# CHAPTER 11

# Air Quality

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

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# 11. Air Quality

## 11.1 Introduction

The purpose of this chapter is to provide an assessment of the impacts of the Inland Rail—Border to Gowrie Project (the Project) on the environmental values of air and subsequent impacts on sensitive receptors.

The air quality impact assessment (AQIA) has been developed through the following steps:

- Identification of typical and peak operation train movements for the year 2040
- An analysis of the expected construction and operation activities from an air quality perspective
- Identification of the relevant ambient air quality goals that protect or enhance the environmental values of the air environment
- Discussion of existing air quality and local meteorology
- Identification of potential sources of air emissions associated with the Project
- Identification of nearby sensitive receptors
- Identification of potential air quality impacts, through:
  - A qualitative risk assessment of particulate emissions from construction works
  - A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements for peak train operations, including prediction of pollutant water concentrations in rainwater water tanks.
- Identification of mitigation and management measures to minimise potential air quality impacts, and assessment of the residual impact as a result of the implementation of these measures.

This chapter should be read in conjunction with Appendix O: Air Quality Technical Report.

## 11.2 Terms of Reference requirements

This chapter has been prepared to address sections 11.127 to 11.138 of the ToR. A compliance check of this chapter against each of the relevant components of the ToR is presented in Table 11.1. Relevant sections of the ToR have also been addressed in Appendix O: Air Quality Technical Report.

Compliance of the draft EIS against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

**TABLE 11.1 COMPLIANCE AGAINST RELEVANT SECTIONS OF THE TERMS OF REFERENCE**

| Air quality Terms of Reference requirements | | Draft EIS section |
|---|---|---|
| **Existing environment** | | |
| 11.127. | Describe the existing air quality that may be affected by the Project in the context of environmental values | Section 11.7.2<br>Appendix O: Air Quality Technical Report—Sections 3.0 and 4.0 |
| 11.128. | Discuss the existing local and regional air shed environment | Section 11.7.1, 11.7.2 and 11.7.3<br>Appendix O: Air Quality Technical Report—Section 4.2 |
| 11.129. | 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 | Section 11.7.1<br>Appendix O: Air Quality Technical Report—Section 4.0 |
| 11.130. | 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 11.7.2 and 11.7.5<br>Appendix O: Air Quality Technical Report—Section 4.2 and 4.5 |

| Air quality Terms of Reference requirements | | Draft EIS section |
|---|---|---|
| **Impact Assessment** | | |
| 11.131. | 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. | Section 11.4<br>Appendix O: Air Quality Technical Report—Section 2.4 |
| 11.132. | 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 11.5<br>Appendix O: Air Quality Technical Report—Section 3 |
| 11.133. | 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 11.3<br>Appendix O: Air Quality Technical Report—Section 3.6 and 5 |
| 11.134. | 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) Include modelling of dust deposition rates and air pollutant concentrations on surfaces that lead to potable water tanks in the vicinity of the Project. This modelling is to be in accordance with the *Australian Drinking Water Guidelines* (Australian Government 2011, updated October 2017)<br>d) 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 11.4, 11.8, 11.9 and 11.11<br>Appendix O: Air Quality Technical Report—Sections 6, 7, 9 and 10 |
| **Mitigation Measures** | | |
| 11.135. | 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 11.9<br>Appendix O: Air Quality Technical Report—Section 8 |
| 11.136. | 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 11.9<br>Appendix O: Air Quality Technical Report—Section 8 |
| 11.137. | 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 11.8, 11.9 and 11.10<br>Appendix O: Air Quality Technical Report—Section 6, 7, 8 and 9 |
| 11.138. | Describe how the achievement of the objectives would be monitored, audited and reported and how corrective actions would be managed | Section 11.9<br>Appendix O: Air Quality Technical Report—Section 8 |

**Table note:**
The ToR for the AQIA refer to the Environment Protection (Air) Policy 2008, however, the assessment has been undertaken against the current version of the policy, which was released in 2019.

## 11.3 Policies, standards and guidelines

The policies, standards and guidelines relevant to air quality in the context of the Project are summarised in Table 11.2.

