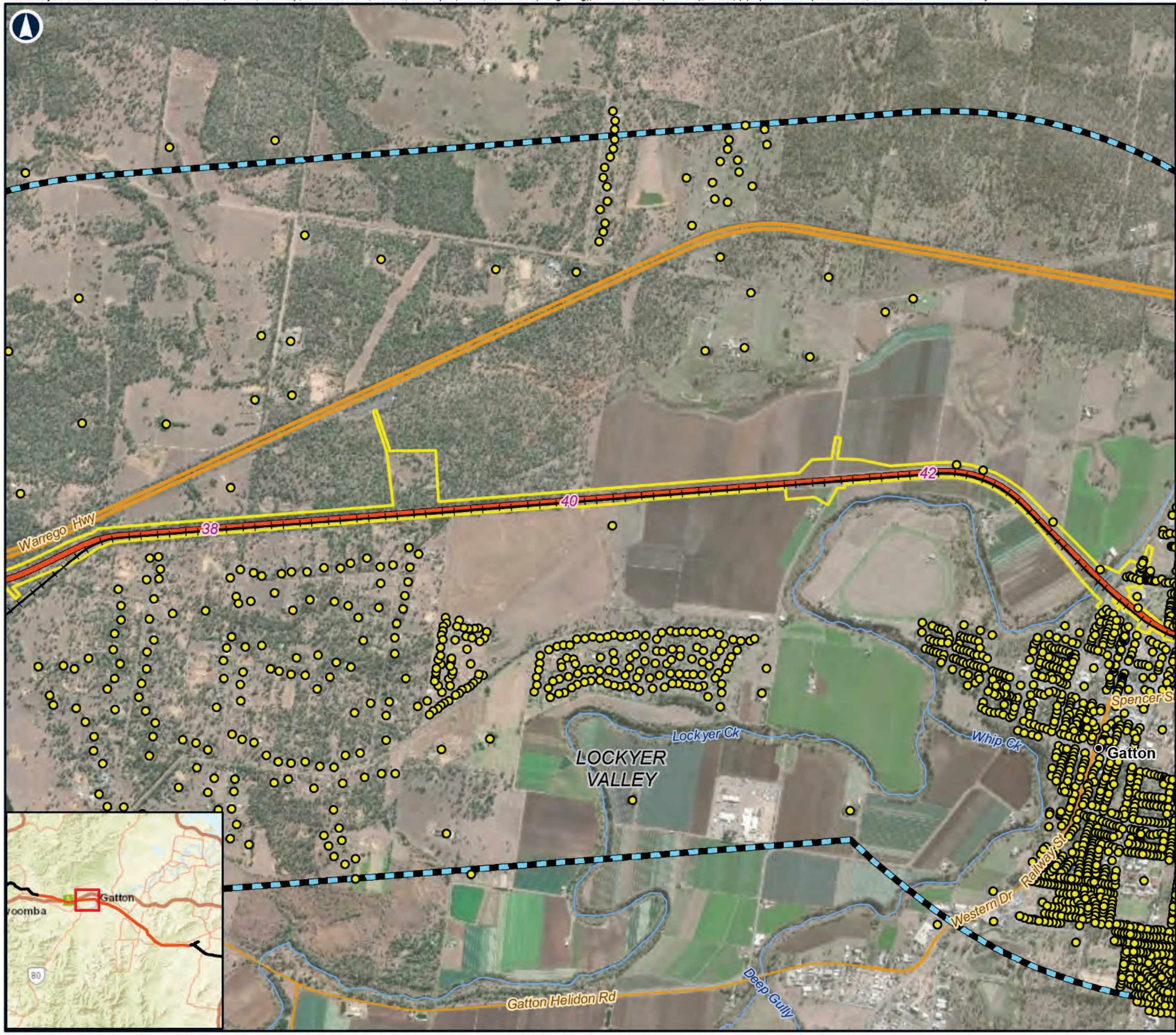
Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.12c: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

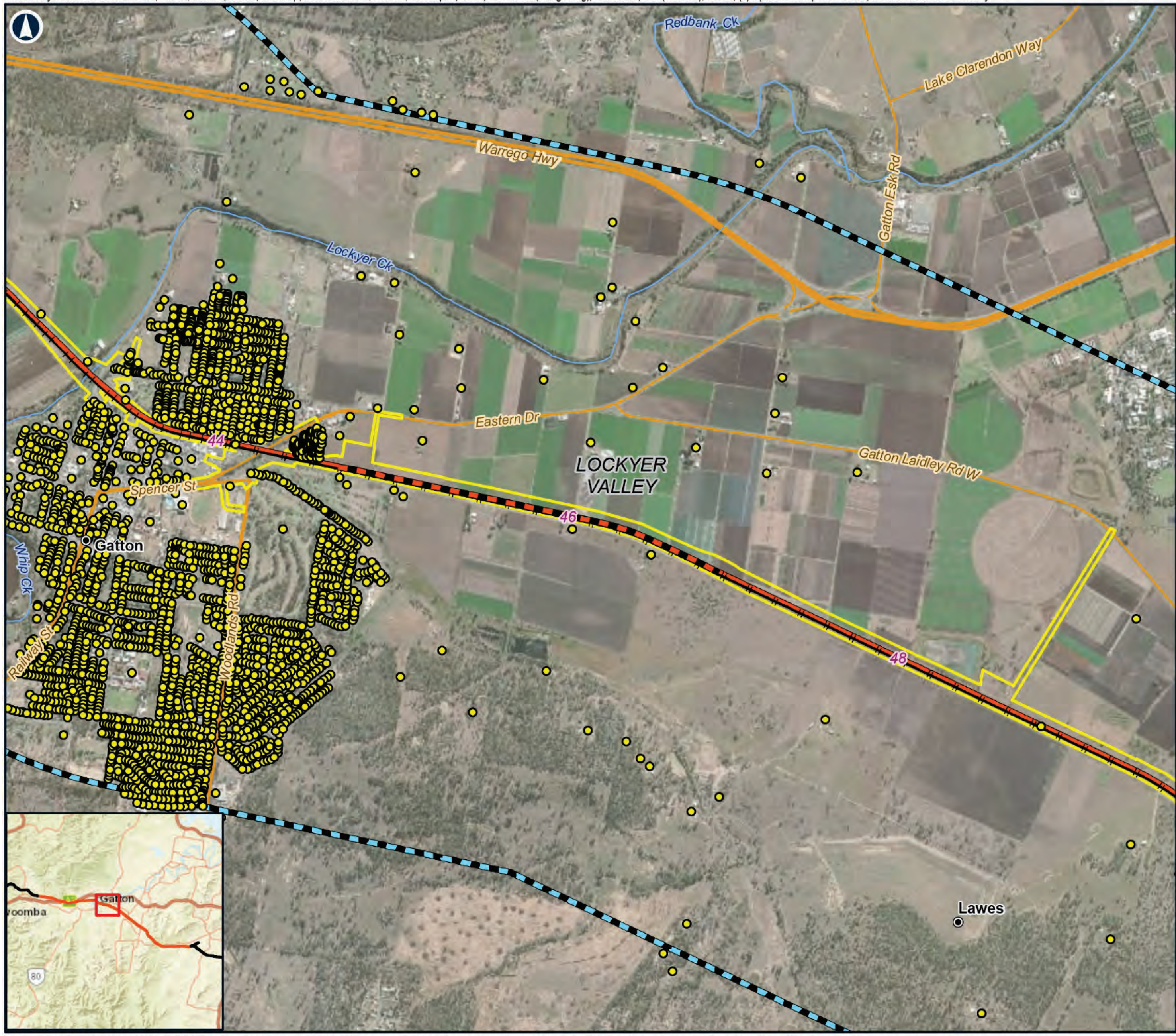
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.12d: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

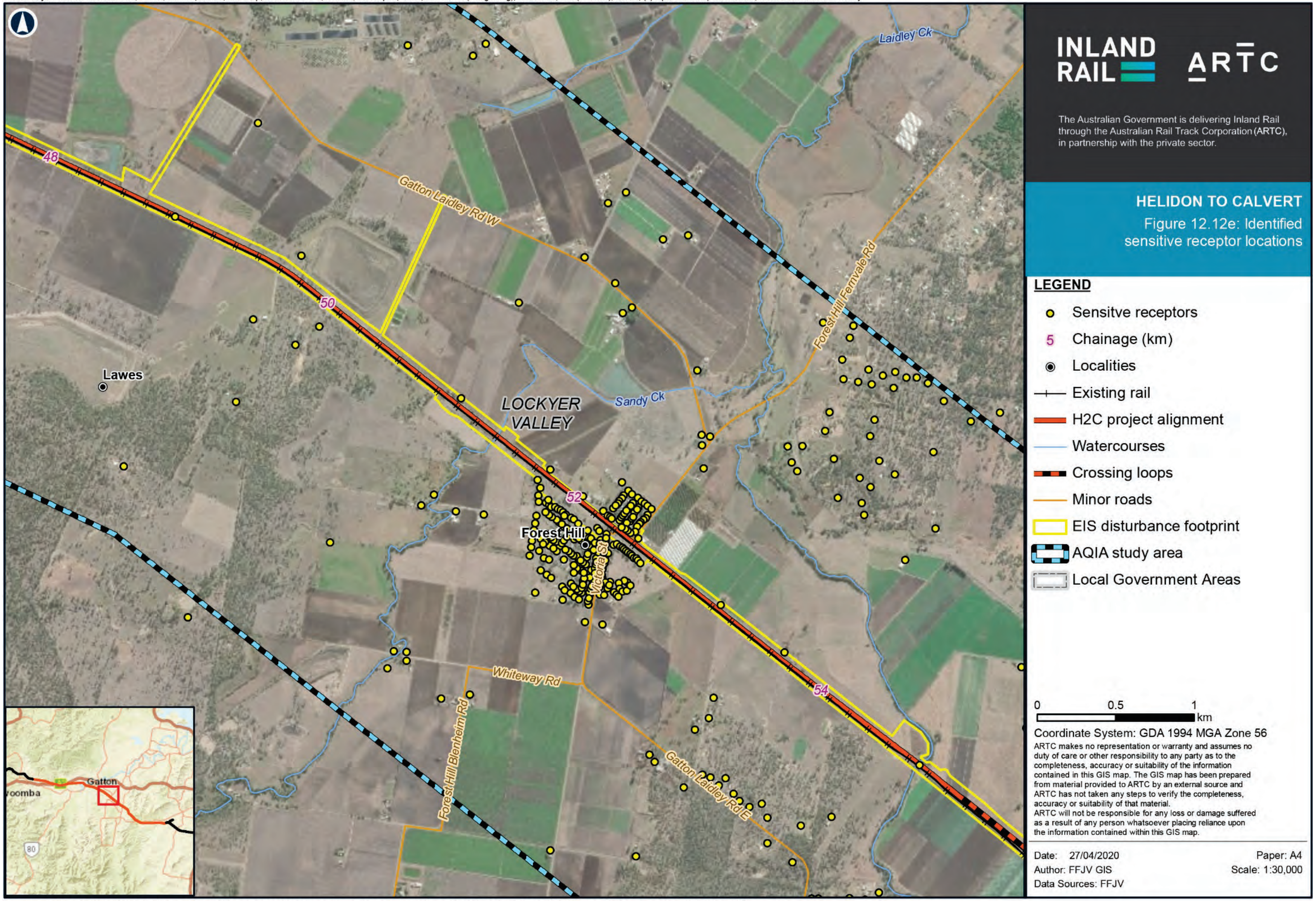
ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:30,000

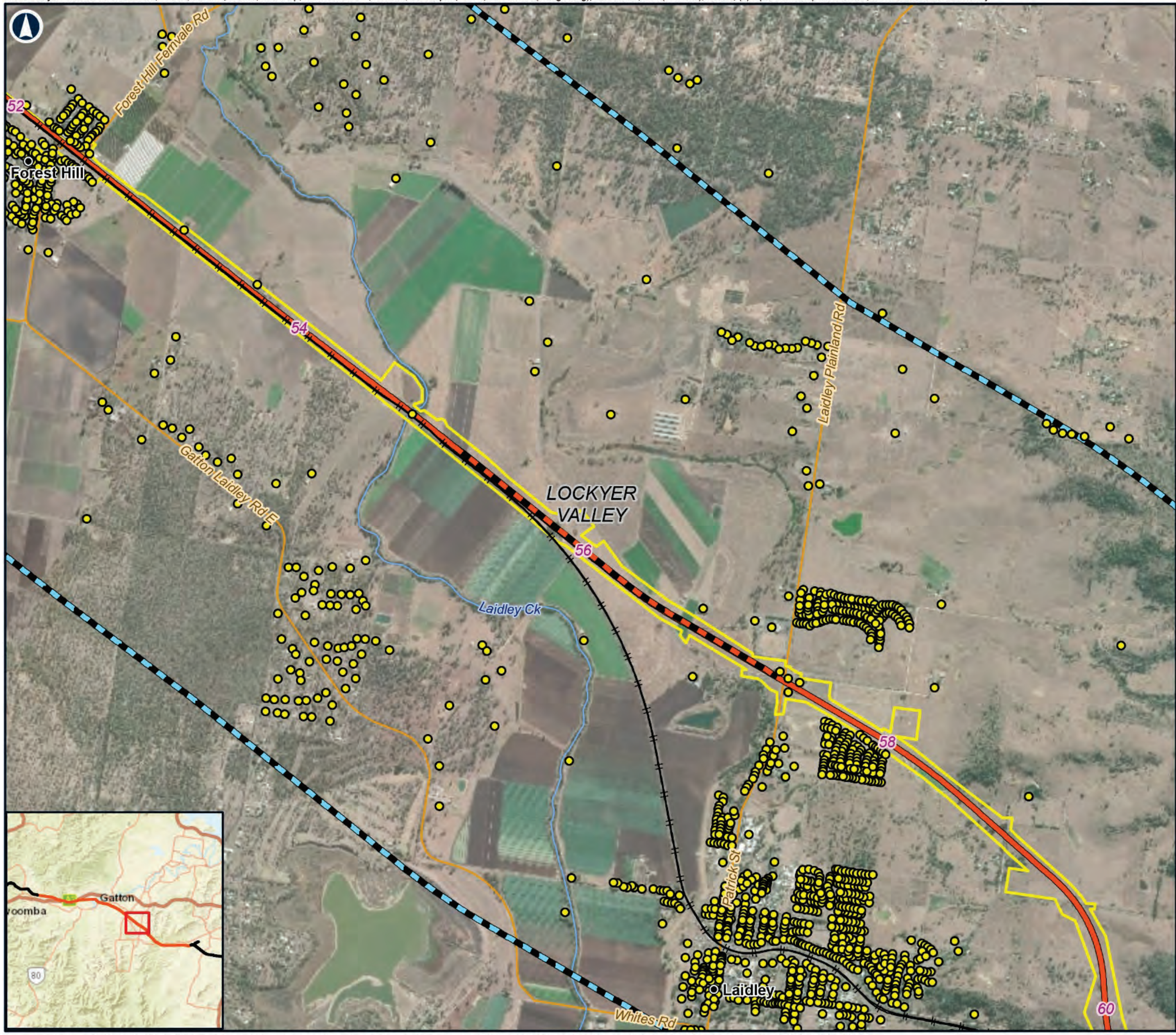
Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.12f: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

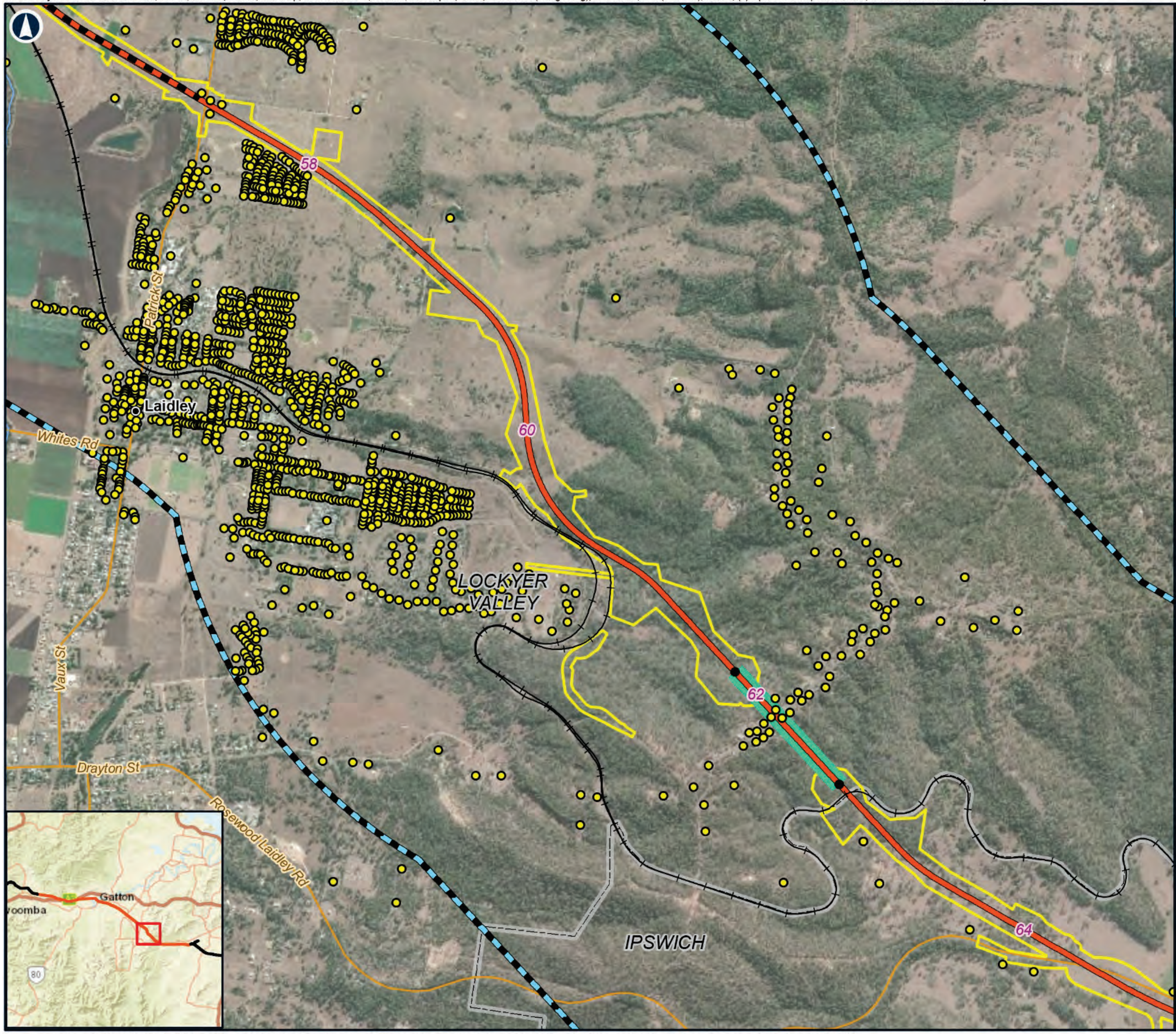
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020 | Paper: A4
Author: FFJV GIS | Scale: 1:30,000
Data Sources: FFJV

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.12g: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- 5 Chainage (km)
- Localities
- Tunnel portals
- Existing rail
- Tunnel
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

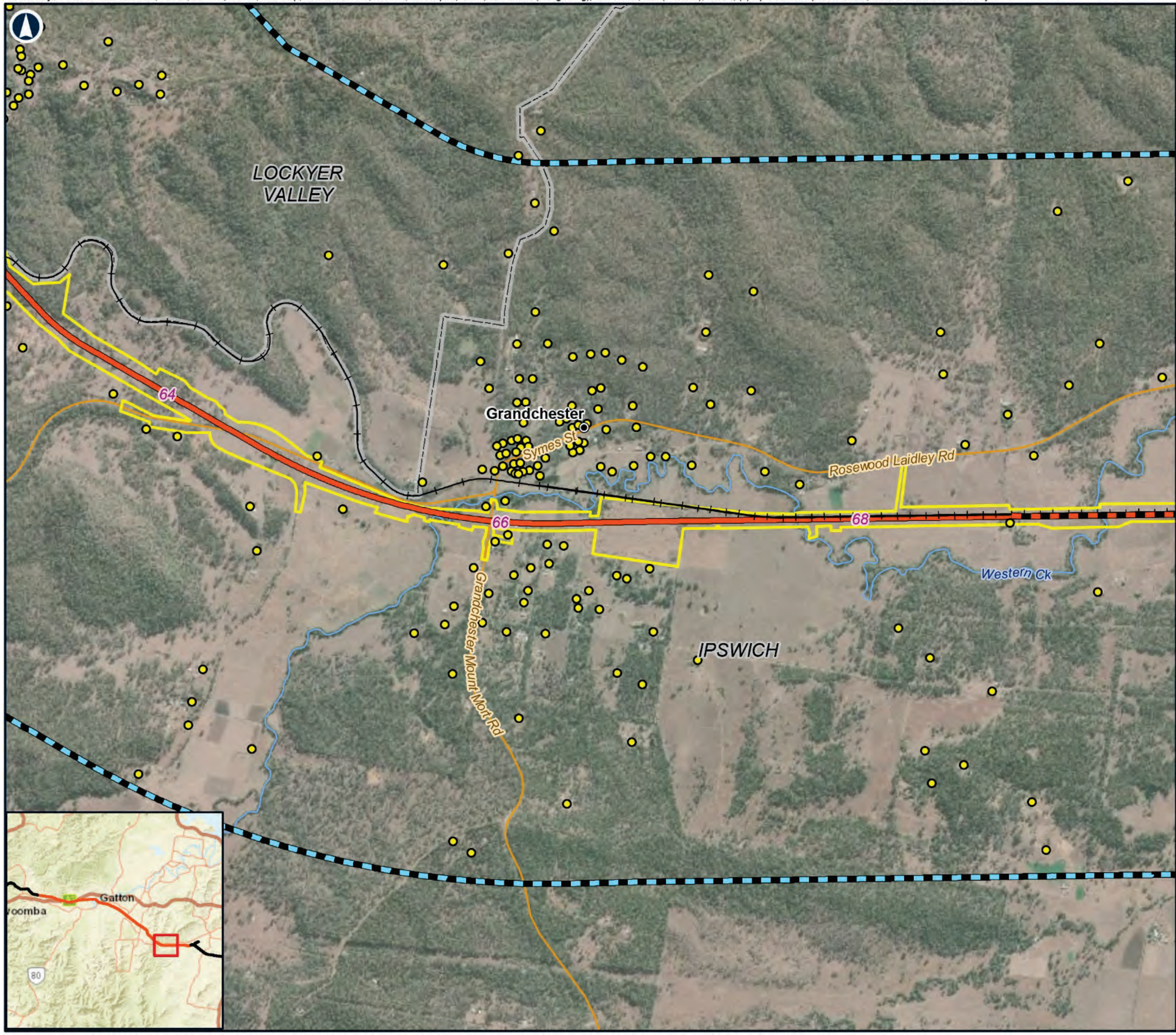
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.12h: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

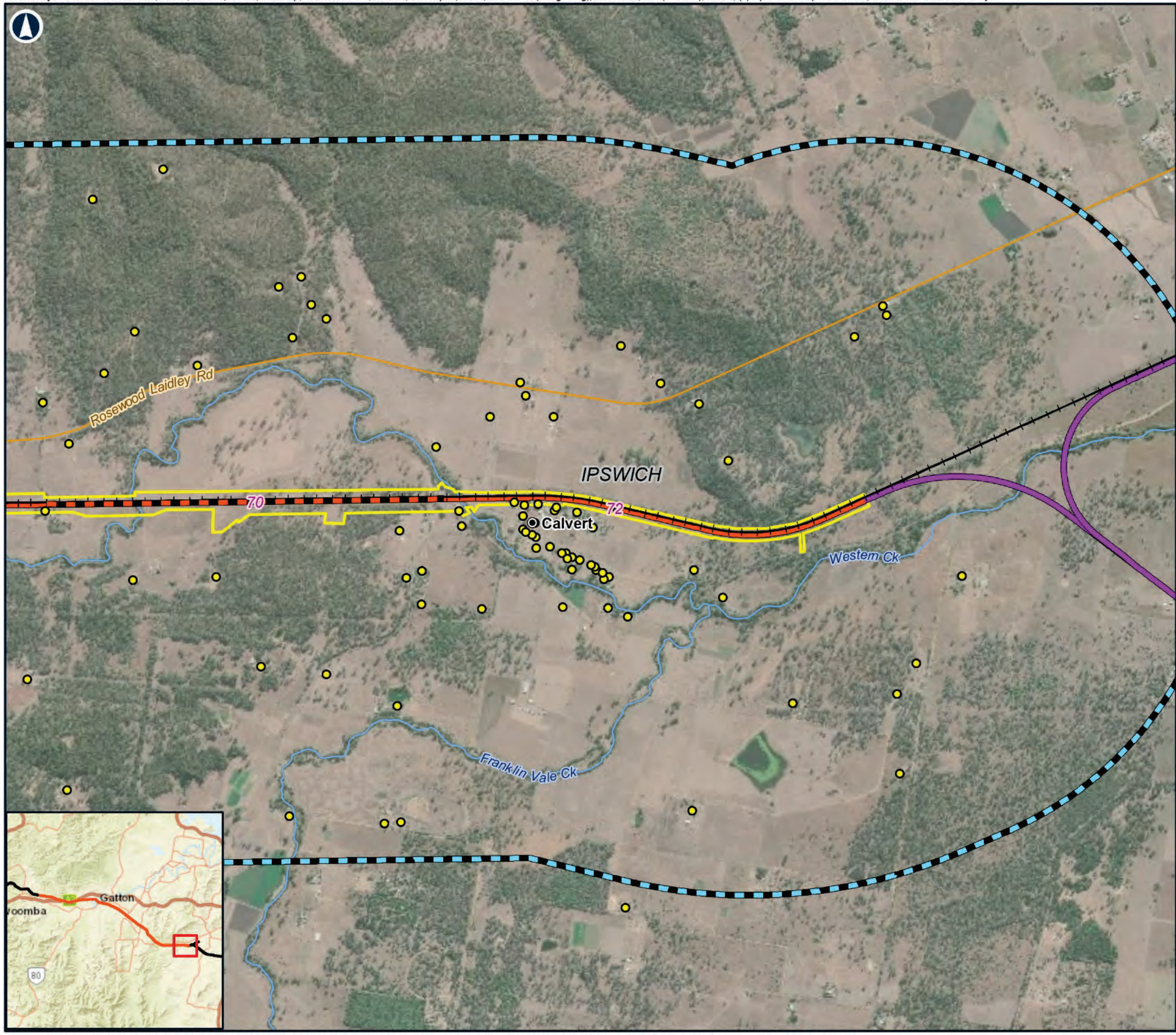
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.12i: Identified sensitive receptor locations

**LEGEND**

- Sensitve receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Crossing loops
- Minor roads
- EIS disturbance footprint
- AQIA study area
- Local Government Areas

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 27/04/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

Map by: LUC/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.12_Sesitive_receptors_v6.mxd Date: 27/04/2020 17:09

## 12.7 Potential air quality impacts

The following sections summarise the potential air quality impacts that may arise at each phase of the Project.