In Queensland, the environmental impacts of air emissions are primarily regulated under the *Environmental Protection Act 1994* (Qld) (EP Act) and subordinate legislation, including the Environmental Protection Regulation 2019 (Qld) (EP Regulation). Discussion on the broader applicability of the EP Act and EP Regulation is presented in Chapter 3: Legislation and Project Approvals Process.

**TABLE 11.2 POLICIES, STANDARDS AND GUIDELINES APPLICABLE TO THE ASSESSMENT OF AIR QUALITY**

| Policy, standard or guideline | Relevance to the Project |
|---|---|
| National Environment Protection Council (NEPC), *National Environment Protection (Ambient Air Quality) Measure* (NEPC, 1998) | Federal legislation, which sets standards for six major air pollutants in Australia, being:<br>▸ Particulate matter less than 10 micrometres<br>▸ Particulate matter less than 2.5 micrometres<br>▸ Nitrogen dioxide<br>▸ Carbon monoxide<br>▸ Ozone<br>▸ Sulphur dioxide.<br>The standards for these pollutants have been considered in this AQIA and, where relevant, adopted as Project air quality goals. The standards in the Air Quality National Environment Protection Measures (NEPM) relevant to the Project correspond to the Environmental Protection (Air) Policy 2019 (EPP (Air) objectives protecting the health and wellbeing environmental values. The Air Quality NEPM standards relevant to the Project are consequently addressed in the air quality objectives in the EPP (Air) (refer Section 11.5 and Section 11.9.3). |
| National Environment Protection Council, *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM) (NEPC, 2004) | Federal legislation with the aim of improving the information base regarding ambient air toxics within the Australian environment, in order to facilitate the development of standards for ambient air toxics.<br>The Air Toxics NEPM includes monitoring investigation levels for use in assessing the significance of monitored levels of air toxics with respect to human health. The monitoring investigation levels are levels of air pollution, below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short term, it does not mean that adverse health effects automatically occur; rather some form of further investigation by the relevant jurisdiction of the cause of the exceedance is required.<br>The standards in the Air Toxics NEPM relevant to the Project correspond to the EPP (Air) objectives protecting the health and wellbeing environmental values (refer Section 11.5 and Section 11.9.3). |
| Queensland Government, *Environmental Protection (Air) Policy 2019* (EPP (Air)) | Policy instrument beneath the EP Act, to protect or enhance the environmental values of the air environment by setting pollutant-specific air quality objectives. Further discussion on the relevance of the EPP (Air) to the Project is provided in Section 11.5. |
| Queensland Government, EP Act—*Guideline: Application requirements for activities with impacts to air* (v4.03), Department of Environment and Science (DES, 2019d) | Queensland Government guideline on information requirements for applications for activities with impacts to air. This guideline has been used to guide the methodology of this air quality impact assessment (refer Section 11.6). |

| Policy, standard or guideline | Relevance to the Project |
|---|---|
| NSW Environment Protection Authority (NSW EPA), *Approved methods for the modelling and assessment of air pollutants in NSW* (NSW EPA, 2017) | Statutory methods for modelling and assessing air quality in NSW. This 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 (refer Section 11.6.4.2). |
| Queensland Government, *Development Affected by Environmental Emissions from Transport Policy. Version 4,* Department of Transport and Main Roads (DTMR, 2017a) | Outlines the 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. |
| NSW EPA, *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* (NSW Office of Environment and Heritage (OEH), 2011) | This document provides guidance on the selection of CALPUFF model variables when establishing a model for assessing air pollutants in accordance with *Approved methods for the modelling and assessment of air pollutants in NSW* (refer Section 11.6.4.2). |
| UK Institute of Air Quality Management (IAQM) *Guidance on the assessment of dust from demolition and construction* (IAQM, 2014). | This document provides a four-step risk-based assessment method for dust emissions associated with demolition, including land clearing and earth moving, and construction activities. The IAQM assessment process has formed the basis for the assessment of construction air quality impacts for the Project (refer Section 11.6.2). |
| Brisbane City Council (BCC) *Air Quality Planning Scheme Policy* (BCC AQ Planning Scheme Policy) (BCC, 2014). | This document provides guidance on assessment methodologies and air quality objectives for air quality assessments undertaken for projects in the BCC local government area (LGA). Air quality objectives from this policy have been used in this assessment in the absence of air quality goals from alternative published sources (refer Section 11.5). |
| Environment Protection Authority Victoria (EPA Victoria) *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. It has been used in the assessment of separation distances from petroleum products and sewage treatment plants that may be required during construction of the Project. |

## 11.4 Project air emissions

Based on a review of expected activities, applicable National Pollution Inventory emission estimation manuals, and EIS literature for similar rail projects, the air pollutants expected to be generated during the construction and operation phases of the Project are listed in Table 11.3. A detailed description of each pollutant is provided in Appendix O: Air Quality Technical Report.

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 considered unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors and therefore have not been assessed for the construction phase.

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

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).

**TABLE 11.3 POLLUTANTS CONSIDERED DURING THE AIR QUALITY IMPACT ASSESSMENT**

| Pollutant | Description[a] |
|---|---|
| TSP | TSP refers to airborne particles ranging from 0.1 micrometres (μm) to 100 μm in diameter. Particles can contain toxic materials (such as lead, cadmium and zinc) and toxic effects can occur from inhalation. Particles can also cause nuisance impacts by settling on surfaces and possessions (dust deposition), 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 ($PM_{2.5}$). |
| Oxides of nitrogen | $NO_x$ describes a mixture of nitric oxide and $NO_2$. $NO_x$ is colourless at low concentrations but has an odour. |
| $NO_2$ | $NO_2$ 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 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, and include xylene, toluene and benzene. |
| Sulphur dioxide | Sulphur dioxide ($SO_2$) is a colourless gas with a sharp, irritating odour. The AQIA assumes low sulphur content fuel as per the requirements of the *Fuel Quality Standards Act 2000* (Cth) and *Fuel Standard (Automotive Diesel) Determination 2001*. 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. |
| 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 | Heavy metals such as cadmium, lead, and mercury are common air pollutants that are typically emitted from industrial activities and fuel combustion. |
| 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. |
| Odour | Odour emissions can be either a single compound or a mixture of compounds that have the potential to affect environmental amenity and cause nuisance. |

**Table note:**

a) The descriptions provided in Table 11.3 have been derived from the information provided on the Commonwealth Department of Agriculture, Water and the Environment National Pollutant Inventory website (**npi.gov.au**) and the NSW Department of Planning, Industry and Environment website (**environment.nsw.gov.au**).

## 11.5 Environmental values and air quality objectives

The EPP (Air) 2019 was prepared by the Queensland Government to achieve the object of the EP Act in relation to the air environment. The air environment in Queensland is enhanced or protected via 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 that have been adopted as air quality goals for the Project is provided in Table 11.4.

The EPP (Air) recommends different strategies to control emissions for different types of activities, including:

- 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 protecting the health and biodiversity of ecosystems
- The qualities of the air environment that are conducive to human health and wellbeing
- The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property
- The qualities of the air environment that are conducive to protecting agricultural use of the environment.

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

Where air quality objectives for identified pollutants are not within the EPP (Air) and NEPM legislation, criteria has been sourced from *Approved methods for the modelling and assessment of air pollutants in NSW* (NSW EPA, 2017) and the BCC Air Quality Planning Scheme Policy (BCC, 2014).

The dust deposition goal shown in Table 11.4 is a daily deposition average (120 mg/m²/day), calculated using the deposition level predicted at a modelled receptor over an averaging period of one month.

The environmental values listed in Table 11.4 that are being protected by each air quality objective are listed for criteria from the EPP (Air) Policy and the NEPM legislation. The environmental values protected through meeting these air quality objectives include the following:

- Health and wellbeing
- Protecting the aesthetics of the 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 that 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 Project (refer Section 11.4) 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 a $NO_2$ air quality objective for the health and biodiversity of ecosystems. The most applicable sensitive receptor described in Section 11.7.5 for assessing the health and biodiversity of ecosystems is a protected area under the NC Act, the *Marine Parks Act 2004* (Qld) or a World Heritage Area. There are no World Heritage Areas or areas protected under the NC Act or the *Marine Parks Act 2004* (Qld) located within one kilometre (km) of the Project alignment and, therefore, the impact of $NO_2$ on the health and biodiversity of ecosystems has not been considered.