### 12.7.1 Construction

The highest proportion of construction emissions are generated by mechanical activity, e.g. material movement or mobile equipment activity, which typically generate coarser particulate emissions ($PM_{10}$ and TSP). Airborne $PM_{10}$ and deposited dust are the main pollutants of concern for construction activities and these pollutant species are the focus of the assessment for construction dust. Airborne $PM_{10}$ has the potential to impact human health due to inhalation of particulate matter, while deposited dust has the potential to cause nuisance impacts but does not directly impact human health.

Particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$) is typically emitted in minor quantities from mechanical sources and is more predominant from combustion point sources (i.e. combustion engines). Point source emissions of combustion gases (e.g. $NO_x$ and CO) and $PM_{2.5}$ from diesel construction vehicles and mobile plant will be significantly lower than particulate emissions from construction activities. Emissions of combustion gases and $PM_{2.5}$ are unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors and have not been assessed for the construction phase.

In addition to construction dust, odour and VOCs will be emitted as fugitive emissions from fuel tanks located at laydown areas. Impacts from fuel storage have been assessed in Section 12.7.1.2.

No other significant pollutant emissions (excluding dust, odour and VOCs) are anticipated from the construction phase of the Project.

#### 12.7.1.1 Construction dust

A qualitative impact assessment of the construction of the Project was completed using the UK IAQM *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The IAQM guidance provides a method for the assessment of airborne $PM_{10}$ and deposited dust, which are the main pollutants of concern from construction. The outcomes of the assessment of construction dust impacts are presented in this section.

**Step 1—Screening assessment**

The IAQM method recommends further assessment of dust impacts for construction activities where sensitive receptors are located closer than:

- 350 m from the boundary of the site
- 50 m from the route used by construction vehicles on public roads (more than 500 m from the site entrance).

The number of identified sensitive receptors in the AQIA study area is 5,903. Their respective distances from the Project alignment are shown in Table 12.27.

The sensitivity of the AQIA study area to construction dust impacts is determined considering the number of sensitive receptors and the separation distance to active construction areas. For the purpose of the construction assessment, the separation distance categories (as presented in Table 12.27) have been determined across the entire length of the alignment, as opposed to breaking construction areas into smaller segments. In reality, construction air quality impacts will be localised to specific construction areas (e.g. laydown areas) and areas with a higher density of sensitive receptors (e.g. townships) will be more sensitive than sparsely populated rural areas.

**TABLE 12.27: SUMMARY OF SENSITIVE RECEPTORS**

| Separation distance (m) | Number of receptors | | |
|---|---|---|---|
| | Access tracks | Laydown areas | Temporary construction disturbance footprint[1] |
| 0 | 0 | 2 | 41 |
| <20 | 6 | 2 (1)[2] | 118 (41)[2] |
| 21 to 50 | 29 | 11 | 122 |
| 51 to 100 | 47 | 36 | 201 |
| 101 to 350 | 405 | 665 | 890 |
| >350 | 5,416 | 5,188 | 4,531 |
| **Total** | | | **5,903** |

**Table notes:**
1. Permanent and temporary disturbance areas
2. It is assumed that the receptors that fall within the disturbance footprint, including those that fall within the laydown areas will be acquired/relocated at the time of construction and thus no longer be sensitive receptors

Based on the location of sensitive receptors, further assessment of potential construction dust impacts is required.

**Step 2—Dust risk assessment**

Step 2 in the IAQM is a risk assessment tool designed to appraise the potential for dust impacts due to unmitigated construction dust emissions. The key components of the risk assessment are defining the dust emission magnitudes (Step 2A), the surrounding area sensitivity (Step 2B), and then combining these in a risk matrix (Step 2C) to determine an overall risk of potential dust impacts.

**Step 2A—Dust emission magnitude**

Dust emission magnitudes are estimated according to the scale of works being undertaken and other considerations such as meteorology, types of material being used, or general demolition methodology. The IAQM guidance provides examples to aid classification, as presented in the following excerpt from IAQM:

> *The dust emission magnitude is based on the scale of the anticipated works and should be classified as Small, Medium, or Large. The following are examples of how the potential dust emission magnitude for different activities can be defined. Note that, in each case, not all the criteria need to be met, and that other criteria may be used if justified in the assessment.*

**Demolition**: *Any activity involved with the removal of an existing structure (or structures). This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time.* Example definitions for demolition are:

- Large: Total building volume >50,000 m², potentially dusty construction material (e.g. concrete), onsite crushing and screening, demolition activities >20 m above ground level
- Medium: Total building volume 20,000 m² to 50,000m², potentially dusty construction material, demolition activities 10 to 20 m above ground level
- Small: Total building volume <20,000 m², construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months.

**Earthworks**: Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. This may also involve levelling the site and landscaping. Example definitions for earthworks are:

- Large: Total site area >10,000 m², potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 t
- Medium: Total site area 2,500 m² to 10,000 m², moderately dusty soil type (e.g. silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t
- Small: Total site area <2,000 m² — soil type with large grain size, e.g. sand, <5 heavy earth moving vehicles at one time, formation of bunds <4 m in height, total material moved <20,000 t, earthworks during wetter months.

**Construction**: The key issues when determining the potential dust emission magnitude during the construction phase include the size of the building(s)/infrastructure, method of construction, construction materials, and duration of build. Example definitions for construction are:

- Large: Total building volume >100,000 m², onsite concrete batching, sandblasting
- Medium: Total building volume 25,000 m² to 100,000 m², potentially dusty construction material (e.g. concrete), onsite concrete batching
- Small: Total building volume <25,000 m², construction material with low potential for dust release (e.g. metal cladding or timber).

**Trackout**: Factors that determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology and duration. As with all other potential sources, professional judgement must be applied when classifying trackout into one of the dust emission magnitude categories. Example definitions for trackout are:

- Large: >50 truck (>3.5 t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length 50 m to 100 m
- Medium: 10 to 50 truck (>3.5 t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m to 100 m.
- Small: <10 truck (>3.5 t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

Potential dust emission magnitudes for the Project were estimated based on the IAQM examples listed above. Justification and the factors used in determining the magnitudes are presented in Table 12.28.

**TABLE 12.28: CONSTRUCTION ACTIVITIES AND DUST EMISSION MAGNITUDE JUSTIFICATION**

| Activity | Potential dust emission magnitude | Justification |
|---|---|---|
| Demolition | Small | ▸ Demolition of small-scale bridge and culvert structures by excavator consisting of concrete and steel<br>▸ Total volume presently unknown although assumed to be <20,000 $m^3$ due to small scale of structures |
| Earthworks | Large | ▸ Multiple work fronts at any one time along the alignment<br>▸ Vegetation clearing for new access tracks and laydown areas will occur where necessary. Clearing is staged to limit size of disturbance area at any one time<br>▸ Topsoil along entire alignment (47 km long) will be stripped (approximate depth of 0.3 m) and stockpiled. Wherever possible, appropriate material will be reused along the Project alignment<br>▸ 32 laydown areas along the alignment, primarily to act as locations for excavation stockpiling. Stockpiles to be located as close as possible to the excavation source<br>▸ Cut volumes of up to 3,600,000 $m^3$ and excavated material re-used as fill of up to 2,300,000 $m^3$. The total length of cut is in the order of 7.6 km (thirteen cuts)<br>▸ Utility relocations—involving up to 662 utility clashes. More information to be provided in the detailed design phase<br>▸ Earthworks material likely to be dusty especially during dry season. Soil types within the disturbance footprint will be confirmed |
| Construction | Large | ▸ Construction period of approximately four years, with multiple work fronts at any one time along the alignment<br>▸ Installation of approximately 47 km of railway using steel rail, sleepers, ballast and concrete. Concrete and ballast present higher dust risk<br>▸ Construction of railway tunnel approximately 850 m in length. Tunnel construction will be undertaken via either roadheader excavation or drilling and blasting<br>▸ Construction of 31 new bridge structures—steel material low dust risk but concrete high dust risk<br>▸ Four temporary site offices and parking facilities<br>▸ Potential for batching plants and material handling facility—high dust risk materials. Assessment of these has been undertaken at two indicative locations along the alignment (laydown areas ID H2C-LDN035.4 (Warrego Highway at Ch 35.4 km) and ID H2C-LDN061.2 (Tunnel Portal West at Ch 61.2 km)) so that potential risks can be identified. Specific locations and details of batching plants and ballast handling facilities will be determined by the construction contractor during the detailed design phase. Construction of seven fuel storage facilities with capacities between 20,000 to 40,000 L<br>▸ Laydown areas to also include temporary parking facilities for construction workers<br>▸ Construction of temporary rail handling facility<br>▸ Construction of temporary and permanent fencing—total lengths to be determined during detailed design phase |
| Trackout | Large | ▸ Multiple work fronts at any one time along alignment<br>▸ High amount of daily vehicle movements expected per work site (both light and heavy vehicles)<br>▸ Movement of ballast via heavy vehicle haulage trucks<br>▸ After construction, access tracks are expected to be reinstated or only used for maintenance activities<br>▸ Total length of unpaved road/access tracks unknown until design is finalised but will be >100 m due to the size of the Project |

Emissions of TSP and $PM_{10}$ from construction have been estimated for loading of spoil, unloading of spoil and spoil haulage to provide an indication of the quantity of emissions from these sources. Emissions have been estimated using the emission factors presented in the *NPI Emissions Estimation Technique Manual for Mining* (NPI, 2012), which are also referenced by the *DTMR Road Traffic Air Quality Management Manual* (DTMR, 2014). Although the emission formulas in this NPI manual are prescribed for mining, they are appropriate to estimate emissions from loading, unloading and haulage due to the similarity of these activities between mining and construction.

Construction dust will be generated by numerous activities (as described in Table 12.28) and will not be limited to loading, unloading and haulage. However, these activities have been considered to provide an indication of potential emissions as they will occur along the alignment.

Emissions have been estimated assuming that the majority of earthworks for the Project are undertaken over a period of two years, and that the volume of cut-and-fill required to be loaded and unloaded is 5,900,000 m3 (as per Table 12.28). Assuming a spoil density of 2,000 kg/m3, this equates to up to 12,000,000 t of spoil that may require handling. The estimated indicative construction dust emissions are summarised as follows:

- Dust from loading spoil has been estimated to generate emissions at a rate of 0.16 kg/tonne for TSP and 0.08 kg/tonne for $PM_{10}$. The total volume of spoil estimated to be loaded per day across the entire Project (assuming two-year earthworks duration) is approximately 10,900 m3, or 21,800 t based on the assumed density of 2,000 kg/m3. This results in estimated total emissions of approximately 3,488 kg/day of TSP and 1,744 kg/day of $PM_{10}$ across the entire Project. As outlined in Table 12.28, thirteen cuts are required to maintain the required track elevations for the proposed alignment. Assuming that the cut volume is equal across each of the 13 locations, the emission rate per cutting area would be approximately 268 kg/day of TSP and 134 kg/day of $PM_{10}$. As noted, (DTMR, 2014), there is no mitigation control efficiency available for loading of spoil.
- Dust from uncontrolled (no mitigation) unloading of spoil has been estimated to generate emissions at a rate of 0.012 kg/tonne for TSP and 0.004 kg/tonne for $PM_{10}$. Assuming the total volume of spoil that is unloaded is 21,800 tonnes/day, this results in an estimated emission rate of approximately 262 kg/day of TSP and 87 kg/day of $PM_{10}$ across the entire Project. Assuming that the spoil is dumped equally across the 12 laydown areas that are nominated to receive ballast, the unmitigated emission rate per laydown area would be approximately 22 kg/day for TSP and 7.3 kg/day for $PM_{10}$. Further assuming that a 70 per cent reduction in emissions could be achieved through the use of water sprays at the point of unloading, the mitigated emission rate per laydown area would be reduced to 6.6 kg/day for TSP and 2.2 kg/day for $PM_{10}$.
- Uncontrolled emissions of dust from the movement of vehicles on unsealed roads has been estimated to generate emissions at a rate of 2.6 kg/vehicle kilometres travelled (VKT) for TSP and 0.72 kg/VKT for $PM_{10}$. Assuming that the transport capacity of the haul trucks used is 50 tonnes/truck, the total weight of spoil generated is 21,800 t, and the total haul distance per truck is 4 km, the total VKT is estimated to be 873 km/day. This results in an estimated emission rate of approximately 2,270 kg/day for TSP and 629 kg/day for $PM_{10}$ across the entire Project. Assuming a 75 per cent reduction in emissions could be achieved through the application of water to the haul roads, the emission rates would be reduced to 567 kg/day for TSP and 157 kg/day for $PM_{10}$ across the entire Project.
- Emissions will also occur from wind erosion of exposed areas and stockpiles. Emission quantities for wind erosion cannot be accurately estimated at this time due to uncertainty regarding the total area of stockpiles and exposed earth. However, there are numerous mitigation measures available including wind breaks (30 per cent emission reduction), water sprays (50 per cent emission reduction) and enclosure (e.g. stockpile covers) (99 per cent emission reduction).

The impact of construction activity on sensitive receptors will be influenced by the source characteristics (e.g. emission rate, emission height), the proximity of the receptor to construction dust sources, and local weather conditions at the time of the activity. The estimates are total emissions at source and do not relate to the level of potential impact at potentially affected sensitive receptors. However, it is evident from the emission estimates that construction dust emissions can be significantly reduced through the implementation of mitigation measures.

The following sections outline the sensitivity of the AQIA study area to unmitigated construction dust impacts. The proposed mitigation measures and the assessed residual impacts following the implementation of the mitigation measures are discussed in Section 12.8 and Section 12.9.

**Step 2B—Sensitivity of surrounding area**

The IAQM methodology allows the sensitivity of an area to dust deposition, human health impacts due to $PM_{10}$, and ecological effects to be classified as high, medium, or low. The classifications are determined according to matrix tables provided in the IAQM guidance document. Individual matrix tables for dust deposition and human health impacts are provided. Factors used in the matrix tables to determine the sensitivity of the surrounding area are described as follows:

- Receptor sensitivity (for individual receptors in the area):
  - High sensitivity—locations where members of the public are likely to be exposed for eight hours or more in a day. For example, private residences, hospitals, schools, or aged-care homes
  - Medium sensitivity—places of work where exposure is likely to be eight hours or more in a day
  - Low sensitivity—locations where exposure is transient—i.e. one or two hours maximum. For example, parks, footpaths, shopping streets, playing fields
- Ambient annual mean $PM_{10}$ concentrations (only applicable to the human health impact matrix)
- Number of receptors in the area
- Proximity of receptors to dust sources.

Table 12.29 details the IAQM guidance sensitivity levels from dust deposition effects on people and property. The total number of receptors identified in the AQIA study area is 5,903, all of which are classified as high sensitivity. Table 12.27 shows that of the 5,903 receptors, 890 are located within 350 m of the temporary construction disturbance footprint; 118 of the 890 receptors are located less than 20 m away.

Assessing the sensitivity level to dust deposition effects from the Project, using the IAQM guidance, it is determined to be 'high' as there are more than 10 receptors located within 20 m of active construction areas. However, the length of the Project is 47 km and the density of receptors near active construction areas is much less than a standard construction site in an urban area. Based on the land use of the AQIA study area, a rating of 'high' for sensitivity to dust deposition is conservative, and a rating of 'medium' is considered more appropriate. A rating of 'medium' has been used for the sensitivity of receptors to potential dust deposition impacts.

**TABLE 12.29: IAQM SURROUNDING AREA SENSITIVITY TO DUST DEPOSITION IMPACTS**

| Receptor sensitivity | Number of receptors | Distance from the source (m) | | | |
|---|---|---|---|---|---|
| | | <20 | <50 | <100 | <350 |
| High | >100 | High | High | Medium | Low |
| | 10–100 | High | Medium | Low | Low |
| | 1-10 | Medium | Low | Low | Low |
| Medium | >1 | Medium | Low | Low | Low |
| Low | >1 | Low | Low | Low | Low |

A modified version of the IAQM guidance for assessing the sensitivity of an area to human health impacts is shown in Table 12.30. For 'high' and 'medium' sensitivity receptors, the IAQM methods takes the existing background concentrations of $PM_{10}$ (as an annual average) experienced in the area of interest (e.g. AQIA study area). As the UK goals for PM differ from the ambient air quality goals adopted for use in this assessment (Queensland air quality goals) the annual mean concentration categories used in the assessment (refer Table 12.30) have been modified from those presented in the IAQM method. This approach is consistent with the IAQM guidance, which states that in using the tables to define the sensitivity of an area, professional judgement will be used to determine alternative sensitivity categories.

### TABLE 12.30: IAQM GUIDANCE FOR CATEGORISING THE SENSITIVITY OF AN AREA TO HUMAN HEALTH IMPACTS

| Receptor sensitivity | Annual mean $PM_{10}$ concentration | Number of receptors | Distance from the source (m) | | | | |
|---|---|---|---|---|---|---|---|
| | | | <20 | <50 | <100 | <250 | <350 |
| High | >25 µg/m³ | >100 | High | High | High | Medium | Low |
| | | 10–100 | High | High | Medium | Low | Low |
| | | 1–10 | High | Medium | Low | Low | Low |
| | 21–25 µg/m³ | >100 | High | High | Medium | Low | Low |
| | | 10–100 | High | Medium | Low | Low | Low |
| | | 1–10 | High | Medium | Low | Low | Low |
| | 17–21 µg/m³ | >100 | High | Medium | Low | Low | Low |
| | | 10–100 | High | Medium | Low | Low | Low |
| | | 1–10 | Medium | Low | Low | Low | Low |
| | <17 µg/m³ | >100 | Medium | Low | Low | Low | Low |
| | | 10–100 | Low | Low | Low | Low | Low |
| | | 1–10 | Low | Low | Low | Low | Low |
| Medium | >25 µg/m³ | >10 | High | Medium | Low | Low | Low |
| | | 1–10 | Medium | Low | Low | Low | Low |
| | 21–25 µg/m³ | >10 | Medium | Low | Low | Low | Low |
| | | 1–10 | Low | Low | Low | Low | Low |
| | 17–21 µg/m³ | >10 | Low | Low | Low | Low | Low |
| | | 1–10 | Low | Low | Low | Low | Low |
| | <17 µg/m³ | >10 | Low | Low | Low | Low | Low |
| | | 1–10 | Low | Low | Low | Low | Low |
| Low | Any | >1 | Low | Low | Low | Low | Low |

**Table notes:**
a) The annual mean $PM_{10}$ concentration categories have been modified from the IAQM guidance to adjust for assessment of a site in Queensland

Annual average $PM_{10}$ concentrations at the Flinders View monitoring station, for the period 2010 to 2017, range from 13.1 to 16.2 µg/m³. Table 12.30 above provides the IAQM guidance sensitivity levels for human health impacts, the lowest concentration category being annual average $PM_{10}$ concentrations less than 17 µg/m³.

Assessing the sensitivity level to human health impacts using the IAQM guidance, the sensitivity is determined to be 'medium' as there are more than 100 receptors located within 20 m of active construction areas. As discussed for the sensitivity to dust impacts, the density of receptors near the Project is not consistent with a construction site in an urban area, and based on the assumed background concentrations, a rating of 'medium' is conservative. However, due to the proximity of some receptors to the disturbance footprint, such as the receptors in the Gatton Caravan Park, the sensitivity category of 'medium' has been used to provide a conservative assessment of potential impacts from construction.

The most sensitive areas to potential construction dust impacts will be areas located near active work sites (e.g. laydown areas) and the several small townships within 5 km of the alignment, including Helidon, Grantham, Placid Hills, Gatton, Forest Hill, Laidley, Grandchester and Calvert.

#### Step 2C—Unmitigated risks of impacts

The dust emission magnitudes for each activity as determined in Step 2A were combined with the sensitivity of the area (refer Table 12.29 and Table 12.30) to determine the risk of construction dust air quality impacts, with no mitigation applied. The risk of impacts for each activity is assessed according to the IAQM risk matrix for each construction activity, which is presented in Table 12.31. The 'without mitigation' dust risk impacts determined for each activity are summarised in Table 12.32.

**TABLE 12.31: IAQM RISK MATRIX**

| Activity | Surrounding area sensitivity | Dust emission magnitude | | |
|---|---|---|---|---|
| | | Large | Medium | Small |
| Demolition | High | High risk | Medium risk | Medium risk |
| | Medium | High risk | Medium risk | Low risk |
| | Low | Medium risk | Low risk | Negligible |
| Earthworks | High | High risk | Medium risk | Low risk |
| | Medium | Medium risk | Medium risk | Low risk |
| | Low | Low risk | Low risk | Negligible |
| Construction | High | High risk | Medium risk | Low risk |
| | Medium | Medium risk | Medium risk | Low risk |
| | Low | Low risk | Low risk | Negligible |
| Trackout | High | High risk | Medium risk | Low risk |
| | Medium | Medium risk | Low risk | Negligible |
| | Low | Low risk | Low risk | Negligible |

**TABLE 12.32: WITHOUT MITIGATION DUST RISK IMPACTS FOR PROJECT CONSTRUCTION ACTIVITIES**

| Potential impact | Risk | | | |
|---|---|---|---|---|
| | Demolition | Earthworks | Construction | Trackout |
| Scale of activity (emission magnitude) | Small | Large | Large | Large |
| Dust deposition | Low | Medium | Medium | Medium |
| Human health | Low | Medium | Medium | Medium |

The result of the qualitative air quality risk assessment shows that the unmitigated air emissions from the construction of the Project poses a potential 'medium' risk of both human health impacts and dust deposition impacts.

**Step 3—Management strategies**

The purpose of Step 2 is to determine if mitigation measures are required to ensure that dust impacts on surrounding sensitive receptors are maintained at an acceptable level. A 'high' or 'medium'-level risk rating means that suitable management measures must be implemented.

A Construction Environmental Management Plan (CEMP) will be developed to mitigate and manage potential impacts during the construction. Proposed mitigation measures for the construction and operation phases of the Project are presented in Section 12.8.3 and in the draft Outline Environmental Management Plan (Drat Outline EMP) (refer Chapter 23: Draft Outline Environmental Management Plan).

**Step 4—Reassessment**

Step 4 of the IAQM method requires reassessment to determine whether there are likely to be significant residual impacts, post-mitigation, arising from a proposed development. The guidance states:

> *For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant'.*

The dust risk assessment in Table 12.32 shows that without mitigation there is a potential 'medium' risk of both human health impacts and dust deposition impacts.

The construction dust sources associated with the Project are common emission sources. Industry standard best practice measures to reduce dust emissions exist for all the identified sources. It is expected that emissions can be well managed through diligent implementation of control measures.

Mitigation measures proposed to mitigate construction impacts are presented in Section 12.8.3. An assessment of the residual significance of impact from construction, with the implementation of the proposed mitigation measures, is presented in Section 12.9.1.

#### 12.7.1.2 Tank fuel storage

Fuel storage is expected to be undertaken at six locations (laydown areas) along the proposed alignment during construction of the Project. Fuel storage has the potential to impact nearby sensitive receptors due to the emission of VOCs and odour. Table 12.33 presents the proposed laydown areas that may include diesel fuel storage, the volumes proposed to be stored, and the distance from each area to the closest identified sensitive receptor.

**TABLE 12.33: FUEL TANK STORAGE LOCATIONS**

| Laydown area ID | Chainage (km) | Location | Fuel storage proposed (L) | Distance from boundary of laydown area to closest sensitive receptor (m) |
|---|---|---|---|---|
| H2C-LDN030.7 | 30.7 | Connors Road | <40,000 | 159 |
| H2C-LDN035.4 | 35.4 | Warrego Hwy | <40,000 | 196 |
| H2C-LDN039.1 | 39.1 | Warrego Hwy | <20,000 | 200 |
| H2C-FBW044.6 | 44.6 | Eastern Drive | <20,000 | 40 |
| H2C-LDN058.0 | 58.0 | Boundary Road | <40,000 | 100 |
| H2C-LDN061.2 | 61.2 | Tunnel Portal West | <20,000 | 200 |

Table 12.33 shows that for the larger fuel storage tanks (40,000 L), the distance to the closest receptor is between 100-196 m, while for the smaller tanks (20,000 L) the distance to the closest receptor is between 40-200 m.