Discussion of background air quality for the Project is provided in Section 11.6.

**TABLE 11.4 PROPOSED AIR QUALITY GOALS**

| Pollutant | Air quality goal (µg/m³) | Averaging period | Environmental value | Source |
|---|---|---|---|---|
| $NO_2$ | 250 | 1 hour[1] | Health and wellbeing | EPP (Air) |
| | 62 | Annual | Health and wellbeing | EPP (Air) |
| TSP | 90 | Annual | Health and wellbeing | EPP (Air) |
| $PM_{10}$ | 50 | 24 hours | Health and wellbeing | EPP (Air) |
| | 25 | Annual | Health and wellbeing | EPP (Air) |
| $PM_{2.5}$ | 25 | 24 hours | 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/m³ | Annual | Health and wellbeing | EPP (Air) |
| Cadmium and compounds (measured as the total metal content in $PM_{10}$) | 5 ng/m³ | 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/m³ | Annual | Health and wellbeing | EPP (Air) |

| Pollutant | Air quality goal (μg/m³) | Averaging period | Environmental value | Source |
|---|---|---|---|---|
| Chromium (III) compounds (as $PM_{10}$) | 9 | 1 hour | - | 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 hours | Health and wellbeing | EPP (Air) |
| | 400 | Annual | Health and wellbeing | EPP (Air) |
| Xylenes | 1,200 | 24 hours | 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/m³ | Annual | Health and wellbeing | EPP (Air) |
| Polychlorinated dioxins and furans | $3.0 \times 10^{-08}$ | Annual | Screening health risk assessment | BCC AQ Planning Scheme Policy |
| Dust deposition | 120 mg/m²/day | Monthly[2] | Nuisance | DES recommended |

**Table notes:**

μg/m³ micrograms per cubic metre
ng/m³ nanograms per cubic metre
mg/m²/day milligram per square metre per day

1. Not to be exceeded more than one day per year
2. Not legislative, recommended Project goal to reduce likelihood of complaints

## 11.6 Methodology

The AQIA methodology for the construction and operation of the Project has included the following key elements:

- Qualitative impact assessment of the construction phase
- Primarily quantitative impact assessment of the operation phase, with minor emissions sources assessed qualitatively
- Identification of potential mitigation measures
- Assessment of the residual impact with the inclusion of the identified mitigation measures.

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

### 11.6.1 Impact assessment area

For the purposes of the AQIA, the impact assessment area (AQIA area) refers to the air environment and footprint of identified sensitive receptor locations within one km of the Project alignment, extending from the NSW/QLD border to Gowrie (refer Section 11.7.5).

### 11.6.2 Construction phase impact assessment

Construction emissions for large linear infrastructure projects are complex due to the number and variety of construction activities that occur, the distribution of sites across a large geographical area, and the transitory nature of many individual construction activities at particular locations. As such, the potential construction air quality impacts associated with the Project were assessed by defining:

- The nature of construction activities
- Plant and equipment that may be used
- Sources and levels of potential emissions.

The main pollutant of concern during the construction phase is particulates, predominantly airborne $PM_{10}$ and deposited dust (TSP). $PM_{2.5}$, a combustion emission, is generally generated in negligible quantities by construction activities and has therefore not been assessed. Gaseous emissions from diesel construction vehicles will be significantly lower than particulate emissions from construction activities and are unlikely to result in exceedance of air quality goals or a significant impact to the environmental value of human health and therefore have not been assessed.

The assessment methodology used for the construction phase is the *Guidance on the assessment of dust from demolition and construction, Version 1.1* (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.

A breakdown of each step and the associated findings of the dust impact assessment are detailed in Section 11.8.1 and in Appendix O: Air Quality Technical Report.

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 11.8.1.3. This assessment of fuel storage tanks has followed guidance from the BCC AQ Planning Scheme Policy (BCC, 2014) and *Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013) which is referenced in the EP Act *Guideline: Application requirements for activities with impacts to air* (DES, 2019d) as being applicable for assessments in Queensland.

Detailed dispersion modelling of construction is not typically undertaken as construction activities are difficult to forecast accurately and emissions are typically well controlled by standard construction dust-mitigation practices. The qualitative assessment method applied for the assessment of construction phase impacts is considered appropriate for the Project and is consistent with industry standard methodology.

### 11.6.3 Commissioning phase impact assessment

The commissioning phase of the Project will involve testing and checking the rail line and communication and signalling systems to ensure that all systems and infrastructure are designed, installed and operating according to ARTC's operational requirements. All rail system commissioning activities will be undertaken in accordance with an approved Test and Commissioning Plan developed by the Principal Contractor and approved by ARTC.

Air emissions during the commissioning phase of the Project are anticipated to be minor and 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.

In regard to locomotive movements along the railway, emissions from the commissioning phase of the Project 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 considered unlikely to generate nuisance or risk exceedance of the Project's air quality goals (refer Section 11.5) and therefore have not been assessed.

### 11.6.4 Operation phase impact assessment

This section outlines the approach taken for the modelling and assessment of the operational phase of the Project, including:

- Emissions inventory and assessment assumptions, including potential cumulative emission sources
- The dispersion modelling methodology, including:
  - Software packages used
  - Meteorological data used
  - Scenarios assessed and model inputs
  - The method applied for the conversion of $NO_x$ to $NO_2$
  - Limitations of the modelling approach.
- The method for the assessment of impacts to water tank quality
- The method for assessment of agricultural freight odour.

#### 11.6.4.1 Emissions inventory

An emissions inventory has been developed to quantify the emissions for diesel locomotives that may operate on the Border to Gowrie section of Inland Rail, based on the engine types, rail traffic quantities and locomotive speeds. The key pollutants of interest included in the emissions inventory for diesel locomotives are TSP, $PM_{10}$, $PM_{2.5}$ and $NO_x$.

The forecast typical and peak volume of trains anticipated to be using the Project by 2040 are presented in Table 11.5, which shows that the forecast for typical train movements (136 trains per week) is significantly fewer than the forecast for peak train movements (174 trains per week). Air emissions as a result of the operation of the Project are directly related to the volume of trains; therefore, a lower number of trains will result in a lower rate of pollutant emissions to air.

Emission rates for both typical and peak train movement scenarios have been calculated; however, dispersion modelling has only been undertaken for peak train movements as this operational scenario has the greater potential to cause significant impact.

**TABLE 11.5 WEEKLY TYPICAL AND PEAK TRAIN MOVEMENTS BY SERVICE IN 2040**

| | Number of trains per week—typical movements | | | Number of trains per week—peak movements | | |
|---|---|---|---|---|---|---|
| **Train type/Description** | **National Rail (NR) Class[1]** | **SCT/LDP Class[2]** | **Class 82[3]** | **NR Class[1]** | **SCT/LDP Class[2]** | **Class 82[3]** |
| MB Express (Bromelton) | 12 | - | - | 14 | - | - |
| MB Express (Acacia Ridge) | 12 | - | - | 14 | - | - |
| MB Superfreighter (Bromelton) | - | 32 | - | - | 40 | - |
| MB Superfreighter (Acacia Ridge) | - | 6 | - | - | 8 | - |
| GB Superfreighter (Bromelton) | - | 16 | - | - | 22 | - |
| GB Superfreighter (Acacia Ridge) | - | 8 | - | - | 10 | - |
| Narrabri—PoB Grain | - | - | 18 | - | - | 24 |
| Yelarbon—PoB Grain | - | - | 18 | - | - | 24 |
| Narrabri—PoB Export Continuation | - | - | 10 | - | - | 12 |
| Yelarbon—PoB Cotton | - | - | 4 | - | - | 6 |
| **Total** | | **136** | | | **174** | |

**Table notes:**
1 UGL National Rail Class locomotive
2 Downer EDI SCT/LDP Class locomotive
3 Downer EDI 82 Class locomotive
PoB – Port of Brisbane

### Diesel locomotive emissions

Emission factors have been sourced from emissions testing completed on locomotives by the NSW EPA (ABMARC, 2016), as well as rated emission standards published by the US Environmental Protection Agency (US EPA) (US EPA, 2009). The US EPA emission factors are the most accurate source of available emissions data for the locomotives and are considered appropriate for use in the assessment. Table 11.6 presents the referenced emissions factors on a grams per kilowatt hour basis (g/kWhr).