The EPA Victoria (2013) provides guidance on separation distances for the storage of petroleum products (100 m for floating roof tanks, and 250 m for fixed roof tanks), but this guidance is for tanks exceeding 2,000 tonnes, which is far greater than the size of the tanks proposed for the Project.

The BCC Service Station Code provides performance outcomes and acceptable outcomes for service stations. The intent is to ensure that service station developments are located at 'sufficient distance from dwellings to maintain residential amenity in adjoining, adjacent or surrounding areas'. Acceptable Outcome AO7.2 specifies separation distances based on annual fuel throughput. For service stations with an annual fuel throughput of less than 1.2 megalitres (ML) the acceptable separation distance is 10 m, while for service stations with annual fuel throughput of between 1.2 ML to 9 ML, the accepted distance is 50 m. The service station code specifically excludes diesel from the definition of fuel; however, diesel is less volatile than petrol and other motor spirits and therefore the application of these buffers is conservative.

To exceed an annual throughput of 9 ML, the 20,000 L tanks would need to be refilled more than once per day (450 times per year), while the 40,000 L tanks would need to be refilled more than once every two days (225 times per year). It is unlikely that this volume of diesel will be consumed, and it is expected that annual fuel throughput will be considerably less than 9 ML.

All construction areas except for H2C-FBW044.6 (Eastern Drive) have a separation distance from the nearest boundary to the closest receptor of greater than 50 m. However, the dimensions of H2C-FBW044.6 are approximately 130 m x 165 m, and therefore the tank in this construction area is able to be located further than 50 m from the nearest receptor.

It is proposed that at a minimum, fuel tanks will be located at least 50 m from the nearest sensitive receptor, but separation distances will be maximised as far as practical within site restrictions. A minimum separation distance of 50 m, combined with compliance to AS 1940:2017 *The storage and handling of flammable and combustible liquids* (Australian Standards, 2017), will result in negligible impacts to any potentially affected sensitive receptors based on the recommendations of the BCC Service Station Code.

### 12.7.2 Commissioning

Potential air impacts during the commissioning phase of the Project are anticipated to be minor. Air emissions are expected to be limited to combustion engine emissions from transport vehicles and train locomotives and limited dust emissions from vehicle travel on unsealed roads.

Air emissions from the commissioning phase of the Project are expected to be insignificant. Any potential incremental impacts are unlikely to generate nuisance or risk exceedance of the Project's air quality goals.

Commissioning phase impacts have not been included in the AQIA.

### 12.7.3 Operation

#### 12.7.3.1 Impacts to air quality

**Dispersion modelling results**

The results of the air quality dispersion modelling of operational impacts are presented in this section. Assessment increments considered are presented in Table 12.34.

**TABLE 12.34: MODELLING INCREMENT DESCRIPTIONS**

| Increments | Description |
|---|---|
| Project-only contribution | Represents the predicted concentrations from modelled Project locomotive emissions (including existing train services travelling along Project alignment). Different versions of the model have been run to assess emissions from the crossing loops as discussed in Section 12.5.4.3 |
| Background concentration | Adopted background concentrations |
| Total cumulative concentration | The cumulative concentration from the Project-only contribution, background concentration and non-Project contributions (from the adjacent G2H and C2K Inland Rail projects and West Moreton System rail corridor movements travelling along Project alignment) |
| With veneering | Contribution from trains with veneering (75 per cent reduction to emissions from coal wagons) (only applicable for TSP, $PM_{10}$, $PM_{2.5}$ and deposited dust) |
| Without veneering | Contribution from trains without veneering (no reduction to coal wagon emissions) (only applicable for TSP, $PM_{10}$, $PM_{2.5}$ and deposited dust) |

The results of the dispersion modelling for typical train operations (based on the *Inland Rail Program Business Case* (ARTC, 2015a) at the worst affected sensitive receptor are shown in Table 12.35. The principal pollutants of concern for emissions from locomotives and coal wagons are $PM_{10}$, $PM_{2.5}$, and $NO_2$. All modelling results are presented in Appendix K: Air Quality Technical Report.

Table 12.35 shows that compliance is predicted for all pollutants for typical operations, with the exception of the annual average goal for $PM_{10}$, which is predicted to be exceeded without veneering. The predicted cumulative annual average concentration for $PM_{10}$ (conservative modelling and conservatively adopted background concentration of 16.2 µg/m$^3$) without veneering is 25.7 µg/m$^3$ at the worst case affected sensitive receptor, which is marginally above the goal of 25 µg/m$^3$. The predicted cumulative annual average concentration for $PM_{10}$ with veneering is 19.1 µg/m$^3$, below the goal of 25 µg/m$^3$. With the inclusion of veneering, the Project contribution to concentrations at sensitive receptors is reduced and compliance with the Project air quality goals is predicted to be achieved for typical operations.

As discussed in Section 12.4.3, the air quality goals adopted for the assessment are prescribed to protect or enhance the environmental values of health and wellbeing and protecting the aesthetic environment. Assessment of the Project's impact to these environmental values is discussed in the following sections.

**Environmental value: human health and wellbeing**

All of the pollutant species considered for the AQIA of operations have goals, which are set for the protection of human health, with the exception of dust deposition and toluene (30-minute average). With the inclusion of veneering, the predicted cumulative concentrations for all pollutants assessed are below the adopted goals for the train volumes assessed.

The assessment has adopted representative (and conservative) background air quality in the prediction of cumulative concentrations, and therefore the results of the assessment can be used to assess the impact on human health. As predicted cumulative concentrations are compliant with the adopted air quality goals; the operation of the Project is not expected to significantly impact the environmental value of health and wellbeing.

**Environmental value: aesthetics of the environment**

The pollutant species that have air quality goals set for the protection of the aesthetic environment are toluene (30- minute average) and dust deposition. Table 12.35 shows that the Project contribution to toluene (30-minute average) is 0.0096 ug/m$^3$, which represent less than 0.1 per cent of the 30-minute average goal of 1,100 ug/m$^3$.

#### TABLE 12.35: HIGHEST PREDICTED GROUND LEVEL CONCENTRATIONS AT WORST-AFFECTED SENSITIVE RECEPTORS (TYPICAL TRAIN OPERATION)

| Pollutant | Receptor | Average period | Highest predicted ground level pollutant concentration at identified sensitive receptor locations (µg/ $m^3$ ) | | | Assessment goal (µg/ $m^3$ ) |
|---|---|---|---|---|---|---|
| | | | Project only contribution (A) | Background concentration (B) | Project only contribution + Background concentration (A + B) | |
| TSP | s3623 | Annual average (with veneering) | 5.1 | 40.5 | 45.6 | 90 |
| | s3623 | Annual average (*without veneering*) | 18.3 | | 58.8 | |
| $PM_{10}$ | s63 | 24-hour maximum (with veneering) | 9.9 | 18.7 | 28.6 | 50 |
| | s3623 | 24-hour maximum (*without veneering*) | 22.6 | | 41.3 | |
| | s3623 | Annual average (with veneering) | 2.9 | 16.2 | 19.1 | 25 |
| | s3623 | Annual average (*without veneering*) | 9.5 | | **25.7** | |
| $PM_{2.5}$ | s63 | 24-hour maximum (with veneering) | 8.1 | 6.4 | 14.5 | 25 |
| | s63 | 24-hour maximum (*without veneering*) | 8.9 | | 15.3 | |
| | s3623 | Annual average (with veneering) | 1.0 | 5.7 | 6.7 | 8 |
| | s3623 | Annual average (*without veneering*) | 1.9 | | 7.6 | |
| Deposited dust | s1627 | 30-day (with veneering) | 0.084 mg/ $m^2$ /day | 50 mg/ $m^2$ /day | 50.1 mg/ $m^2$ /day | 120 mg/ $m^2$ /day [c] |
| | s1627 | 30-day (*without veneering*) | 0.29 mg/ $m^2$ /day | | 50.3 mg/ $m^2$ /day | |
| $NO_2$ | s5701 | 1-hour maximum | 165.1 | 24.6 | 189.7 | 250 |
| | s1627 | Annual average | 10.6 | 7.8 | 18.4 | 62 |
| Arsenic and compounds | s3623 | Annual average | $1.88 \times 10^{-4}$ ng/ $m^3$ | -[b] | -[b] | 6 ng/ $m^3$ |
| Cadmium and compounds | s3623 | Annual average | $1.88 \times 10^{-2}$ ng/ $m^3$ | -[b] | -[b] | 5 ng/ $m^3$ |
| Chromium III and compounds | s5701 | 1-hour maximum | $7.67 \times 10^{-4}$ | -[b] | -[b] | 9 |
| Chromium VI and compounds | s5701 | 1-hour maximum | $7.67 \times 10^{-4}$ | -[b] | -[b] | 0.1 |
| | s3623 | Annual average | $9.42 \times 10^{-5}$ | -[b] | -[b] | 0.01 |
| Lead and compounds | s3623 | Annual average | $1.67 \times 10^{-6}$ | -[b] | -[b] | 0.5 |
| Nickel and compounds | s3623 | Annual average | 0.23 ng/ $m^3$ | -[b] | -[b] | 22 ng/ $m^3$ |
| Dioxins and furans | s3623 | Annual average | $3.36 \times 10^{-11}$ | -[b] | -[b] | $3 \times 10^{-8}$ |

| Pollutant | Receptor | Average period | Highest predicted ground level pollutant concentration at identified sensitive receptor locations (µg/ m$^3$) Project only contribution (A) | Background concentration (B) | Project only contribution + Background concentration (A + B) | Assessment goal (µg/m$^3$) |
|---|---|---|---|---|---|---|
| Polycyclic aromatic hydrocarbon (as benzo[a]pyrene) | s3623 | Annual average | 0.011 ng/m$^3$ | -[b] | -[b] | 0.3 ng/m$^3$ |
| 1,3-butadiene | s3623 | Annual average | 0.12 | -[b] | -[b] | 2.4 |
| Benzene | s3623 | Annual average | 0.0012 | 5.2 | 5.2 | 5.4 |
| Toluene | s63 | 30-minute maximum [a] | 0.0096 | 23.0 | 23.0 | 1,100 |
| | s63 | 24-hour maximum | 0.00347 | 21.7 | 21.7 | 4,100 |
| | s3623 | Annual average | 0.00017 | 18.5 | 18.5 | 400 |
| Xylenes | s63 | 24-hour maximum | 0.478 | 31.5 | 32.0 | 1100 |
| | s3623 | Annual average | 0.023 | 26.0 | 26.0 | 950 |

**Table notes:**

a) 30-minute averages calculated from 1-hour modelling results as per (Turner, 1970)
b) No background monitoring data available for modelled pollutant
c) Goal of 120 mg/m$^2$ /day, calculated based on the average deposition over a period of one month
Predicted concentrations which exceed the air quality goal are shown in **bold**

The predicted maximum Project contribution to deposited dust for typical operations is 0.084 mg/m²/day with veneering and 0.29 mg/m²/day without veneering. The predicted contributions represent less than 0.4 per cent of the adopted goal of 120 mg/m²/day.

Based on the magnitude of the predicted Project contributions, and as the predicted cumulative concentrations are well below the air quality goals for toluene and deposited dust, the operation of the Project is not expected to significantly adversely impact the environmental values of aesthetic environment and the risk of amenity impacts as a result of the operation of the Project is considered to be low.

**Impacts to the assimilative capacity of the air environment**

The assessment has adopted representative (and conservative) background air quality in the prediction of cumulative concentrations and deposition levels at sensitive receptors and has therefore considered the assimilative capacity of the air environment in determining compliance with the adopted air quality goals.

The remaining assimilative capacity of the receiving environment with the operation of the Project has been calculated for TSP, $PM_{10}$, $PM_{2.5}$ and $NO_2$, which are the pollutants emitted in the highest quantities by the operation of the Project. The remaining assimilative capacity for the typical train volume scenarios have been calculated for the worst-affected receptor with the results presented in Table 12.36. It is highlighted that this is a conservative assessment of the assimilative capacity of the receiving environment as predicted concentrations vary significantly at different receptors.

It is also noted that for the assessment of 24-hour average concentrations of $PM_{10}$ and $PM_{2.5}$, the background concentration adopted for each pollutant is based on the highest measured 70th percentile 24-hour concentration between 2010 to 2017 at existing DES monitoring stations (Flinders View for $PM_{10}$ and Springwood for $PM_{2.5}$). The assessment methodology assumes the 24-hour background concentration for both pollutants to be constant throughout the year of assessment. In reality, ambient air quality fluctuates and therefore the actual background concentration on the calendar day of the modelled maximum predicted concentration may be lower or higher than the assumed background concentration (measured 70th percentile 24-hour concentration). Table 12.36 shows that the pollutant with the highest predicted change to the assimilative capacity of the air environment is $NO_2$, which is predicted to change by 66 per cent for 1-hour predictions. However, it is noted that even at the worst-affected receptor, the remaining assimilative capacity is 24 per cent for 1-hour concentrations, which is considered acceptable considering that the maximum 1-hour prediction presents the worst-case impact of the Project on a sensitive receptor.

For particulates, Table 12.36 shows that with veneering included the maximum change to the assimilative capacity of the receiving environment for typical train volumes is 32 per cent calculated for 24-hour average $PM_{2.5}$. The remaining assimilative capacity for 24-hour concentrations of $PM_{2.5}$ is greater than 40 per cent, which is a significant proportion of the air quality goal.

**Concentration contours**

Predicted cumulative pollutant concentration contours for $PM_{10}$ (24-hour), $PM_{2.5}$ (annual) and $NO_2$ (1 hour) for the typical train volume scenario are presented in Figure 12.13(a-i), Figure 12.14(a-i) and Figure 12.15(a-i). The figures do not represent particular dispersion patterns but rather the extent of potential impacts.

## TABLE 12.36: REMAINING ASSIMILATIVE CAPACITY FOR TYPICAL OPERATIONS FOR WORST AFFECTED RECEPTOR

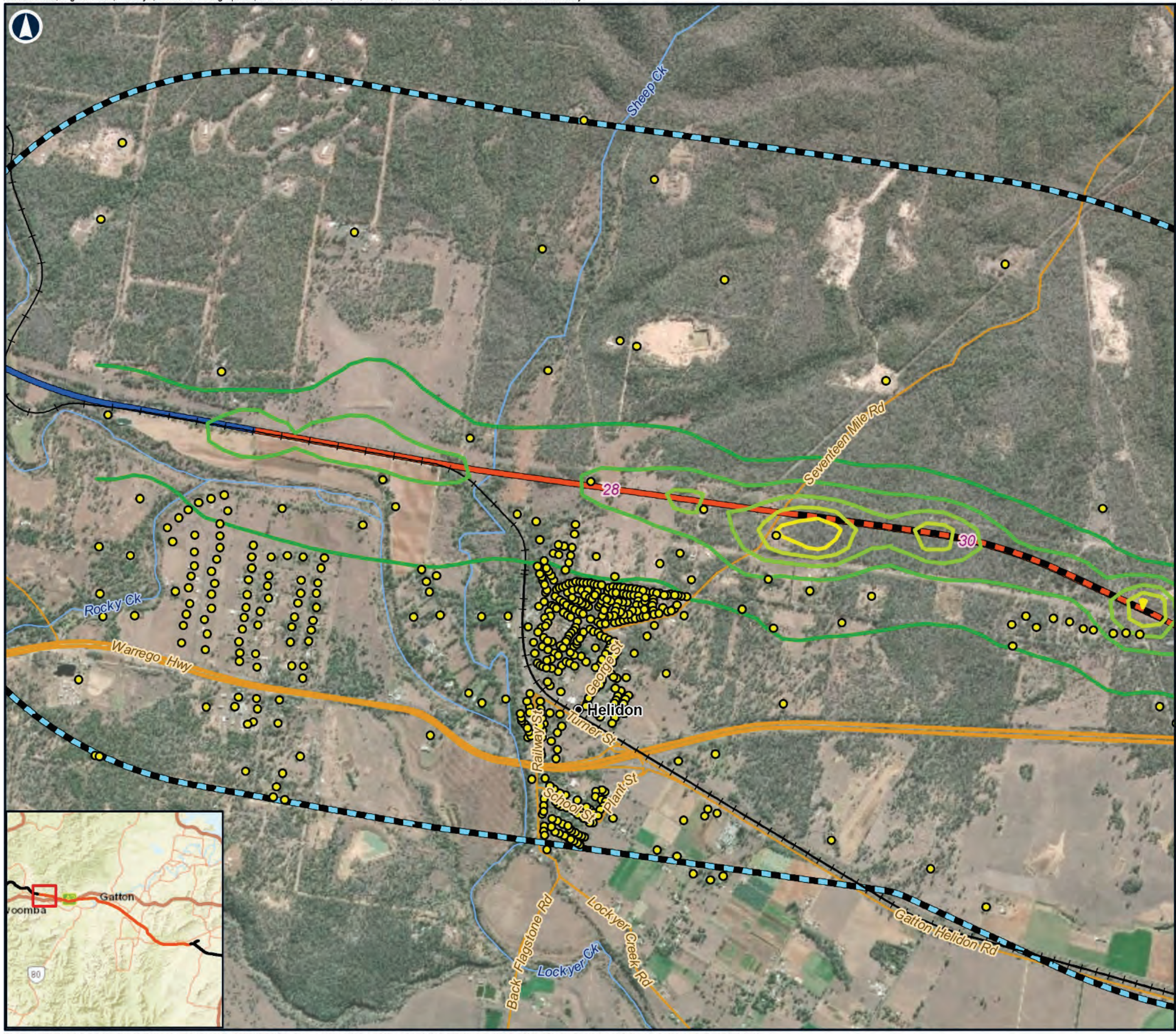
| Pollutant | Averaging period | Receptor | Project only contribution (µg/m$^3$) | Total cumulative concentration (µg/ m$^3$) | Air quality goal (µg/ m$^3$) | Remaining assimilative capacity at worst affected receptor (per cent) | Change to assimilative capacity at worst affected receptor (per cent) |
|---|---|---|---|---|---|---|---|
| TSP | Annual average (with veneering) | s3623 | 5.1 | 45.6 | 90 | 49 | 6 |
| | Annual average (*without veneering*) | s3623 | 18.3 | 58.8 | 90 | 35 | 20 |
| $PM_{10}$ | 24-hour maximum (with veneering) | s63 | 9.9 | 28.6 | 50 | 43 | 20 |
| | 24-hour maximum (*without veneering*) | s3623 | 22.6 | 41.3 | 50 | 17 | 45 |
| | Annual average (with veneering) | s3623 | 2.9 | 19.1 | 25 | 24 | 12 |
| | Annual average (*without veneering*) | s3623 | 9.5 | 25.7 | 25 | -3 | 38 |
| $PM_{2.5}$ | 24-hour maximum (with veneering) | s63 | 8.1 | 14.5 | 25 | 42 | 32 |
| | 24-hour maximum (*without veneering*) | s63 | 8.9 | 15.3 | 25 | 39 | 36 |
| | Annual average (with veneering) | s3623 | 1.0 | 6.7 | 8 | 16 | 13 |
| | Annual average (*without veneering*) | 7.6 | 8 | 5 | 24 | | |
| $NO_2$ | 1 hour | s5071 | 165.1 | 189.7 | 250 | 24 | 66 |
| | Annual average | s1627 | 10.6 | 18.4 | 62 | 70 | 17 |

**Table notes:**

a) The remaining assimilative capacity of the receiving environment at the worst-affected receptor considering contributions from the operation of the Project

b) Negative percentage values occur for pollutants where the goal is exceeded.

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.13a: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentrations**

- 20
- 22
- 24
- 26
- 28
- 50 µg/m³ Criterion

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

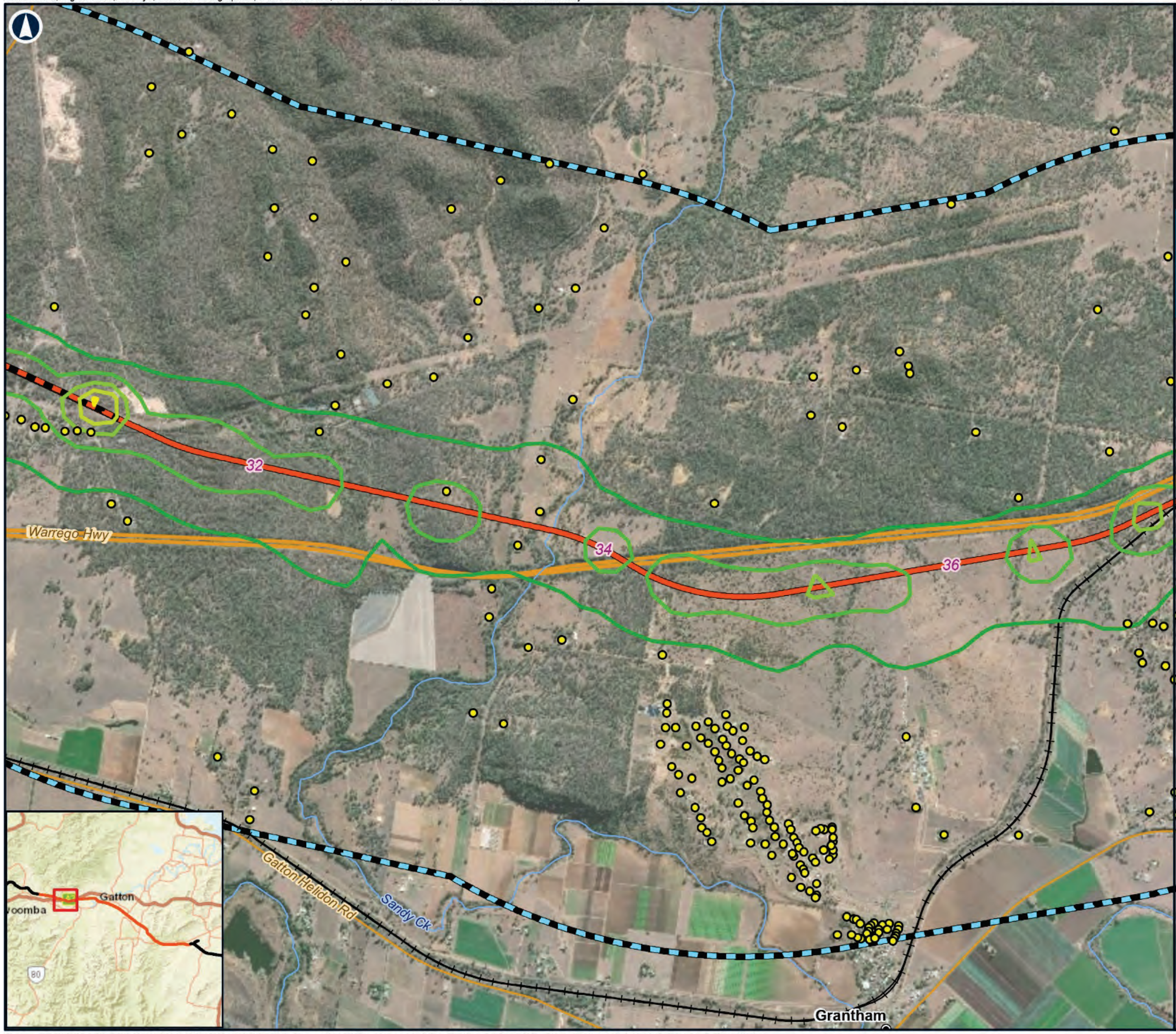
ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.13b: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentrations**

- 20
- 22
- 24
- 26
- 28
- 50 µg/m³ Criterion

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

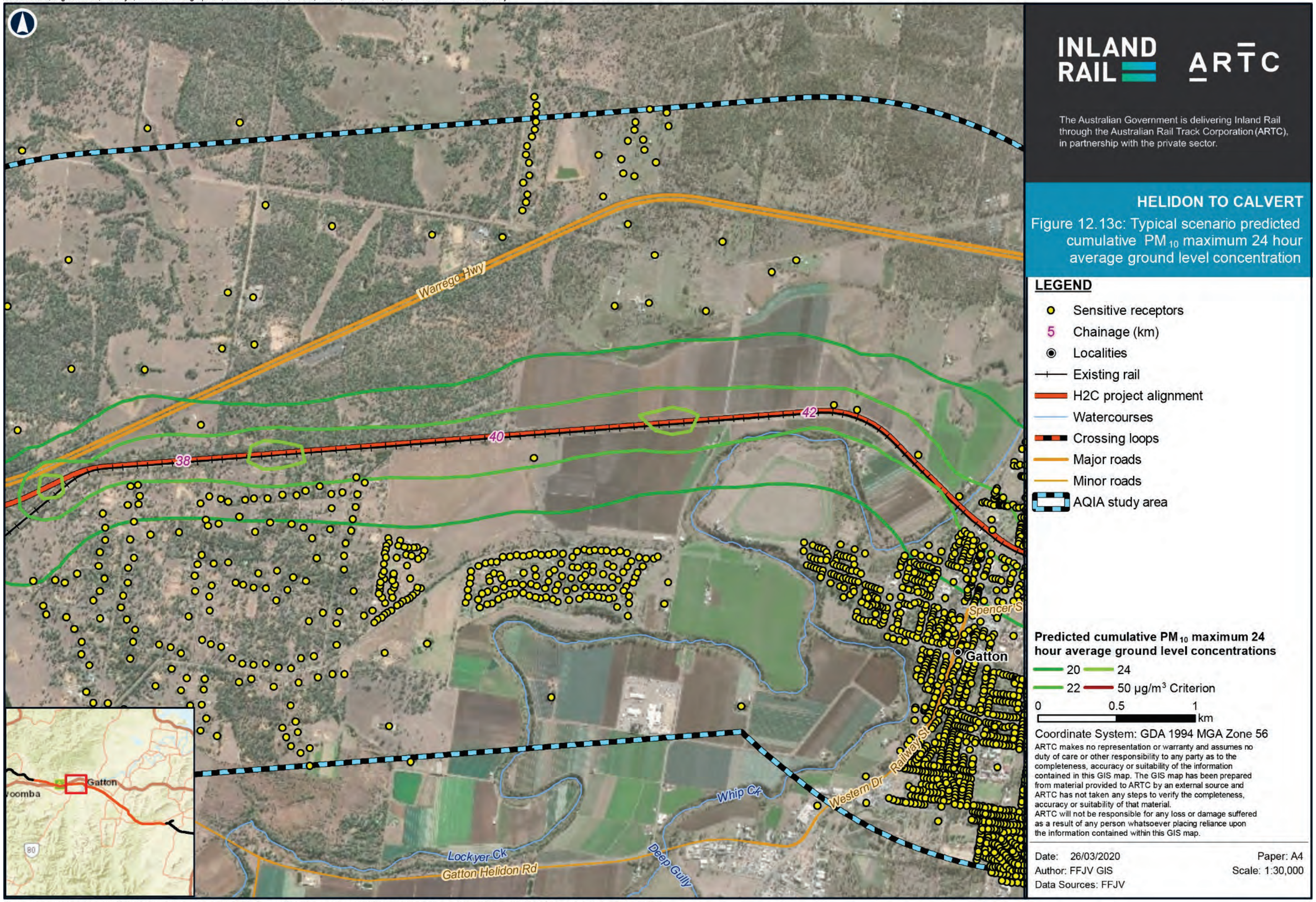
ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

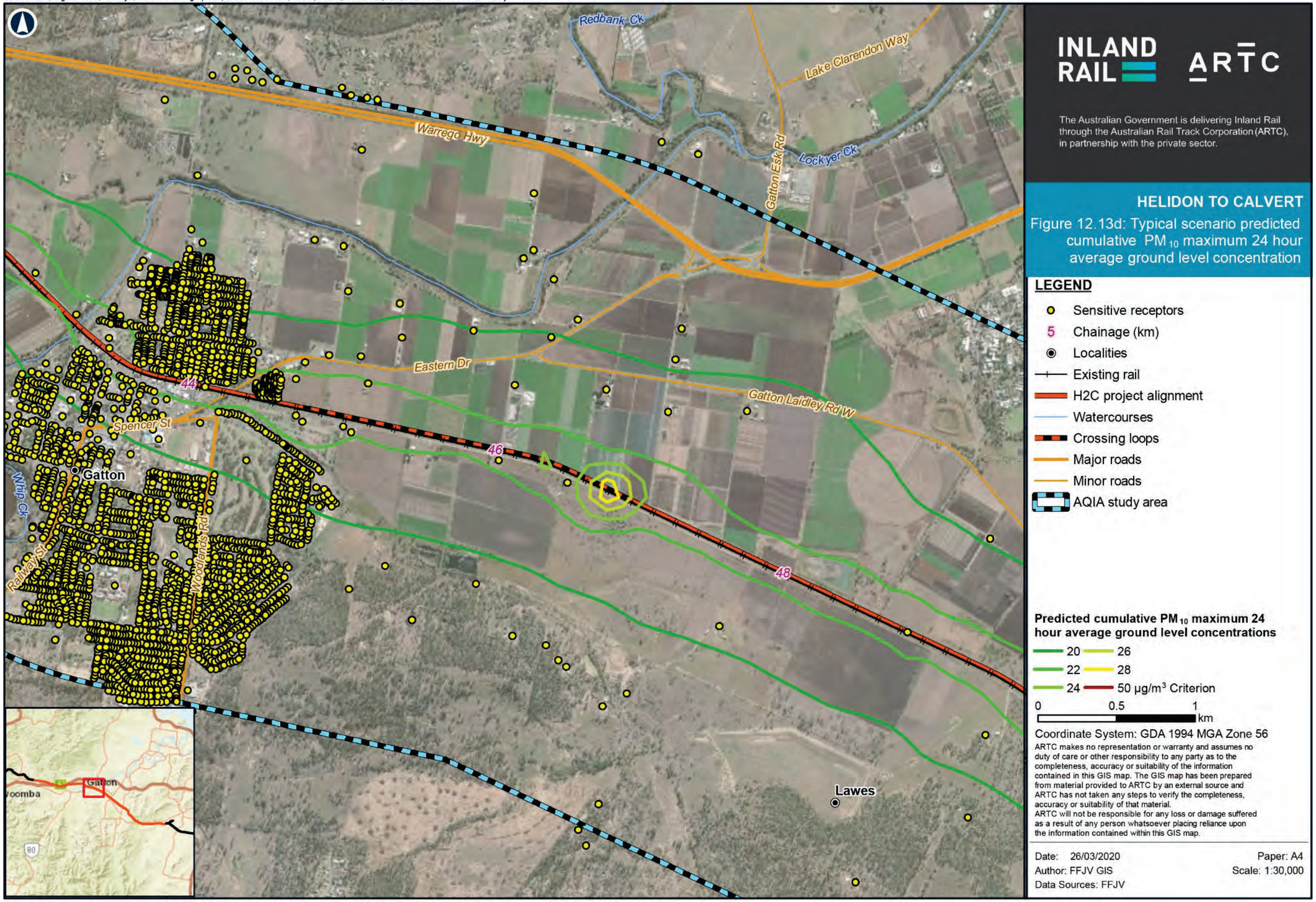
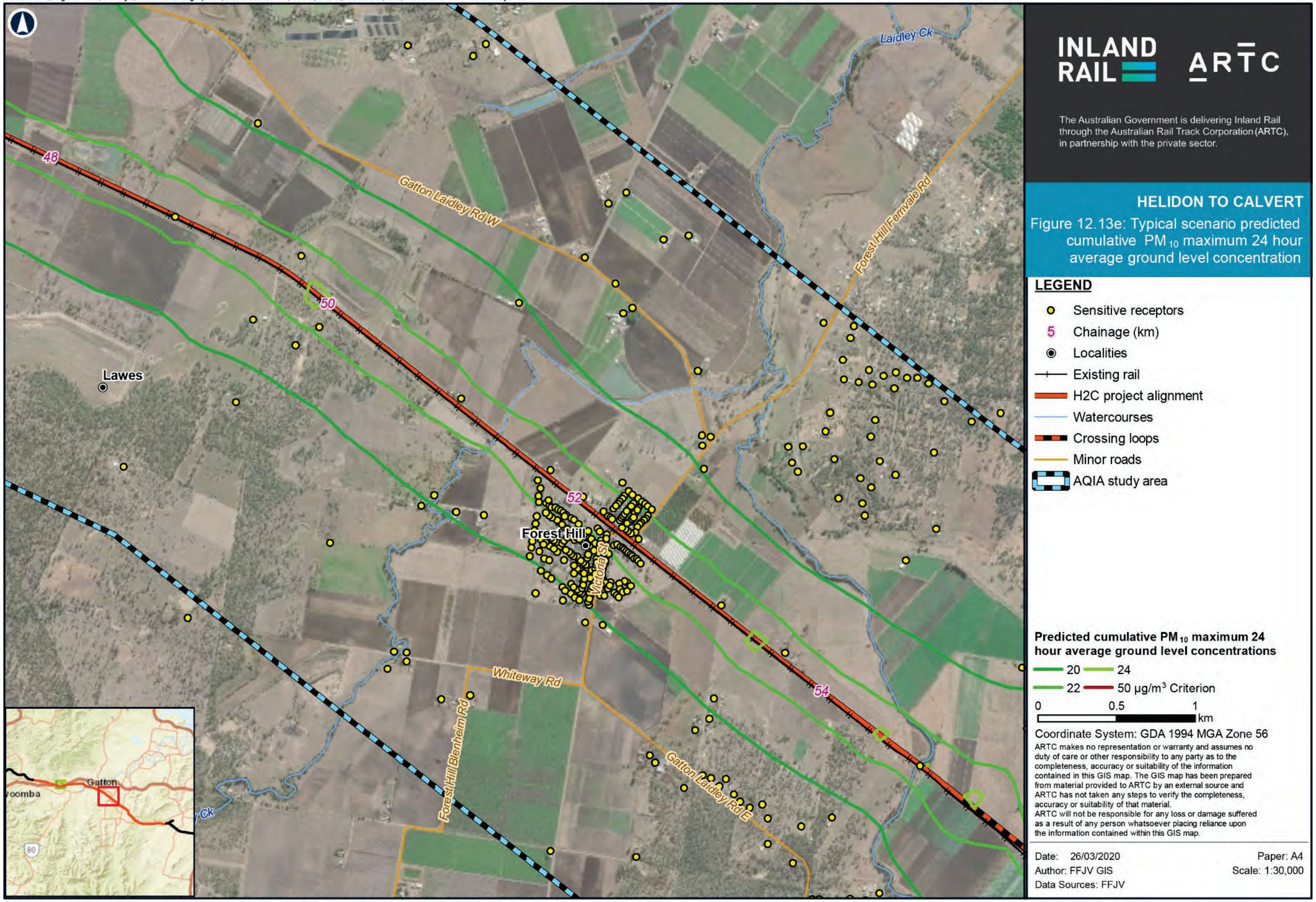


Figure 12.13d: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

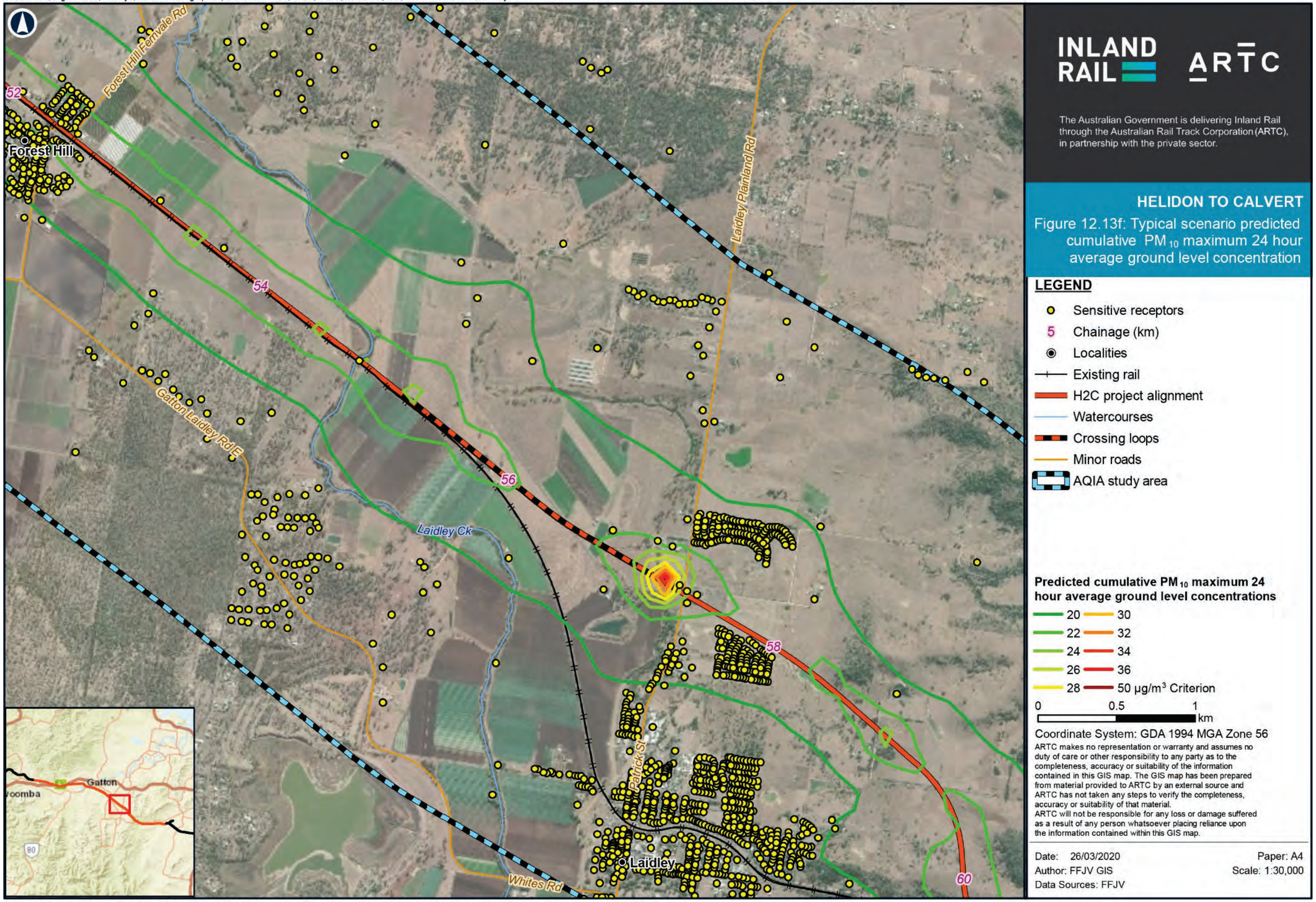



HELIDON TO CALVERT

Figure 12.13e: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

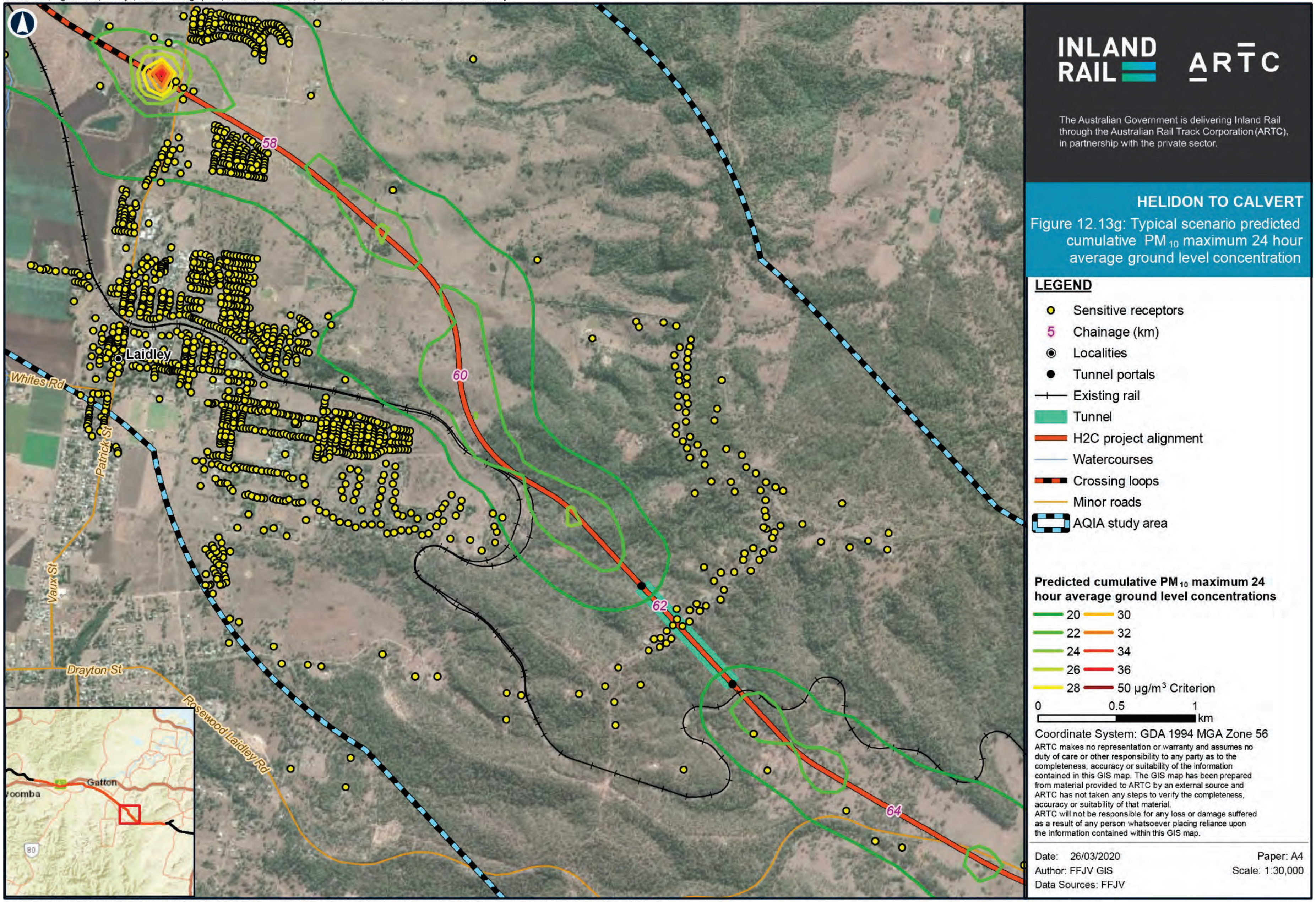
Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



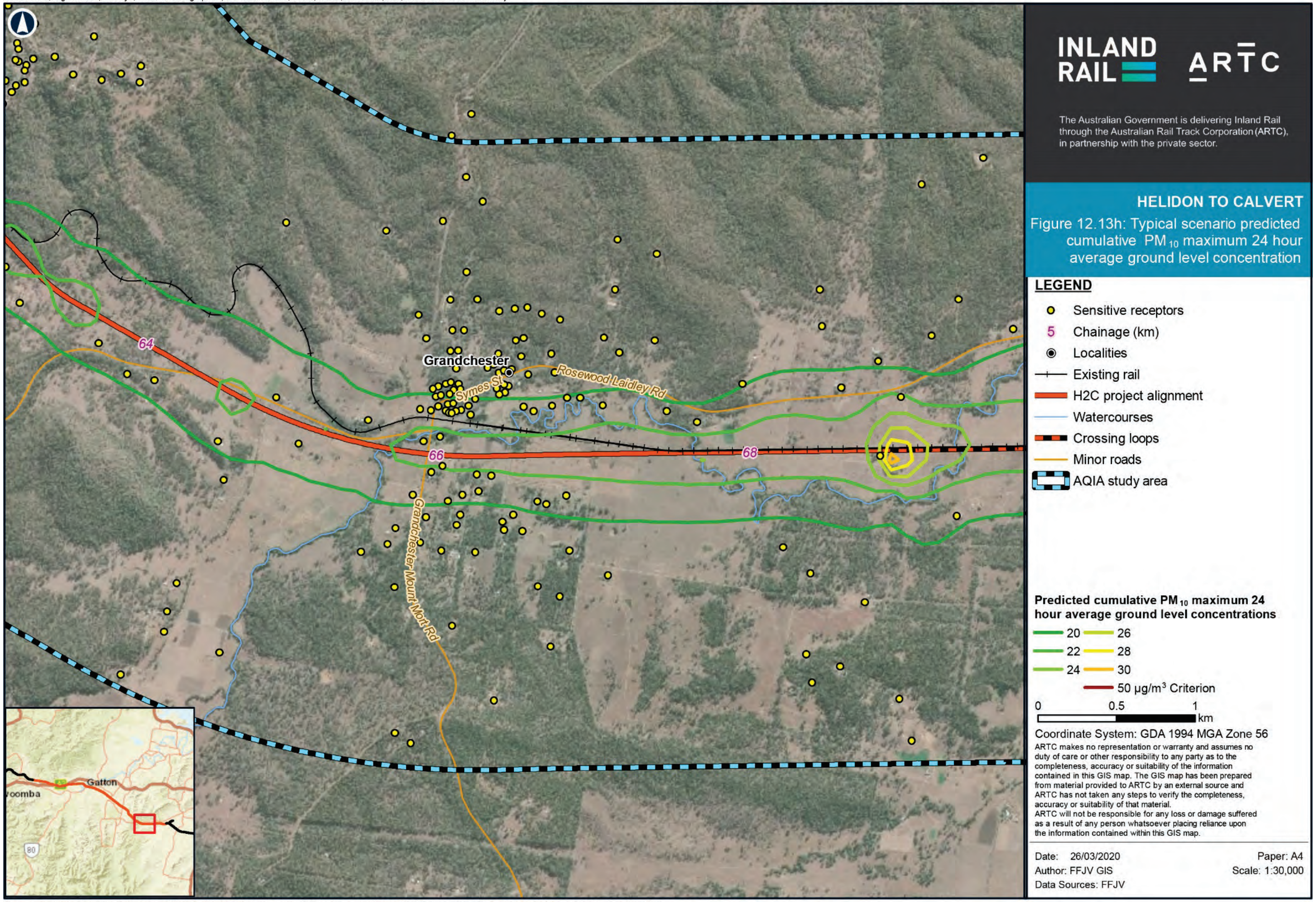

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

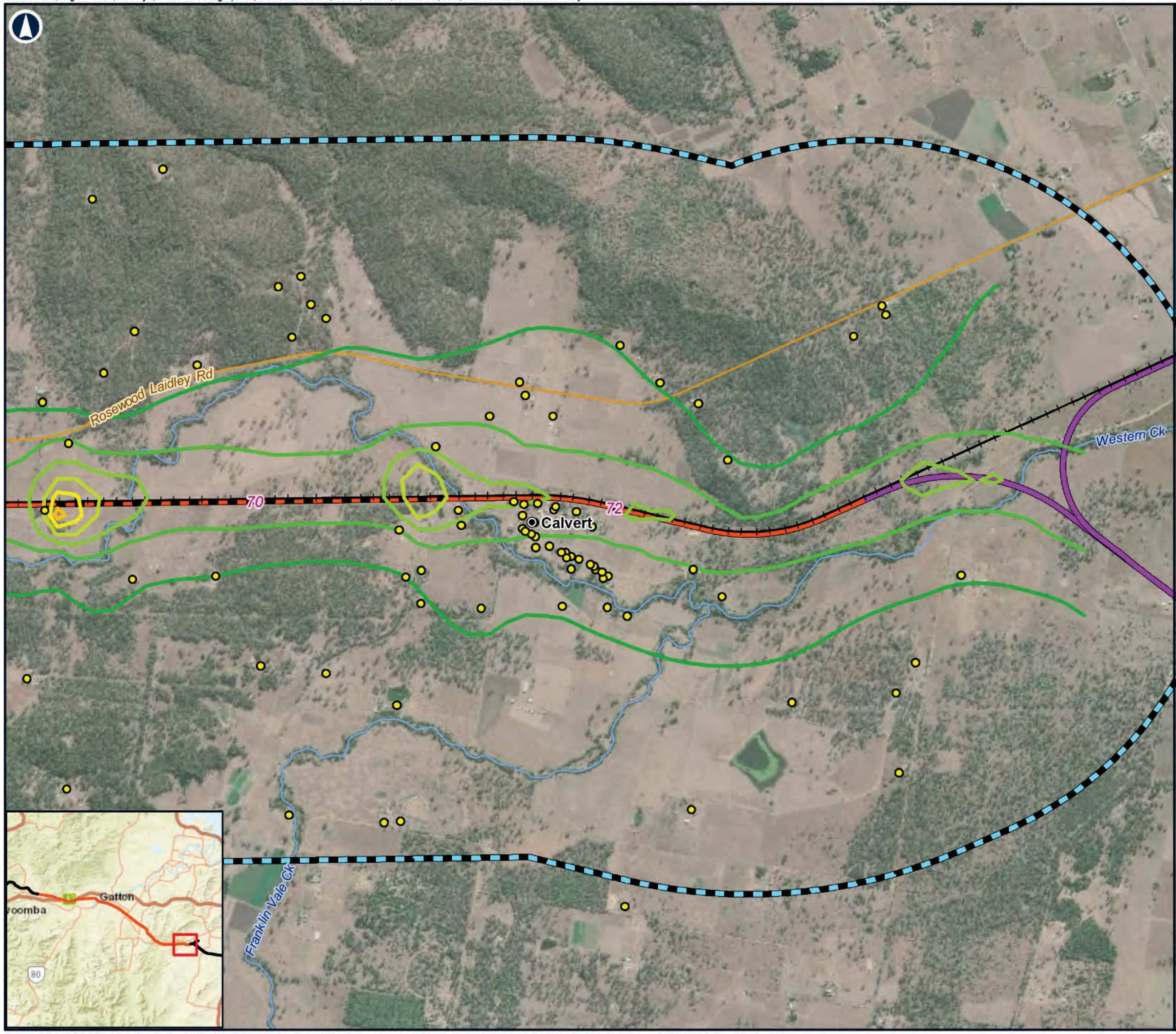
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




HELIDON TO CALVERT
Figure 12.13h: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.13i: Typical scenario predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{10}$ maximum 24 hour average ground level concentrations**

- 20
- 22
- 24
- 26
- 28
- 30
- 50 µg/m³ Criterion

0 0.5 1 km

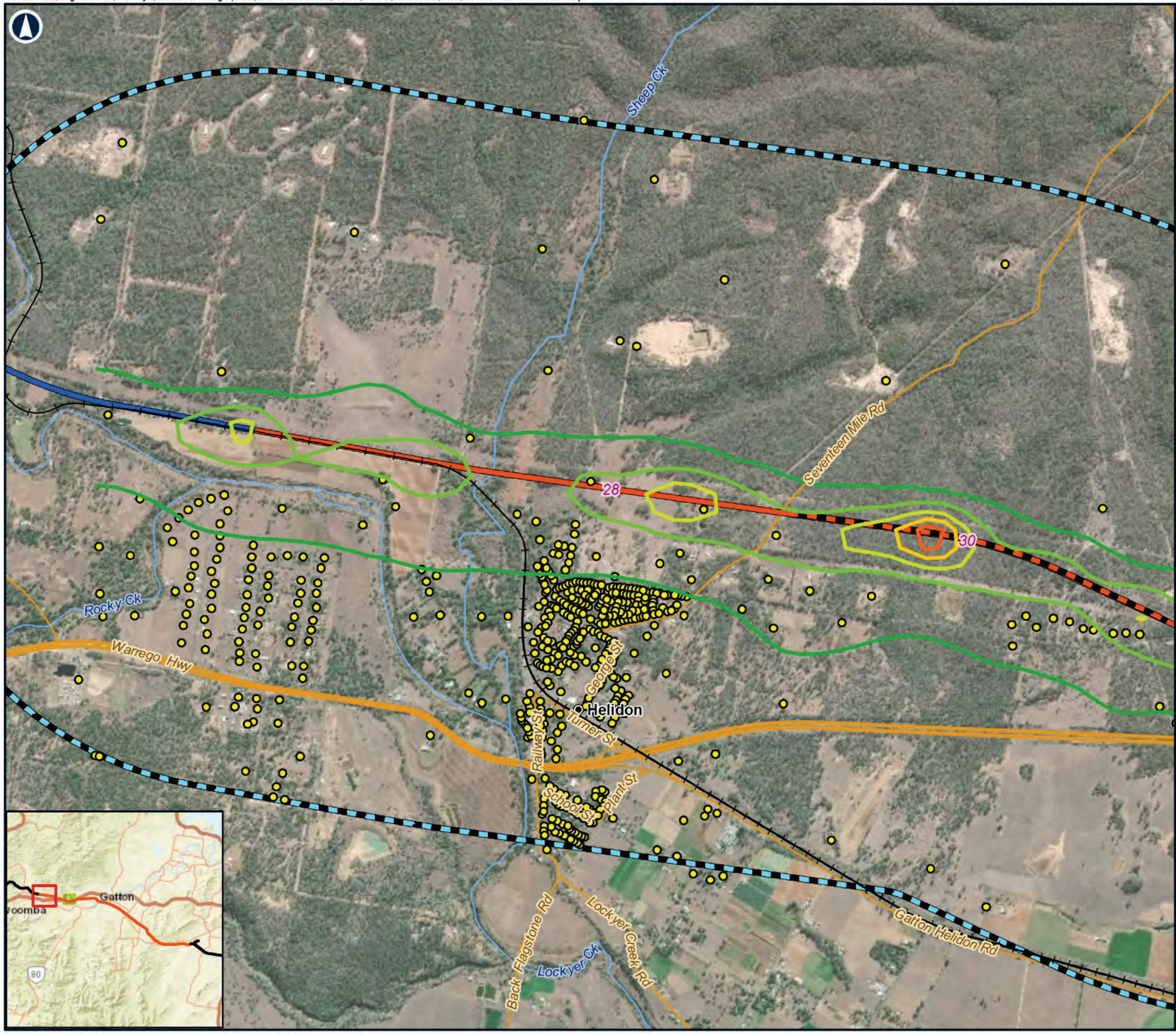
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.13_Typical_PM10.mxd Date: 6/25/2020 10:29

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.14a: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 8 µg/m³ Criterion

0 0.5 1 km

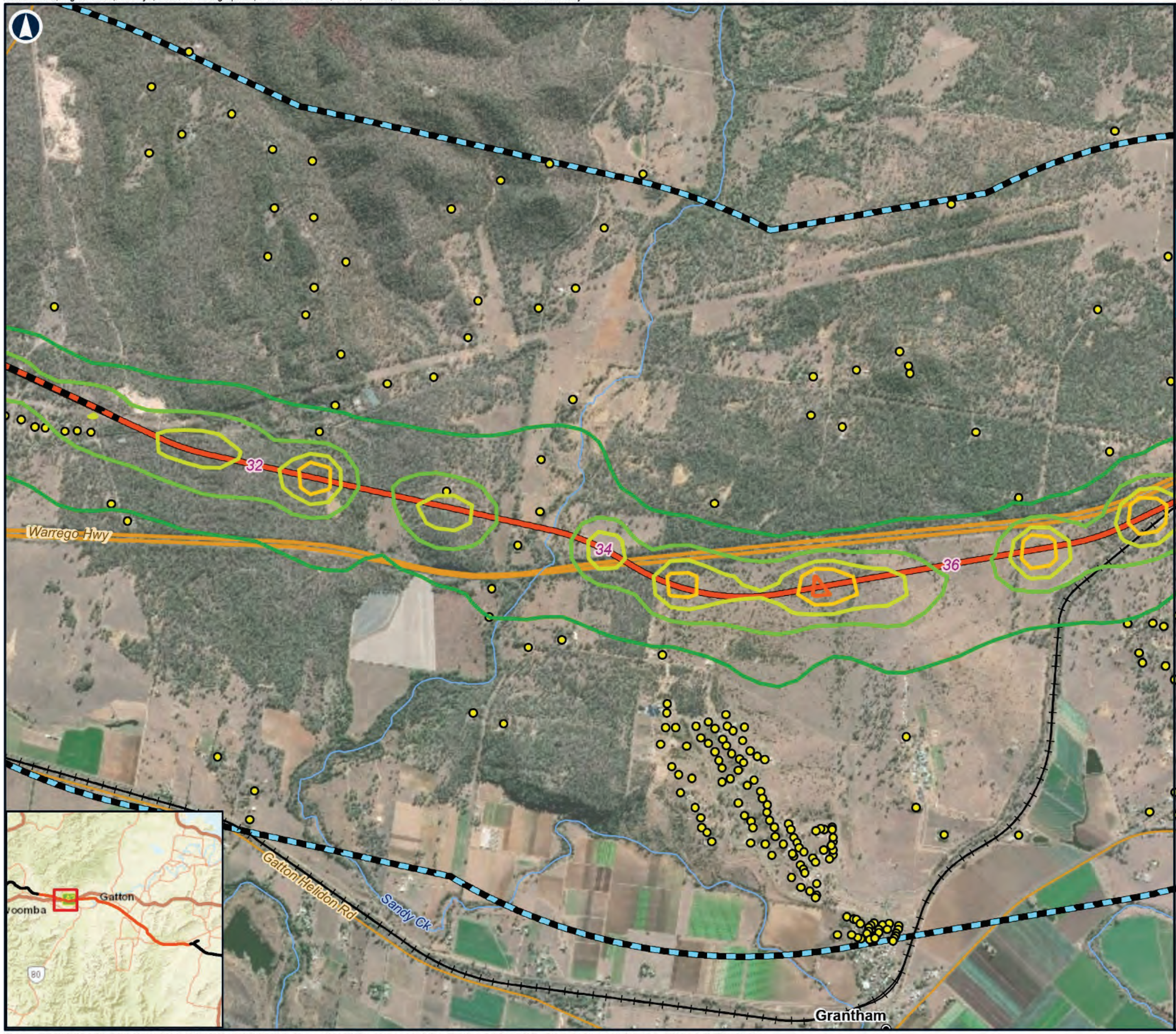
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.14b: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 8 μg/m³ Criterion

0 0.5 1 km

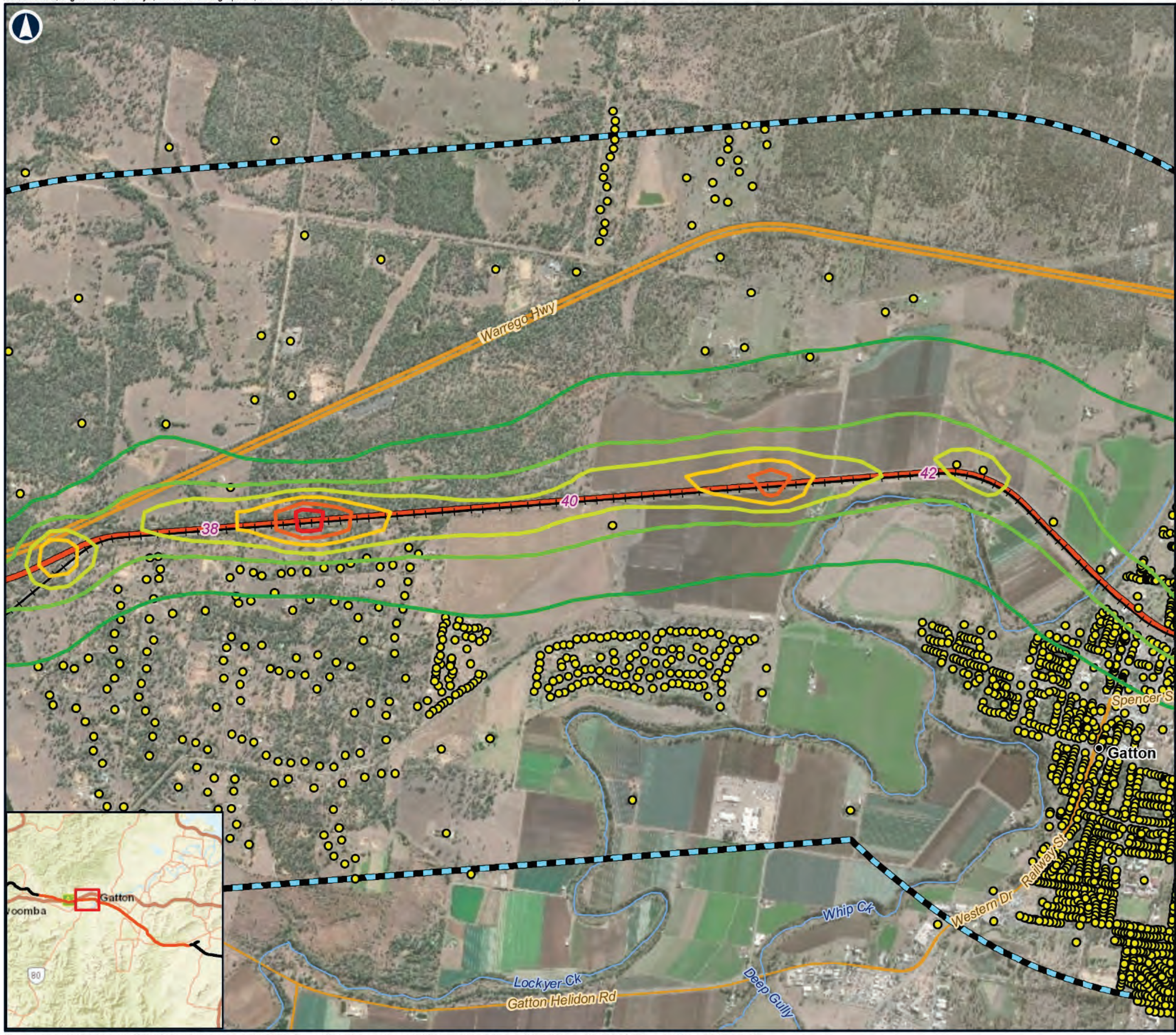
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.14c: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8
- 8 µg/m³ Criterion

0 0.5 1 km

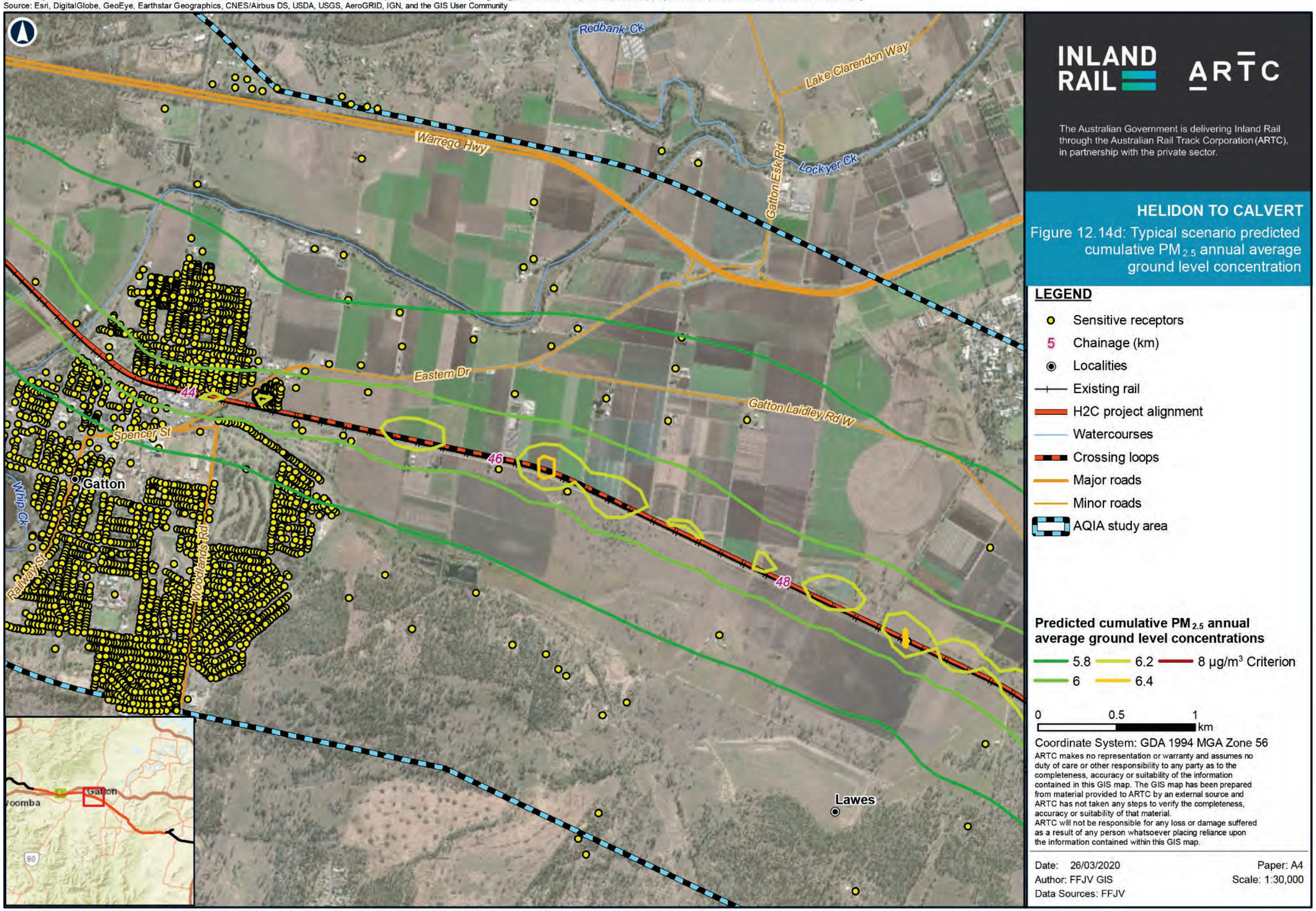
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

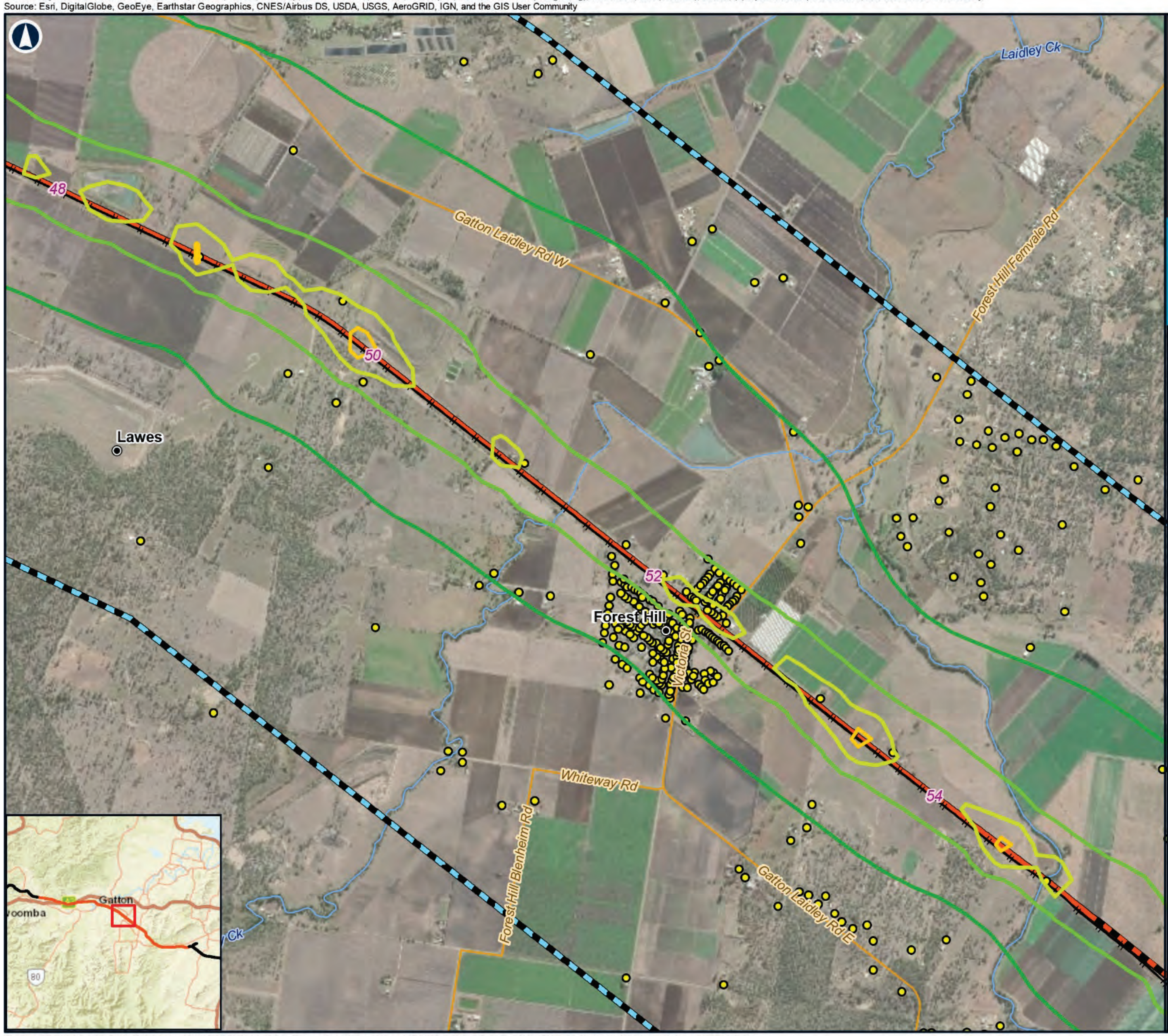
Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.14e: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 8 µg/m³ Criterion

0 0.5 1 km

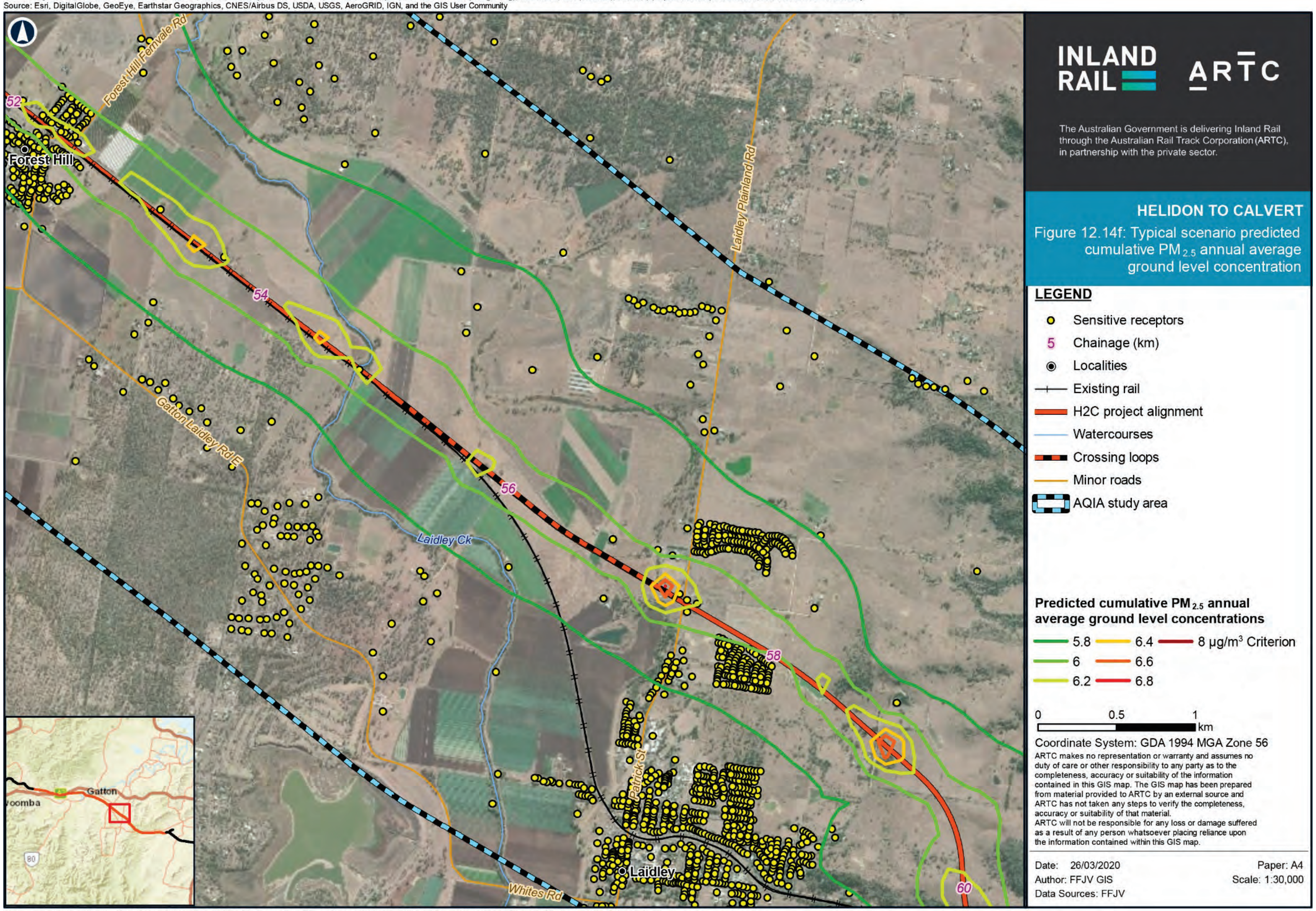
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

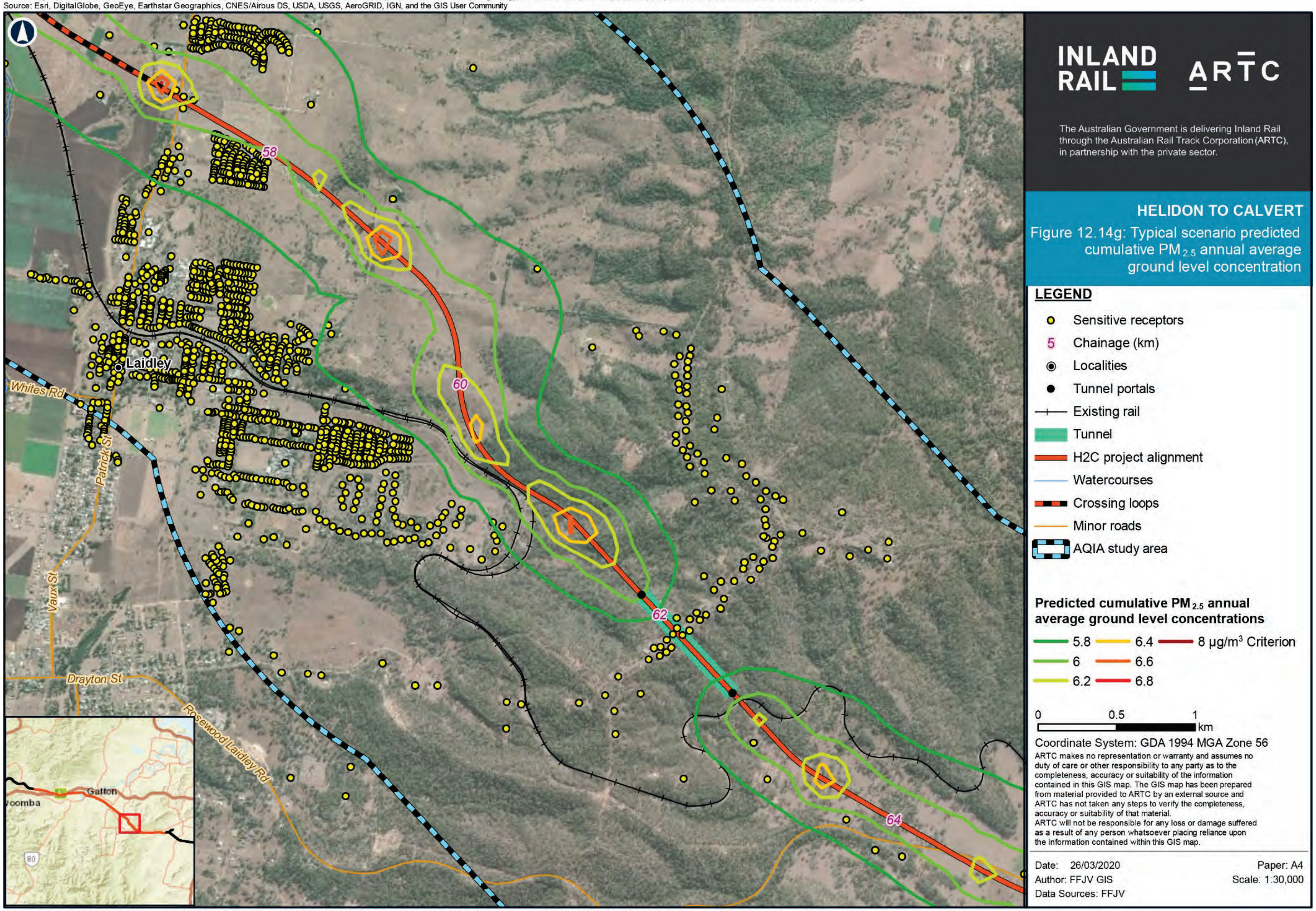
Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

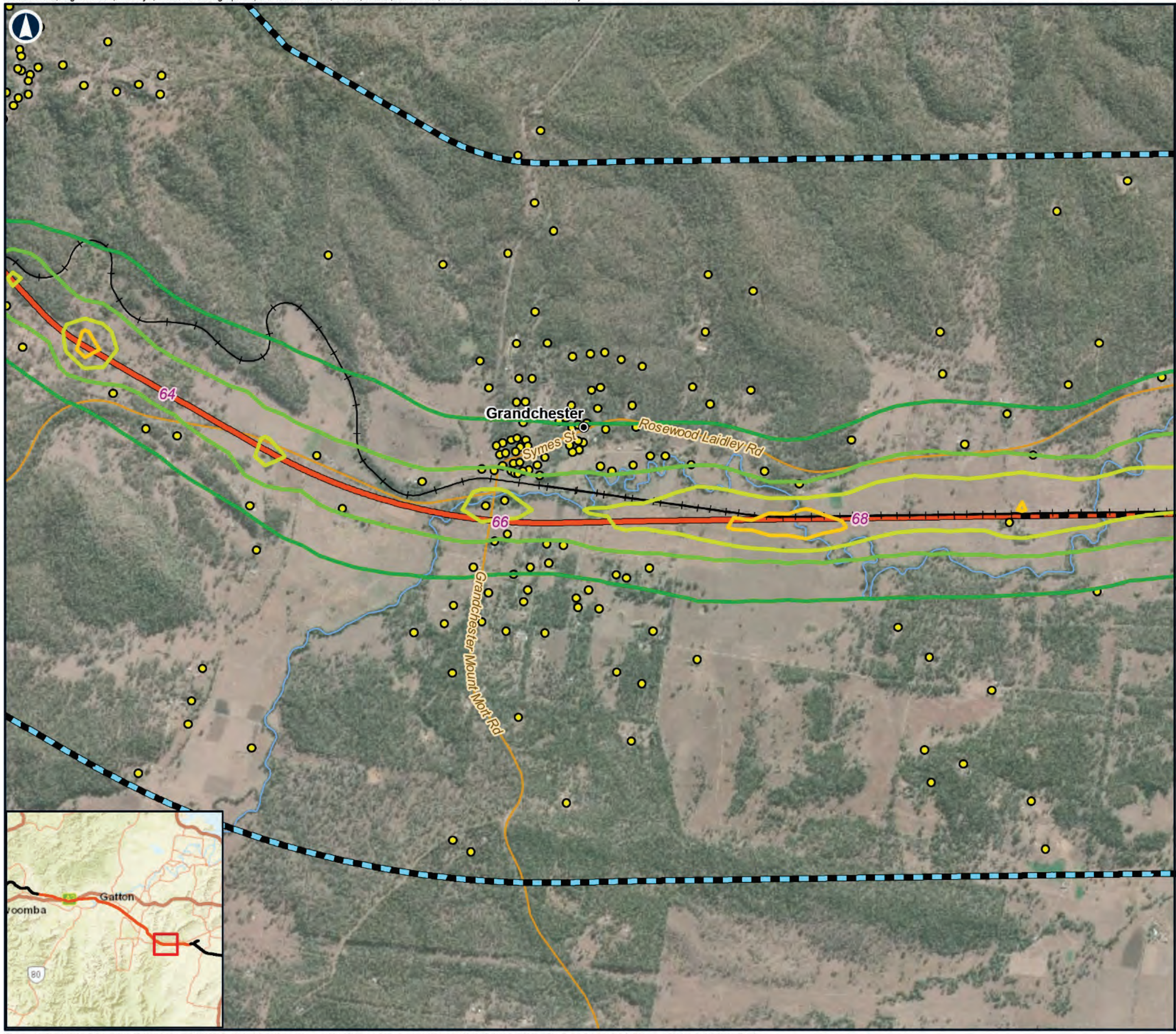



HELIDON TO CALVERT

Figure 12.14g: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.14h: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 8 µg/m³ Criterion

0 0.5 1 km

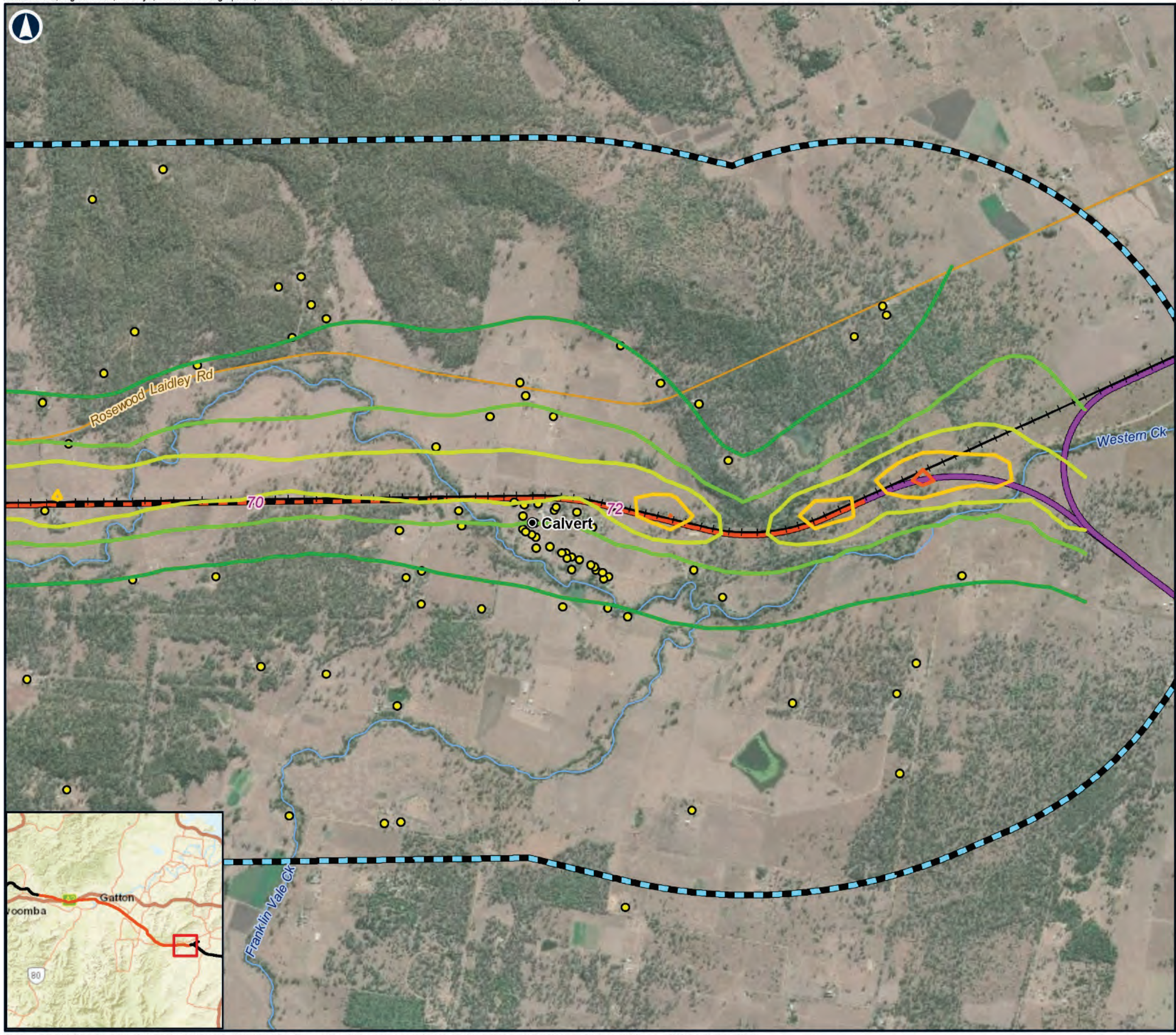
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.14i: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $PM_{2.5}$ annual average ground level concentrations**

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 8 µg/m³ Criterion

0 0.5 1 km

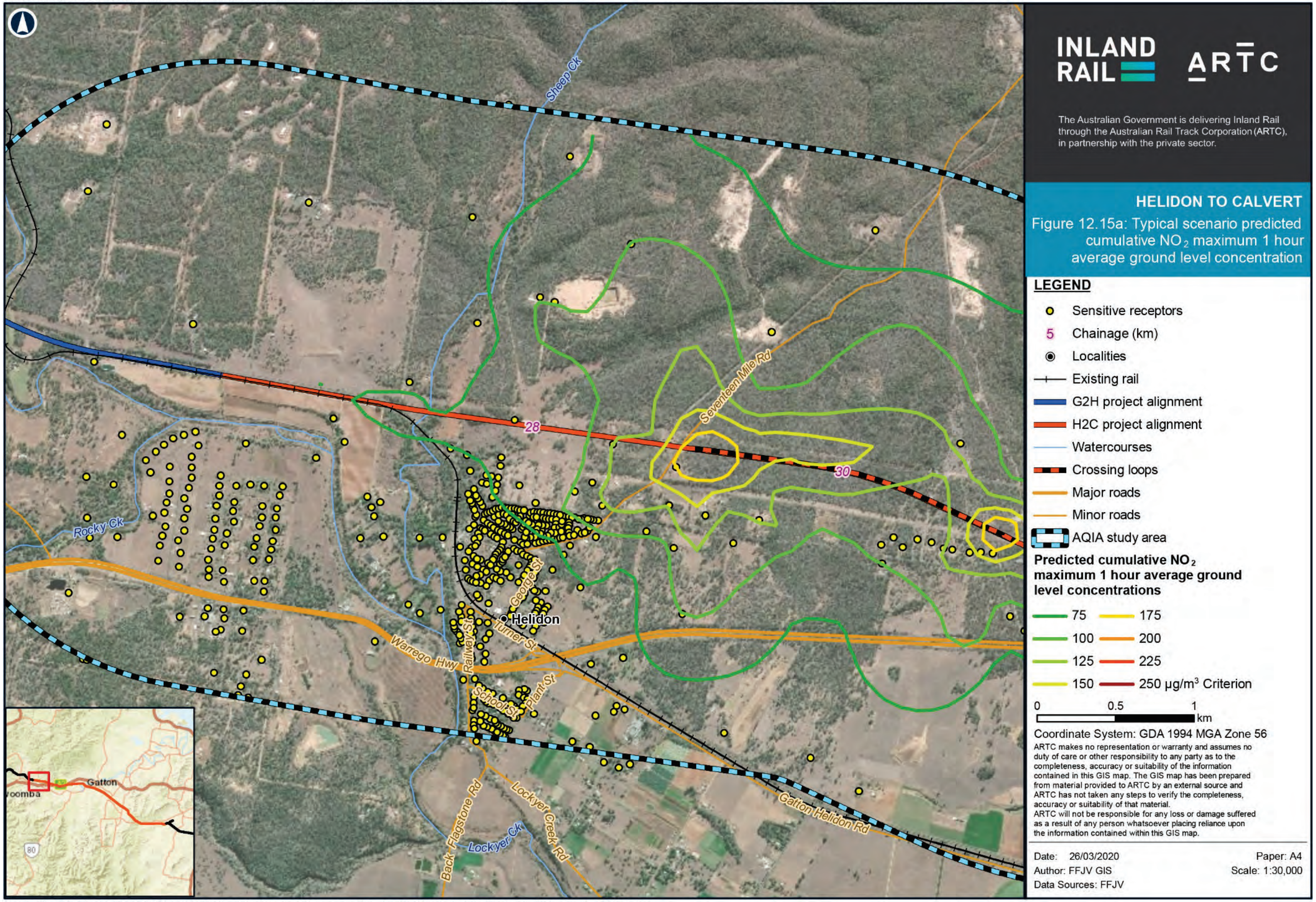
Coordinate System: GDA 1994 MGA Zone 56



Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

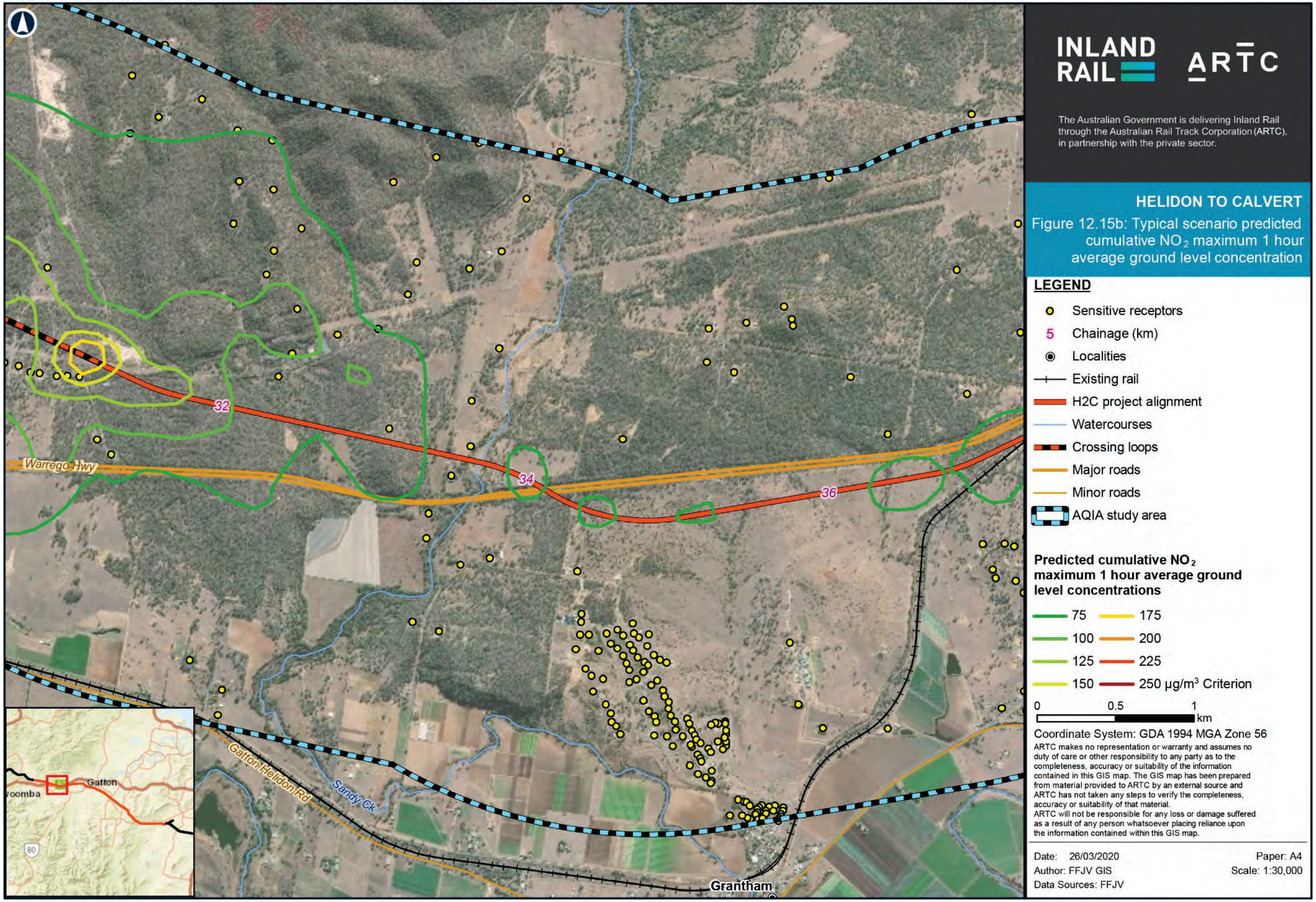
Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.14_Typical_PM2_5.mxd Date: 4/2/2020 12:00

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



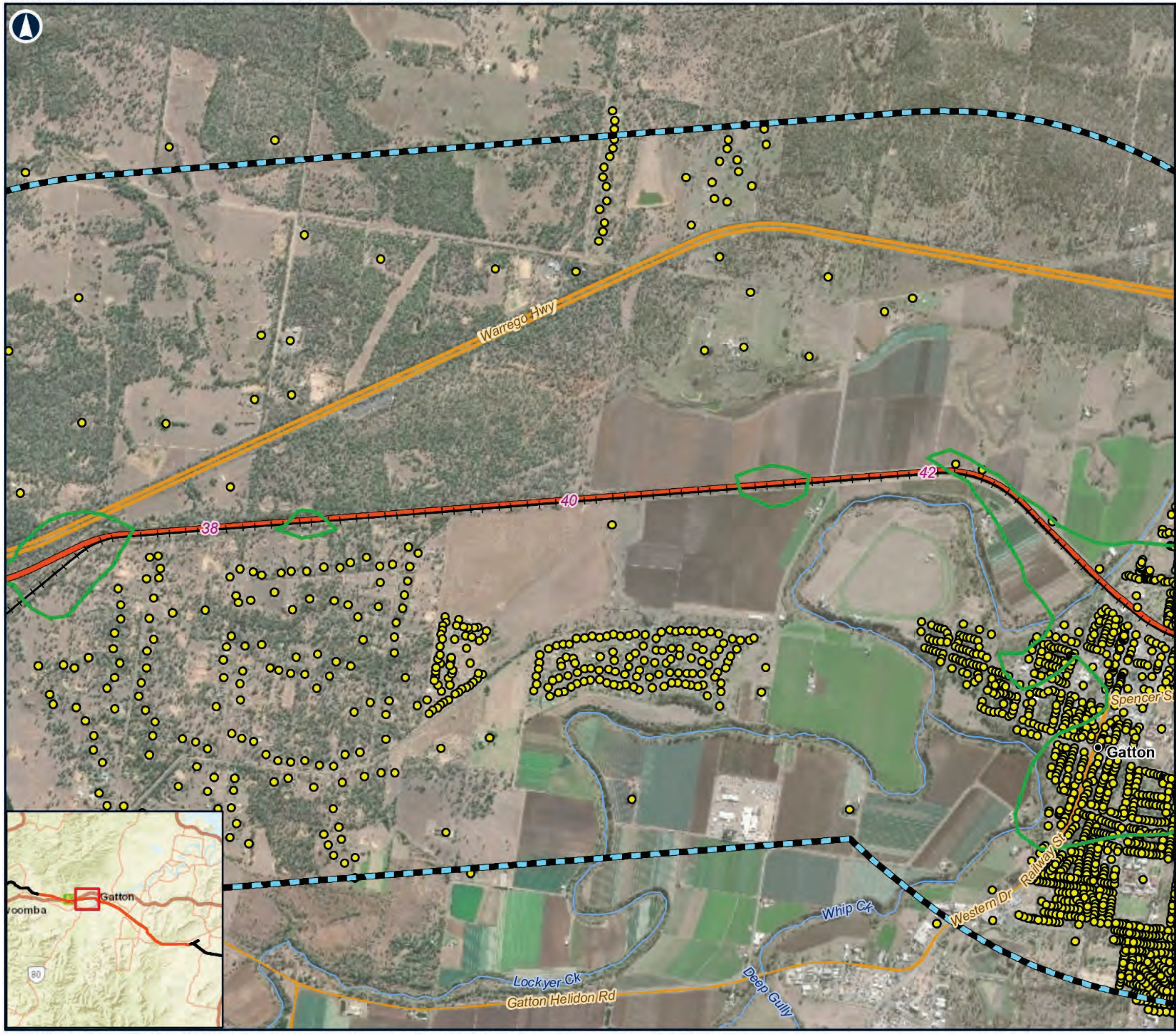

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.15c: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Major roads
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 µg/m$^3$ Criterion

0 0.5 1 km

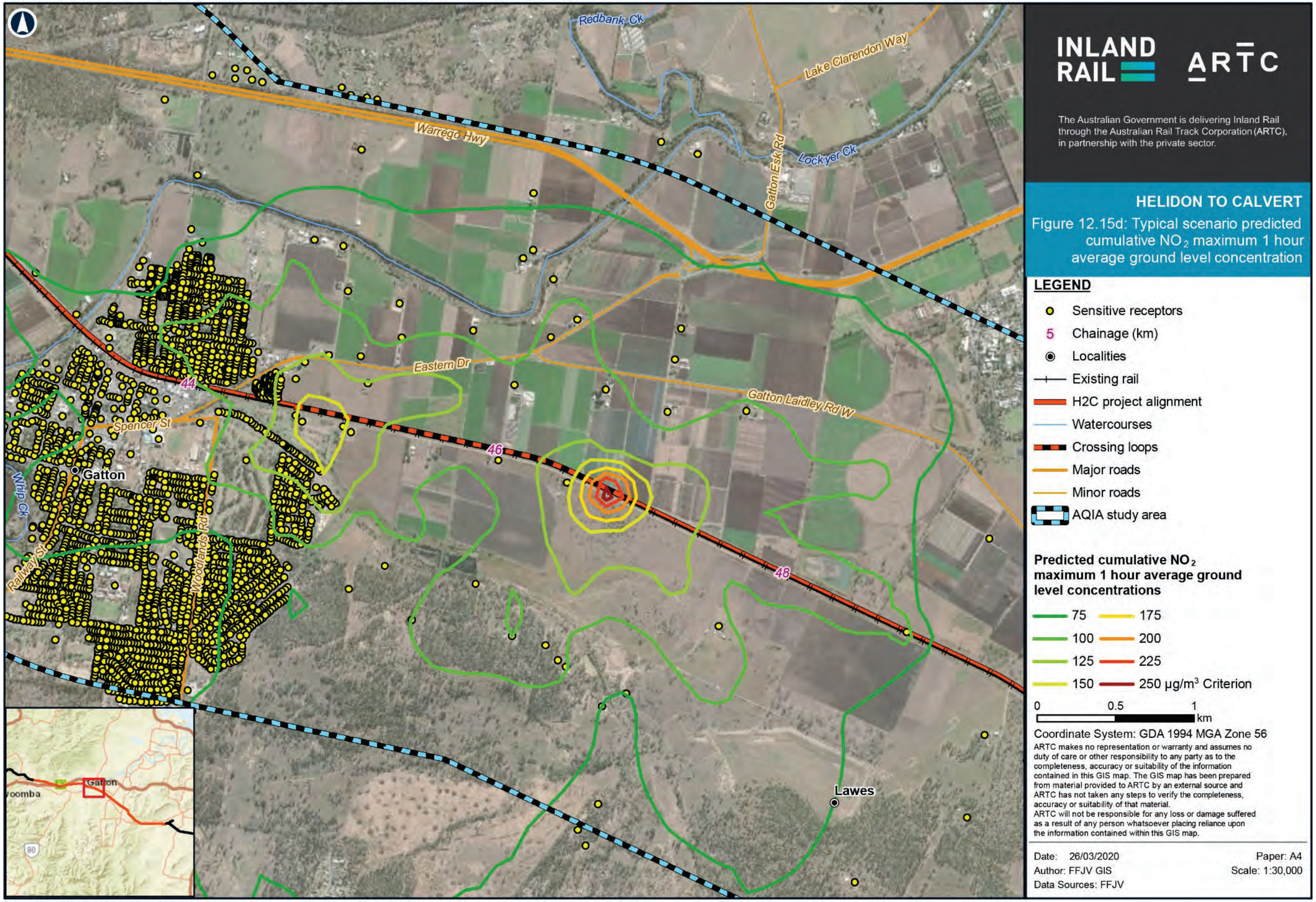
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




HELIDON TO CALVERT

Figure 12.15d: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.15e: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 µg/m³ Criterion

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.15f: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 μg/m³ Criterion

0 0.5 1 km

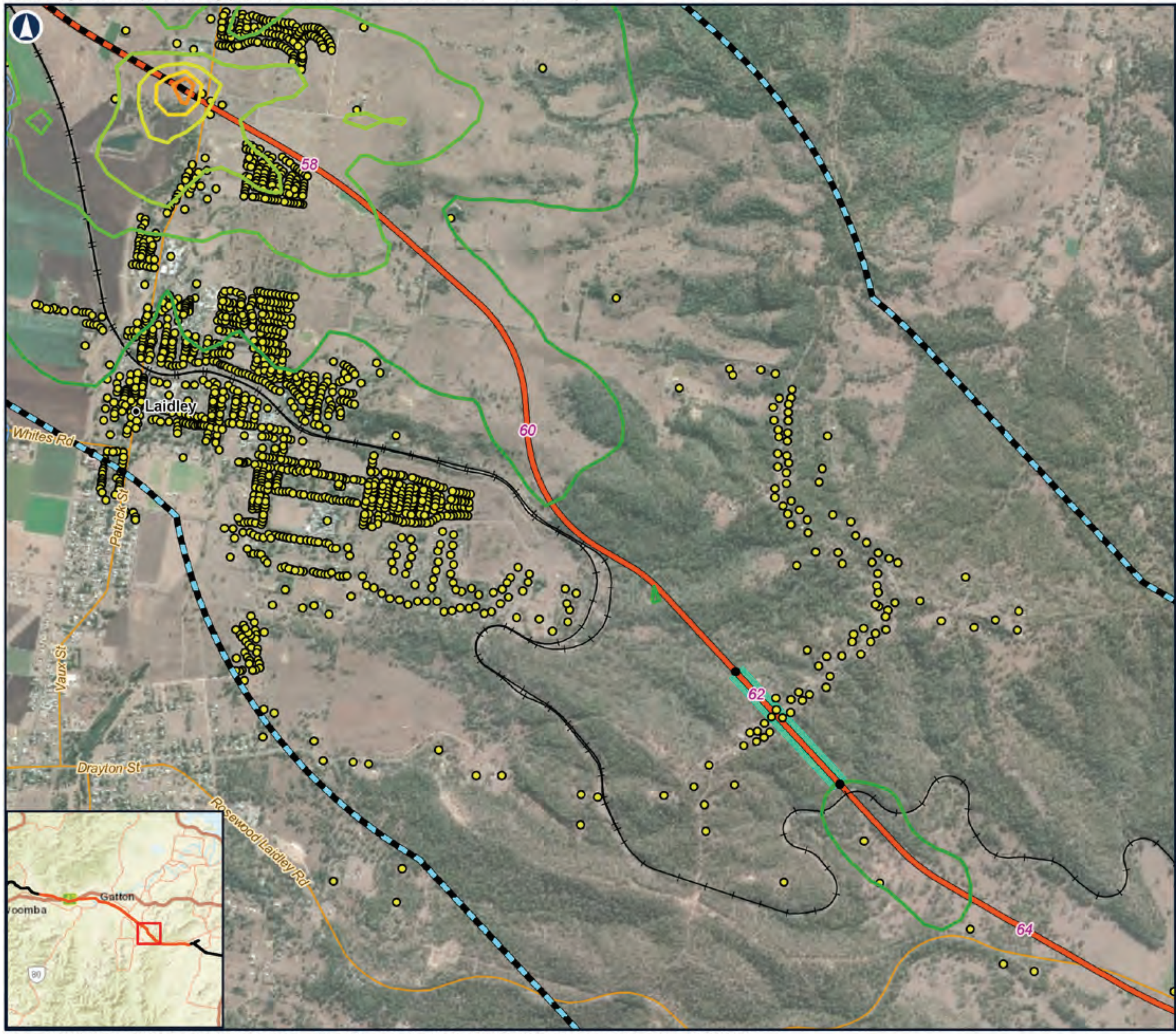
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material. ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

**HELIDON TO CALVERT**

Figure 12.15g: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Tunnel portals
- Existing rail
- Tunnel
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 µg/m$^3$ Criterion

0 0.5 1 km

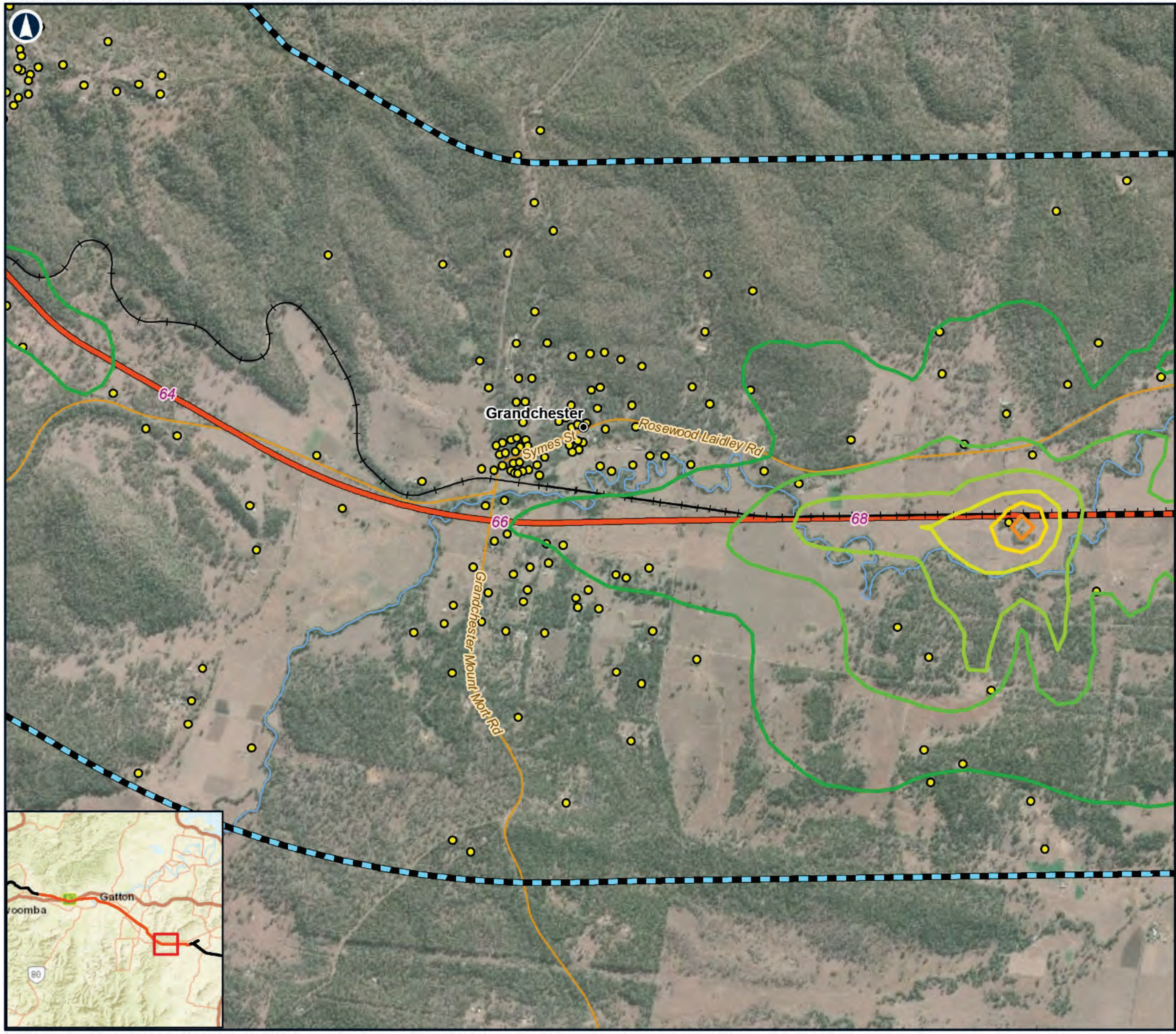
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.15h: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 µg/m³ Criterion

0 0.5 1 km

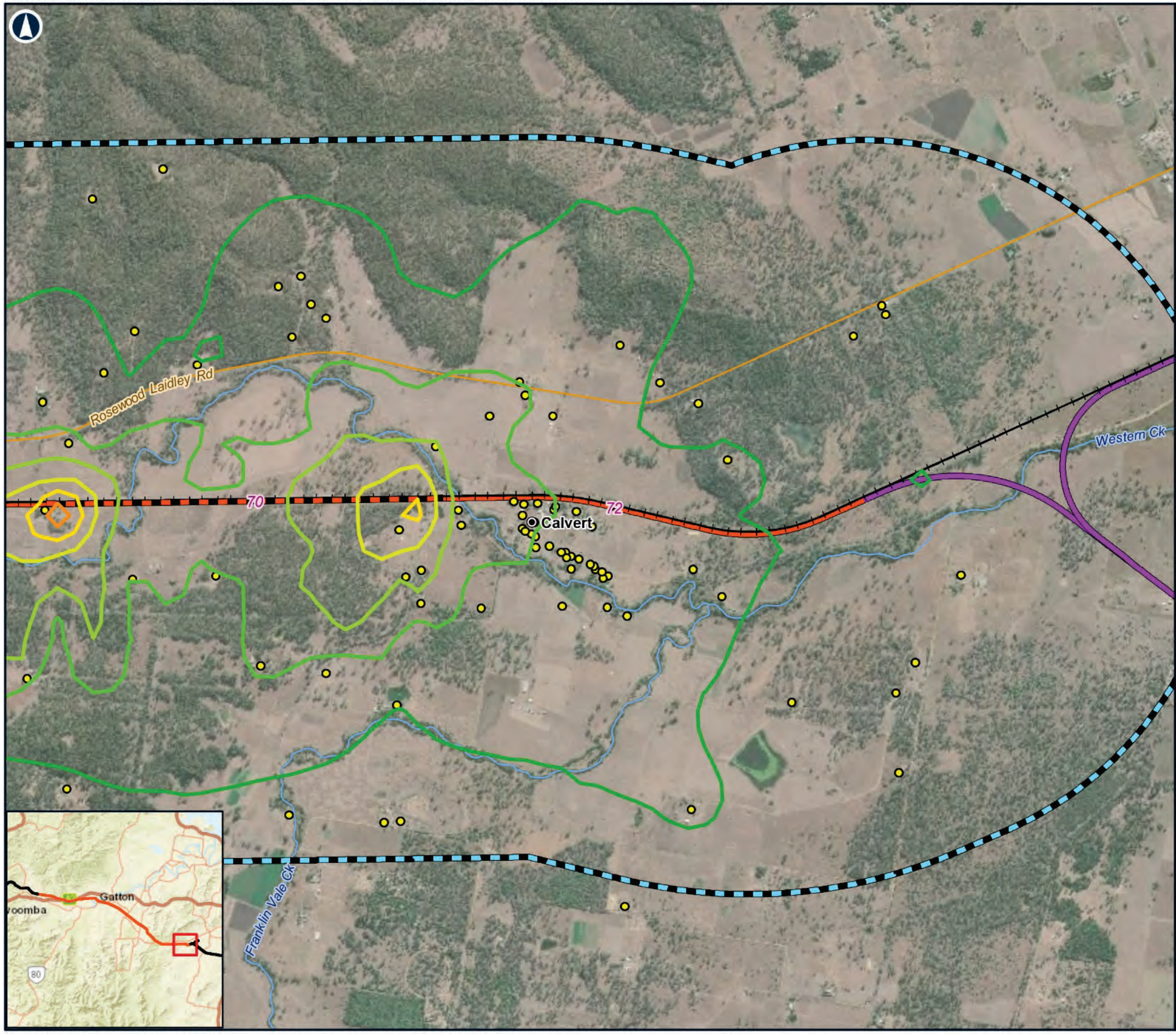
Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:30,000

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## HELIDON TO CALVERT

Figure 12.15i: Typical scenario predicted cumulative $NO_2$ maximum 1 hour average ground level concentration

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Crossing loops
- Minor roads
- AQIA study area

**Predicted cumulative $NO_2$ maximum 1 hour average ground level concentrations**

- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 250 µg/m³ Criterion

0 0.5 1 km

Coordinate System: GDA 1994 MGA Zone 56

ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
ARTC will not be responsible for any loss or damage suffered as a result of any person whatsoever placing reliance upon the information contained within this GIS map.

Date: 26/03/2020 Paper: A4
Author: FFJV GIS Scale: 1:30,000
Data Sources: FFJV

Map by: GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.15_Typical_NO2.mxd Date: 6/25/2020 10:41

### 12.7.3.2 Impacts to tank water quality

Table 12.37 presents the highest predicted pollutant concentrations for the water tanks for the worst-affected sensitive receptor for the typical train operations scenario without veneering. Table 12.37 also presents the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

**TABLE 12.37: HIGHEST PREDICTED WATER TANK CONCENTRATIONS AT WORST CASE RECEPTOR (TYPICAL TRAIN OPERATION)**

| Pollutant | Receptor | Maximum predicted annual deposition rate (µg/m /s) | Estimated roof area ($m^2$) | Maximum predicted total deposited mass (µg) | Tank water volume (L) | Highest predicted concentration (mg/L) | Guideline value (mg/L) |
|---|---|---|---|---|---|---|---|
| Arsenic | s1627 | $2.48 \times 10^{-11}$ | 200 [a] | 0.16 | 1,000 [b] | $1.57 \times 10^{-7}$ | 0.01 |
| Cadmium | | $2.48 \times 10^{-9}$ | | 15.7 | | $1.57 \times 10^{-5}$ | 0.002 |
| Lead | | $1.24 \times 10^{-10}$ | | 0.78 | | $7.38 \times 10^{-7}$ | 0.01 |
| Nickel | | $1.78 \times 10^{-8}$ | | 110 | | $1.10 \times 10^{-4}$ | 0.02 |
| Chromium VI | | $1.24 \times 10^{-8}$ | | 78.3 | | $7.83 \times 10^{-5}$ | 0.05 |

**Source:** *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018)
**Table notes:**
a) Based on the average surface area of a large house
b) Assumption of a 10,000 L water tank at 10 per cent capacity, with a resultant water volume of 1000 L.

Table 12.37 shows that at the worst-affected receptor, compliance is readily predicted for all pollutants.

As compliance with the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018) is predicted by a significant margin, the residual impact to drinking water is expected to be insignificant.

### 12.7.3.3 Agricultural impacts

The predicted maximum dust deposition levels for the worst-affected agricultural receptor in the AQIA study area are shown in Table 12.35 for the typical train volume scenarios with and without veneering. The predicted maximum cumulative (Project and background) deposition levels are summarised as follows:

- Typical train volume with veneering: cumulative deposition level of 50.1 mg/$m^2$/day
- Typical train volume without veneering: cumulative deposition level of 50.3 mg/$m^2$/day.

As discussed in Section 12.4.3, research on vegetation response to dust deposition impact has shown that a measurable reduction in crop growth is not observed below a dust deposition rate of 1,000 mg/$m^2$/day, and that a deposition rate of up to 4,000 mg/$m^2$/day does not influence the amount of feed cattle eat or the amount of milk produced. For each of the scenarios assessed the predicted maximum cumulative dust deposition level at the worst-affected receptor is well below these levels, with the highest predicted level being in the order of 50 mg/m /day. Based on the predicted results, the impact of dust deposition on agricultural uses within the AQIA study area is not anticipated to be significant.

### 12.7.3.4 Agricultural train odour impacts

Odour emissions from agriculture freight train passbys will be diluted due to the volume of air that will pass through and around the train over the duration of travel, and therefore odour emissions from moving agriculture freight trains are unlikely to cause significant impact.

Table 12.38presents an assessment of odour impacts from livestock freight trains using the FIDOL factors (refer Section 12.5.4.8 for definitions and methodology). Livestock trains will be the agriculture freight with the highest potential to impact sensitive receptors (greater potential than grain, as an example) and therefore have been assumed for the assessment of odour.

**TABLE 12.38: SUMMARY OF FIDOL FACTORS FOR ODOUR GENERATED BY AGRICULTURAL TRAINS**

| FIDOL factor | Livestock trains |
|---|---|
| Frequency (F) | During operations, it is expected that a maximum of six livestock trains per week will travel the alignment. As such, the frequency of the event is low, with an average of less than one livestock train per day. |
| Intensity (I) | Odour intensity is expected to range from strong to very strong for livestock trains |
| Duration (D) | Duration of exposure is expected to be short, with the time of exposure limited to the length of time taken for the train to pass a point along the alignment. At crossing loops, the exposure is expected to be longer but will still be relatively short. |
| Offensiveness (O) | The offensiveness of the odour is expected to be unpleasant |
| Location (L) | The land use of the receiving environment can be classified as mainly rural residential, rural, and residential for the larger town centres of Gatton and Laidley. Due to the land use of the receiving environment, odour from agricultural activities and livestock is expected to be common to the existing ambient air environment. People living and visiting rural areas are expected to have a higher tolerance for rural activities and their associated effects, such as odour. |

It is expected that odour produced from passing trains or trains stopped at crossing loops could be of high intensity and offensiveness, depending on the separation distance of the nearest sensitive receptors and the sensitivity of the receptor to odour. However, impacts are expected to be infrequent and of a short duration (one hour or less), and the Project is located in a predominantly rural area where odour from agricultural uses is likely to be common to the existing airshed. Odour emissions from agriculture freight are therefore unlikely to result in significant impact to neighbouring sensitive receptors.

### 12.7.4 Cumulative impact assessment

When projects occur within proximity to each other they can cause cumulative impacts. It is a requirement of the ToR that potential cumulative impacts are considered.

As discussed in Section 12.5.4, assessment of the operational phase of the Project has assessed cumulative impacts by considering emissions from existing or planned developments that are, or will, be a significant source of ‘pollutants of interest’ that are also relevant to the Project. Specifically, dispersion modelling undertaken for the assessment of operational phase air quality impacts has included emissions from the adjoining sections of the Inland Rail Program adjacent to the Project, namely the G2H and C2K sections. No other projects (in addition to G2H and C2K) were identified that required inclusion in the assessment of cumulative operational phase impacts. As cumulative impacts for the operational phase have already been considered in detail, this cumulative impact assessment is limited to the construction phase of the Project only.

In addition to G2H and C2K, there are three ‘State significant’ or ‘strategic’ projects located within or near the air quality study area that require consideration of cumulative air quality impacts for the construction phase. The significance of cumulative impacts resulting from the construction of these projects, concurrently with the construction of the Project, has been assessed in this section.

The potential significance of cumulative impacts that may arise as a result of the Project, in combination with others, has been assessed following the risk matrix method presented in Chapter 22: Cumulative impacts, adapted to consider individual projects. The significance of the potential cumulative impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect (low, medium or high). Details on the assessment methodology for cumulative impacts is also presented in Appendix K: Air Quality Technical Report.

The projects considered in the cumulative impact assessment are listed in Table 12.39. The locations of the assessed projects are shown in Figure 12.16.

**TABLE 12.39: PROJECTS CONSIDERED FOR THE CUMULATIVE IMPACT ASSESSMENT**

| Project and proponent | Location | Description | Construction dates |
|---|---|---|---|
| G2H (ARTC) | Immediately west of the Project, the rail alignment travels from Gowrie to Helidon | Comprised of approximately 26 km single-track dual-gauge freight rail line, a tunnel through the Toowoomba Range and connection to the existing West Moreton Railway Line. | 2021 to 2026 |
| C2K (ARTC) | Immediately east of the Project, the rail alignment travels from Calvert to Kagaru | Comprised of approximately 53 km single-track dual-gauge freight rail line, a tunnel through the Teviot Range, a connection to the existing Sydney to Brisbane interstate railway line at Kagaru and connection to the existing West Moreton Railway Line. | 2021 to 2026 |
| RAAF Base Amberley future works (Department of Defence) | RAAF Base Amberley is approximately 14 km to the east of the Project at its closest point | A white paper has been issued dedicated to future upgrades to RAAF Base Amberley. The total cost of the upgrade work is anticipated to be approximately $1 billion. | 2016 to 2022 |
| Gatton West Industrial Zone (GWIZ) (Lockyer Valley Regional Council) | 3 km north-west Gatton, adjacent to the northern boundary of the Project | Industrial development including a transport and logistics hub on the Warrego Highway. | 2019 to 2024 |
| InterLinkSQ (InterLinkSQ) | 13 km west of Toowoomba, approximately 24 km to the west of the western extent of the Project | 200 ha of new transport, logistics and business hubs. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways. | 2017 to 2037 |

The results of the assessment of cumulative impacts are presented in Table 12.40.

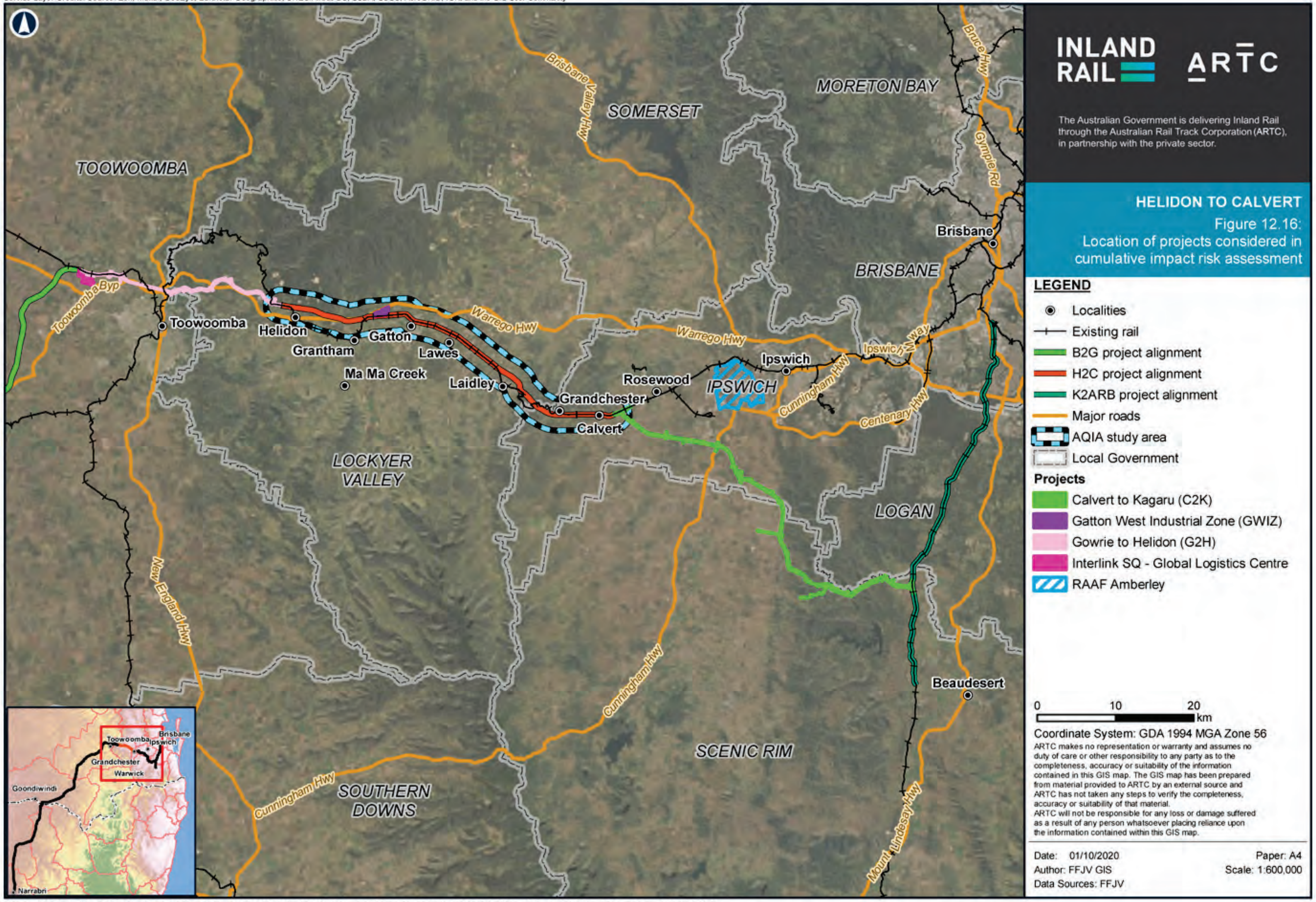
As discussed, this cumulative impact assessment (excluding G2H and C2K) assesses the potential for cumulative impacts arising from emissions during the construction phase of these projects only. However, for information, comments on anticipated operational emissions from the assessed projects have also been provided in Table 12.40.

The relevance factor for the sensitivity of the receiving environment in Table 12.40 has been assigned as 'Low' for all projects. This factor has been assigned considering the number of sensitive receptors that may be affected by cumulative impacts with the assessed project, the sensitivity to the emissions that will cause the impact (e.g. dust) and the mostly isolated nature of construction phase emissions from the Project.

Based on the assigned relevance factors, Table 12.40 shows that cumulative air quality impacts are expected to be of Low significance for all assessed projects.

Mitigation measures for the construction phase of the Project are recommended in Section 12.8.3. The recommended mitigation measures for the Project will reduce the potential for cumulative impacts at sensitive receptors and it is expected that implementation of the recommended mitigation measures in combination with the implementation of a CEMP will be sufficient to minimise the risk of significant cumulative impacts.

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community




HELIDON TO CALVERT

Figure 12.16: Location of projects considered in cumulative impact risk assessment

Map by: DMcP/MF/LCT/IW/DTH Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201908261353_Air_quality_100pc_delivery\330-EAP-201908261353_ARTC_Fig12.16_Cumulative.mxd Date: 1/10/2020 14:45

**TABLE 12.40: CUMULATIVE IMPACT ASSESSMENT OF ASSESSABLE PROJECTS**

| Project | Potential cumulative impact | Aspect | Relevance factor | Sum of relevance factors | Impact significance | Comments and management measures |
|---|---|---|---|---|---|---|
| G2H (ARTC) | The construction and operation of the Project will occur concurrently with the construction and operation of G2H. Air emissions could impact receptors located near both projects. Air emissions from the operation of G2H have been assessed as part of the assessment of the operation of the Project. | Probability of the impact<br>Duration of the impact<br>Magnitude/ intensity of the impact<br>Sensitivity of the receiving environment | Medium (2)<br>Medium (2)<br>Low (1)<br>Low (1) | 6 | Low | ▶ The significance of cumulative is considered to be Low.<br>▶ Recommended mitigation measures for the construction phase of the Project are presented in Section 12.8.3. Mitigation measures will also be recommended for the G2H project in the projects EIS. It is expected that the potential for cumulative impacts will be appropriately managed through the implementation of mitigation measures and a CEMP.<br>▶ Cumulative impacts as a result of the operation of both projects has been assessed in detail, with the results of the operational phase assessment presented in Section 12.7.3. |
| C2K (ARTC) | The construction and operation of the Project will occur concurrently with the construction and operation of C2K. Air emissions could impact receptors located near both projects. Air emissions from the operation of C2K have been assessed as part of the assessment of the operation of the Project. | Probability of the impact<br>Duration of the impact<br>Magnitude/ intensity of the impact<br>Sensitivity of the receiving environment | Medium (2)<br>Medium (2)<br>Low (1)<br>Low (1) | 6 | Low | ▶ The significance of cumulative impacts is considered to be Low.<br>▶ Recommended mitigation measures for the construction phase of the Project are presented in Section 12.8.3. Mitigation measures will also be recommended for the C2K project in the projects EIS. It is expected that the potential for cumulative impacts will be appropriately managed through the implementation of mitigation measures and a CEMP.<br>▶ Cumulative impacts as a result of the operation of both projects has been assessed in detail, with the results of the operational phase assessment presented in Section 12.7.3. |
| RAAF Base Amberley future works (Department of Defence) | Overlap of construction of the Project with construction to upgrade RAAF Base Amberley. | Probability of the impact<br>Duration of the impact<br>Magnitude/intensity of the impact<br>Sensitivity of the receiving environment | Low (1)<br>Low (1)<br>Low (1)<br>Low (1) | 4 | Low | ▶ The significance of cumulative impacts is considered to be Low.<br>▶ Due to separation distance, significant cumulative impacts are not anticipated due to simultaneous construction activities. Ongoing development at RAAF Base Amberley may see an increase in localised road traffic but this is not expected to result in significant impacts.<br>▶ No additional mitigation measures are required. |

| Project | Potential cumulative impact | Aspect | Relevance factor | Sum of relevance factors | Impact significance | Comments and management measures |
|---|---|---|---|---|---|---|
| Gatton West Industrial Zone (GWIZ)<br>(Lockyer Valley Regional Council) | The construction and operational phases of the GWIZ project overlap with the construction and operational phases of the Project. The GWIZ is located adjacent to the northern boundary of the Project, between the Project alignment and the Warrego Highway. Air emissions during the construction and operational phases could impact receptors located near both projects. | Probability of the impact | Low (1) | 4 | Low | ▸ The significance of cumulative is considered to be Low.<br>▸ Construction of the GWIZ will generate emissions to air. However, it is considered unlikely that construction for each project will occur in the same localised area simultaneously to the extent that would cause significant impacts to existing receptors. Based on the locations of sensitive receptors near both projects, significant cumulative impacts are considered unlikely.<br>▸ The operation of the GWIZ will likely increase road traffic on surrounding roads, including the Warrego Highway. However, increases in emissions as a result of the GWIZ project are not considered to present a risk of significant cumulative impacts to receptors in the AQIA study area. Emissions may occur from the operation of industries within the GWIZ. However, the type of emissions will depend on the individual industries, and individual impact assessments will be required for proposed polluting land uses.<br>▸ No additional mitigation measures are required further to those recommended for the Project. It is expected that the recommended mitigation measures for the construction of the Project will be sufficient to minimise the risk of cumulative impacts. |
| | | Duration of the impact | Low (1) | | | |
| | | Magnitude/ intensity of the impact | Low (1) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |
| InterLinkSQ (InterLinkSQ) | Overlap of the construction and operation of InterLinkSQ with the construction and operation of the Project.<br>The InterlinkSQ site is located approximately 24 km to the west of the western extent of the Project. | Probability of the impact | Low (1) | 4 | Low | ▸ The significance of cumulative impacts is considered to be Low.<br>▸ Air emissions will be generated during construction (predominantly construction dust) and operation (predominantly combustion gases from transport engines). The InterlinkSQ project is located near G2H but has significant separation distance from the Project (approximately 24 km). Emissions to air from this project do not present a risk of cumulative impacts due to the separation distance between the project and the AQIA study area.<br>▸ No additional mitigation measures are required. |
| | | Duration of the impact | Low (1) | | | |
| | | Magnitude/ intensity of the impact | Low (1) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |

### 12.7.5 Decommissioning

Given the uncertainty associated with the timeframe for decommissioning, this phase has not been considered further in this AQIA.

## 12.8 Mitigation

This section outlines the initial mitigation measures included in the Project design and identifies proposed mitigation measures to manage potential air quality impacts during relevant Project phases.

No comprehensive guideline information is currently available for best practice environmental management measures for the emissions of air pollutants from construction-related emissions in Queensland or Australia. Guidance on management measures is provided within the UK IAQM *Guideline for the assessment of dust from demolition and construction* (UK IAQM, 2014); however, many of these measures are tailored to the United Kingdom and are not necessarily applicable for Australia. Where similar conditions do exist, the recommended mitigation measures do align with the suggested mitigation measures from the UK IAQM guideline document. Mitigation measures prescribed in the *NPI Emissions Estimation Manual for Mining* (NPI, 2012) are also considered applicable for the construction phase and select mitigation measures from this document have been recommended.The identified mitigation measures represent best practice environmental management of air emissions.

### 12.8.1 Design considerations

The mitigation measures incorporated in the Project design are presented in Table 12.41. These design measures have been identified through collaborative development of the design and consideration of environmental constraints and issues, including proximity to potentially affected sensitive receptors. The design measures are relevant to both construction and operational phases of the Project.

**TABLE 12.41: INITIAL MITIGATION IN DESIGN**

| Aspect | Initial mitigation |
|---|---|
| Emissions from refuelling activities during construction | The planning, siting and assessment of potential fuel storage locations has taken into consideration the location of existing potentially affected sensitive receptors. |
| Emissions from construction vehicles | The horizontal and vertical alignment has been established to optimise the earthworks and minimise excess spoil (where possible). By minimising the material deficit for construction of the Project, the volume of material required to be handled and transported has been reduced. Less material handling reduces potential road transport truck movements and reduces emissions.<br>Construction phase haulage routes that provide the shortest journey time between origin and destination have been considered. Optimised haulage routes minimise fuel consumption and vehicular emissions. |
| Fugitive dust emissions (windborne erosion) during construction and operation | The Project disturbance footprint has aimed to minimise clearing extents to that required to construct and operate the works.<br>Laydown areas and other construction-phase facilities have been located to avoid impacts.<br>Batters, embankments and exposed surfaces have been designed with regard to slope and stabilisation. This will reduce potential fugitive dust emissions. |
| Emissions from operational locomotives | The Project has been aligned to avoid, where possible, steep terrain and topographical constraints to provide for more efficient operational track geometry and grade. This results in faster train transit time and less locomotive emissions. |
| Emissions from idling locomotives | The planning and siting of crossing loops at Helidon, Gatton, Laidley, and Calvert has considered the location of nearest existing potentially affected sensitive receptors. |

### 12.8.2 Operational management measures

Dust and air quality management measures will be incorporated into the environmental risk management frameworks that will apply to all third-party freight train operators. These will be implemented as part of future network access agreements. The access agreements established will require train operators to prepare suitably detailed environmental and risk management plans for their operations. The plans will include clear performance requirements and traceable corrective measures. The plans will be subject to verification and auditing.

The operational AQIA has assumed that a number of the operational management measures as required by the *South West Supply Chain QR West Moreton System rail corridor Coal Dust Management Plan* (South West Supply Chain, 2019), such as veneering, are applied to the Project. The mitigation measures aim to minimise surface lift-off of materials in the transit of coal and establishes protocols to minimise spillage onto external areas of wagons to reduce potential emissions. Additional measures currently implemented through the South West Supply Chain include:

- Coal washing and moisture management
- Load profiling and use of 'garden bed profile'
- Monitoring of performance.

The assessment of the operational phase has determined that veneering will minimise and reduce potential particulate matters impacts. The implementation of veneering has been assumed to reduce coal dust emissions from coal laden trains by 75 per cent as discussed in Section 12.5.4.2. With veneering, the assessment of the operational phase of the Project for impacts to air quality and water tank quality (refer Section 12.7.3) has determined that compliance is predicted for all adopted air quality and water quality goals.

Veneering is currently applied to coal trains that use the West Moreton System rail corridor. Therefore, existing coal services that currently use the West Moreton System rail corridor and will use the Project in the future, will already implement veneering.

Prior to operation of the Project, engagement will be undertaken with existing stakeholders and members of the South West Supply Chain (including DTMR, DES Queensland Resources Council, local councils and Queensland Rail) with regards to coal dust management and monitoring requirements necessary to maintain the integrity of the existing South West Supply Chain Coal Dust Management Plan. The South West Supply Chain Coal Dust Management Plan is considered to be best practice with respect to managing emissions from coal trains. Section 12.8.4.3 discusses how the performance of mitigation measures will be monitored, reported and audited.

Commissioning and maintenance activities with the potential to generate dust or air quality impacts will be governed by ARTC's Environmental Management System and managed in accordance with the measures described in draft Outline EMP (refer Chapter 23: Draft Outline Environmental Management Plan).

### 12.8.3 Proposed mitigation measures

To manage Project risks during construction and operation, mitigation measures have been proposed. The air quality mitigation measures have been identified to address: Project-specific issues and opportunities, legislative requirements and accepted government plans, policy and practice.

Table 12.42 identifies the relevant Project phase, the aspect to be managed, and the proposed potential mitigation measures. For several of the proposed mitigation measures, the expected control efficiency (emission reduction percentage) has been nominated. The control efficiencies reported have been obtained from the NPI *Emissions Estimation Manual for Mining* (NPI, 2012).

For key emission sources, there are multiple mitigation measures available. In the pre-construction and construction phases of the Project, dust sources will be variable and transitory in nature and the potential for impacts will vary with proximity to sensitive receptors. The exact method of mitigation implemented will be determined during construction phase planning and following confirmation of the availability and suitability of water supply sources.

During the commissioning phase of the Project, air emissions are expected to be limited to combustion engine emissions associated with transport vehicles and train locomotives, and limited dust emissions from vehicle travel on unsealed roads. Mitigation measures for transport vehicles (dust and combustion engine emissions) are the same during the construction and commissioning phases and, therefore, the mitigation measures in Table 12.41 are combined for these phases. Air emissions from train locomotives during the commissioning phase are not expected to be significant and therefore no mitigation measures are required for train locomotives in this phase.

The draft Outline EMP (Chapter 23: Draft Outline Environmental Management Plan), provides further context and the framework for implementation.

**TABLE 12.42: AIR QUALITY MITIGATION MEASURES**

| Delivery phase | Aspect | Proposed mitigation measures |
|---|---|---|
| Detailed design | Availability of water for dust suppression and stabilisation during construction | Prior to construction, quantities of water required for dust suppression, construction, landscaping and stabilisation activities will be confirmed. The availability and suitability of water supply sources will be determined and where water supply is deemed insufficient or in high demand for other uses, other dust suppression and stabilisation methods will be implemented. |
| | Emissions from refuelling activities during construction | Design of fuel storage areas will ensure that fuel tanks will be located at least 50 m from the nearest sensitive receptor, with separation distances maximised as far as practical within site restrictions. |
| | Fugitive dust emissions (windborne erosion) | Clearing extents limited to the disturbance footprint and minimised to that required to safely construct, operate and maintain the Project.<br>Laydown areas and other construction-phase facilities will be designed and arranged to minimise emissions and reduce the potential for air quality impacts to sensitive receptors. Design considerations will include the locations of stockpiles, activity areas, travel routes, rumble grids and truck washdown areas.<br>Earthworks and landscape design of railway batters and other exposed surfaces will be designed to incorporate treatments and enable stabilisation to reduce wind erosion. |
| | Emissions reporting requirements | Emissions reporting requirements for the construction phase will be confirmed during detail design and be consistent with the Sustainability Management Plan. |
| Pre-construction and construction | Dust generation pre-construction activities | Vehicle travel on unsealed roads will be minimised as far as practical. Sealed roads will be used where possible, in accordance with the Project Construction Traffic Management Plan.<br>Disturbed areas will be rehabilitated and stabilised as soon as practical upon completion of works. |
| Construction and commissioning | Dust generation from earthworks, clearing and grubbing, mobile plant activity and wind erosion of exposed areas within the temporary construction disturbance footprint | Limit clearing to:<br>▸ The disturbance footprint as identified during the detailed design constructability assessment and planning<br>▸ That required to safely construct and operate the Project.<br>Where practical, stage clearing and grubbing and construction activities to limit the size of exposed areas.<br>Adequate precautions to effectively minimise the generation of dust, which may affect the safety and general comfort of the travelling public, the construction contractor's employees and/or occupants of adjacent buildings, during the construction of the work will be undertaken. This will involve regular applications of water or other measures along the sections of the work traversed by the travelling public, as required, to minimise dust.<br>Implement water sprays or other measures to reduce dust emissions from:<br>▸ Excavation or disturbance of soils or vegetation, or handling ballast<br>▸ Trucks unloading material (up to 70 per cent reduction achievable)<br>▸ Mobile plant loading to or from material stockpiles (up to 50 per cent reduction achievable).<br>To reduce wind erosion, the following mitigation methods will be used subject to water availability and stockpile activity:<br>▸ Water sprays (up to 50 per cent reduction achievable)<br>▸ Wind breaks or earthworks profiling (up to 30 per cent reduction achievable)<br>▸ Application of rock armour/covering (up to 30 per cent reduction achievable)<br>▸ Covering of the stockpile (i.e. tarpaulin) or binding agent (up to 100 per cent reduction achievable).<br>If water sprays or other measures are implemented for stockpiles, the application rate of water will be increased for stockpiles that will receive new material regularly, such as tunnel excavation stockpiles. |

| Delivery phase | Aspect | Proposed mitigation measures |
|---|---|---|
| Construction and commissioning (continued) | Dust generation from earthworks, clearing and grubbing, mobile plant activity and wind erosion of exposed areas within the temporary construction disturbance footprint (continued) | Disturbed areas and exposed surfaces will be stabilised as a soon as practical. The following mitigation methods will be used subject to final purpose of the exposed area:<br>- Initial establishment of vegetation (up to 30 per cent reduction achievable)<br>- Maintained revegetation (up to 90 per cent reduction achievable)<br>- Establishment of self-sustaining rehabilitation vegetation (up to 100 per cent reduction achievable)<br>- Sealing of exposed surface (i.e. concrete, asphalt) (up to 100 per cent reduction achievable).<br>Long-term stockpiles will be avoided where possible. However, where necessary (e.g. topsoil), long-term stockpiles will be established in locations with suitable separation from sensitive receptors. During periods of inactivity, stockpiles will be stabilised appropriately.<br>Establish and communicate the protocol for notifying relevant stakeholders when potentially dust-generating activities are planned to be carried out, with contact details for queries or complaints. |
| | Emissions from combustion engines (construction vehicles and generators) | Construction plant, vehicles and machinery will be maintained and operate in accordance with manufacturer's recommendations. |
| | Use of non-potable water for dust suppression | Water used in dust suppression will be of suitable quality and not result in environmental or human health risks, or impact rehabilitation outcomes. Water additives used to improve dust suppression effectiveness (e.g. the addition of soil binders to water for dust suppression on roads or hard stand areas) will be risk assessed prior to adoption. |
| | Dust generated by traffic on access tracks | To reduce emissions from construction vehicle movements on unsealed roads, road watering (emission reduction of up to 50 to 75 per cent achievable) or other appropriate measures will be implemented for haul roads.<br>Water additives used to improve dust suppression effectiveness will be considered. |
| | Fugitive dust emissions from vehicles transporting materials to and from site | Vehicles transporting potentially dust- and/or spillage-generating material to and from the construction site will have their loads covered immediately after loading (prior to traversing public roads).<br>Rumble grids and the operation of truck washdown areas will be maintained to reduce trackout of material onto public roads where it will become resuspended.<br>Site-based construction traffic is limited to identified haul routes as per the Project Construction Traffic Management Plan. |
| | Cumulative effects of dust emissions from construction and external land uses or activities | If construction or track work is undertaken on adjacent Inland Rail projects or on existing rail networks proximate to the Project, interfacing environmental risks will be considered and enhanced mitigation will be implemented if required to mitigate impacts to receptors. |
| | Dust generation and deposition as a result of adverse weather conditions | Avoid ground-disturbing activities including excavation and vegetation clearing during windy conditions where practical.<br>When avoidance of ground-disturbing activities is not practical, implement enhanced management measures, such as water application and/or implementation of temporary stabilisation treatments. |

| Delivery phase | Aspect | Proposed mitigation measures |
|---|---|---|
| Operations | Emissions from the operation of the rail corridor | Prior to commencement of operational activities, engagement will be undertaken with existing stakeholders and members of the South West Supply Chain (including DTMR, DES Queensland Resources Council, local councils and Queensland Rail) with regards to coal dust management and monitoring requirements necessary to support the existing South West Supply Chain Coal Dust Management Plan.<br>Implementation of a number of the operational mitigation measures as required by the South West Supply Chain Coal Dust Management Plan(where applicable and relevant) to the Project.<br>Monitor air quality during operation of the Project and report and audit monitoring results as consistent with the Operational Environmental Management Plan.<br>Monitor, record and audit complaints about dust and emissions in accordance with the Complaint Management Handling Procedure described in the draft Outline EMP (Chapter 23: Draft Outline Environmental Management Plan) and the requirements of the Social Impact Management Plan. |

### 12.8.4 Monitoring, reporting and auditing

This section describes how the Project will monitor, report and audit compliance with the Project's air quality goals. The methodology and deliverables for reporting for the Project are also discussed in the draft Outline EMP (refer Chapter 23: Draft Outline Environmental Management Plan).

#### 12.8.4.1 Construction phase—weather conditions monitoring

To aid in the avoidance of dust generation during adverse weather conditions, weather forecasts and observations for adverse weather (e.g. winds > 36 km/hr or 20 knots) will be observed during the construction phase of the Project using existing BoM weather stations. The BoM monitoring station that is considered to be the most representative for the Project is the BoM UQ Gatton station.

To assist with auditing and the analysis of air quality monitoring and complaints (if received), periods of adverse weather periods will be recorded in monthly environmental reports.

#### 12.8.4.2 Construction phase—air quality monitoring

Visual monitoring of dust generation (visible plumes) will be undertaken throughout construction. Daily onsite inspections of dust generation will be undertaken by construction staff to monitor dust being generated onsite to inform mitigation measures. In addition, routine offsite inspection will be undertaken at sensitive receptors located near high intensity construction areas such as heavily trafficked haul roads, excavation areas and laydown areas.

In the event that air quality complaints regarding Project construction works dust are received, quantitative monitoring of air quality may be required. Subject to receiver-specific requirements, monitoring could be undertaken to investigate either dust deposition or airborne particulate concentrations (TSP or $PM_{10}$). Monitoring site selection, duration and pollutants will be tailored to conditions present to allow appropriate corrective measures to be implemented.

All relevant results (inspections, monitoring, corrective measures and follow-up) will be included in the regular environmental monitoring reports prepared by the construction contractor.

#### 12.8.4.3 Operational phase—air quality monitoring

Requirements for an air quality monitoring station along the alignment will be discussed with the stakeholders of the South West Supply Chain, including DTMR, DES, and Queensland Resources Council, local councils and Queensland Rail. It is expected that should an air quality monitoring station be employed within the Project alignment; it will be equivalent in nature (including pollutants monitored) to the existing monitoring stations operating as part of the South West Supply Chain Coal Dust Management Plan.

The duration of operation for the air quality monitoring station, the responsibility for maintenance and ongoing operation of the monitoring station and the responsibility for reporting (including frequency) will be discussed and agreed on with stakeholders of the South West Supply Chain.

If a complaint related to air quality is received during operations, investigations will be undertaken to verify the cause and nature of the complaint. Response and corrective measures will be consistent with ARTC's Environmental Management System.

Requirements for operational phase monitoring will be included in an Operational Environmental Management Plan, which will be developed in future stages of Inland Rail.

#### 12.8.4.4 Operational phase—emissions reporting

Emissions reporting will be undertaken, where applicable.

## 12.9 Residual impact assessment

### 12.9.1 Construction

Assessment of the residual impact of the construction phase of the Project, following the implementation of the proposed mitigation measures (Section 12.8.3), is presented in this section.

The assessment of residual impacts to sensitive receptors during the construction of the Project is presented in Table 12.43. The methodology for the residual impact assessment includes:

- Receptor sensitivity, initial emission magnitude and initial significance for each construction activity category (demolition, earthworks, construction and trackout) presented in Table 12.43 is the assessed risk of impacts without mitigation as presented Section 12.7 and summarised in Table 12.32
- Residual emission magnitude has been determined qualitatively based on the anticipated reduction to construction dust emissions considering the available mitigation measures and expected control efficiencies
- Residual significance (residual impact) has been determined using the IAQM risk matrix for each construction activity (refer Table 12.31) considering the residual emission magnitudes assigned for each activity and receptor sensitivity.

Table 12.43 shows that following the IAQM risk matrix, the residual significance with the proposed mitigation measures is low or negligible.

The IAQM construction dust assessment guidance states:

> *For almost all construction activity, the aim should be to prevent significant effects on sensitive receptors through the use of suitable and effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant'.*

It is expected that with proposed mitigation measures implemented, potential air quality impacts (dust deposition and human health) will not be significant.

### 12.9.2 Operation

A quantitative (compliance) assessment has been undertaken for potential operational impacts, as predicted concentrations at sensitive receptors have been assessed against legislative and other nominated goals.

The Project operational AQIA for residual impacts to air quality and water tank quality (refer Section 12.7.3) indicates that compliance will be readily achieved. This assumes existing veneering of coal trains (consistent with current use of the West Moreton System rail corridor) will continue.

The Project is not expected to significantly (or adversely) impact identified environmental values, including human health and the aesthetic environment.

**TABLE 12.43: INITIAL AND RESIDUAL SIGNIFICANCE ASSESSMENT FOR POTENTIAL AIR QUALITY IMPACTS ASSOCIATED WITH CONSTRUCTION**

| Activity | Aspect | Potential impact | Receptor sensitivity | Initial significance | | Residual significance | |
|---|---|---|---|---|---|---|---|
| | | | | Emission magnitude | Significance | Emission magnitude | Significance |
| Demolition | All dust generating sources associated with demolition | Dust deposition | Medium | Small | Low | Small | Low |
| | | Human health | Medium | Small | Low | Small | Low |
| Earthworks associated with pre-construction and construction phase | All dust generating sources associated with pre-construction and construction phase earthworks | Dust deposition | Medium | Large | Medium | Small | Low |
| | | Human health | Medium | Large | Medium | Small | Low |
| Construction | All dust generating sources associated with construction phase for the Project | Dust deposition | Medium | Large | Medium | Small | Low |
| | | Human health | Medium | Large | Medium | Small | Low |
| Trackout associated with pre-construction and construction phase. | All dust generating sources associated with pre-construction and construction phase traffic associated with the Project | Dust deposition | Medium | Large | Medium | Medium | Low |
| | | Human health | Medium | Large | Medium | Medium | Low |

## 12.10 Conclusions

An AQIA has been completed to determine potential Project-related air quality impacts. The AQIA was undertaken in accordance with the ToR for the EIS.

The AQIA comprised:

- Identification of operational train movements for the year 2040
- Analysis of the expected construction and operational activities with the potential to adversely impact air quality
- Identification of relevant environmental values for the air environment and establishment of air quality goals to protect or enhance the identified environmental values
- Discussion of existing air quality and local meteorology
- Identification of potential sources of Project air emissions
- Identification of nearby existing potentially affected sensitive receptors
- A qualitative risk assessment of air emissions resulting from the construction phase
- A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements, including prediction of potential pollutant concentrations in rainwater water tanks
- Identification of appropriate mitigation and management measures to minimise potential air quality impacts
- Discussion of Project-specific monitoring, reporting and auditing practices that will be implemented
- Assessment of the residual impact with the implementation of the proposed mitigation measures.

A qualitative construction dust risk assessment was undertaken using the UK IAQM document *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The risk of dust deposition and human health impacts due to particulate matter ($PM_{10}$) on surrounding areas has been determined based on the scale of activities and proximity to sensitive receptors. Without mitigation, Project construction works were determined to present a medium risk. Mitigation strategies have been proposed to minimise potential impacts from proposed Project construction works, and the residual impact with the implementation of these mitigation strategies has been assessed to be 'low'. With the implementation of mitigation, it is expected that the air quality impacts of construction on sensitive receptors will not be significant.

A quantitative dispersion modelling assessment was undertaken for the operational phase using the dispersion models CALPUFF and GRAL. Twelve months of meteorological input data representative for the study area was developed for use in CALPUFF. Diesel exhaust emissions from locomotives and fugitive emissions from coal trains were estimated for projected train volumes for the Project. Ground-level concentrations for all pollutant species of interest including TSP, $PM_{10}$, $PM_{2.5}$, $NO_2$, VOCs and heavy metals were predicted at sensitive receptors and assessed against air quality goals.

The results showed that compliance is predicted for all pollutant species, at all modelled receptors, with the application of direct dust control (veneering—consistent with current use of the West Moreton System rail corridor) to coal trains.

An investigation into the deposition of dust emissions at sensitive receptor locations showed that predicted pollutant water concentrations would be significantly lower than *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

The potential impact of odour from agricultural trains using the alignment has been assessed qualitatively using FIDOL factors. Odour impacts from agricultural trains are not expected to be significant.

The AQIA undertaken for the Project has demonstrated that with appropriate mitigation in place, potential Project air quality impacts can be appropriately managed.

Project air quality impacts at nearby existing potentially affected sensitive receptors will be minimised to an acceptable level. The nominated environmental values of the air environment will be protected.