**TABLE 11.6 LOCOMOTIVE EMISSIONS FACTORS FOR $NO_X$, TOTAL PARTICULATES AND VOCS (AS TOTAL HYDROCARBONS)**

| | NR Class[2] | | | |
|---|---|---|---|---|
| **Locomotive** | **Cycle weighted** | **Idling** | **SCT/LDP[3]** | **82 Class[4]** |
| Locomotive max power in kilowatts (kW) | 2,917 | | 3,350 | 2,425 |
| Rated emission standard | US EPA—Tier 0 | - | US EPA—Tier 1 | US EPA—Tier 0 |
| Total particulates (g/kWhr) | 0.101 | 1.09 | 0.60 | 0.8 |
| $NO_x$ (g/kWhr) | 16.6 | 43.7 | 9.92 | 12.74 |
| Total hydrocarbons (THC)[1] (g/kWhr) | 0.519 | 4.66 | 0.74 | 1.34 |
| Source | US EPA Emissions Factors for Locomotives (US EPA, 2009) | NSW EPA's Diesel Locomotive Fuel Efficiency & Emissions Testing (ABMARC, 2016) (applicable for NR121 and 93 Class) | US EPA Emissions Factors for Locomotives (US EPA, 2009) | |

**Table notes:**
1. VOCs are a subset of THC. For this assessment 100% of THC emissions are assumed to be VOCs
2. UGL National Rail Class locomotive
3. Downer EDI SCT/LDP Class locomotive
4. Downer EDI 82 Class locomotive

Where emissions factors for specific pollutants of concern were not available from NSW EPA or the US EPA (refer Table 11.6), emission factors from the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual for Railway Yard Operations* (DEWHA, 2008) and the European Monitoring and Evaluation Programme and the European Environment Agency *EMEP/EEA air pollutant emission inventory guidebook 2016* (EMEP/EEA, 2016a in addition to EMEP/EEA, 2016b) were used. The referenced and speciated locomotive emissions factors are presented in Table 11.7.

**TABLE 11.7 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 | (DEWHA, 2008) |
| $PM_{2.5}$ | 3.39 | Kg/kL | 93.7 | (DEWHA, 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) |
| $SO_2$ | 0.0167 | kg/kL | 0.046 | (DEWHA, 2008) |

| 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 | 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 (TEQ) | $8.35 \times 10^{-11}$ | kg/kL | - | (DEWHA, 2008) |

Table 11.8 summarises the operating mode percentages of maximum engine power used for each engine notch setting to calculate average duty cycle power ratings.

#### TABLE 11.8 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 | 100.0 | |

In terms of time spent at each engine notch setting or operating mode, data from United States (US) rail operations was used to provide a basis for average duty cycle power ratings. Table 11.9 presents US EPA data (Ireson, Germer & Schmid, 2005), which represents duty cycle data for line-haul diesel locomotives in the US. The line haul data is representative of analysis from 63 line-haul trains and 2,475 operational hours.

#### TABLE 11.9 DUTY-CYCLES FOR LINE HAUL LOCOMOTIVES IN THE US (PERCENTAGE TIME IN NOTCH)

| Notch setting/operating mode | Line haul (per cent) |
|---|---|
| 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 11.7 and Table 11.9. The calculated average hourly power consumption rates, in addition to the maximum and idling power consumption rates for each locomotive, are presented in Table 11.10.

**TABLE 11.10 LOCOMOTIVE POWER USAGE**

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

**Table notes:**
1. UGL National Rail Class locomotive
2. Downer EDI SCT/LDP Class locomotive
3. Downer EDI 82 Class locomotive

Pollutant diesel combustion emission rates were then calculated using the following parameters:

- A peak weekly total of 174 trains (as per Table 11.5)
- Locomotive type and configuration (as per Table 11.5)
- Total locomotive journey time consists of:
  - Moving 75 per cent of the time
  - Stationary and idling in crossing loops 25 per cent of the time (an assumption used for the operational modelling for the full length of the Inland Rail Program).

Table 11.11 presents the maximum anticipated locomotive travel speeds along the Project alignment. Average line speeds were estimated to be 75 per cent of the maximum line speeds for the Project.

**TABLE 11.11 LOCOMOTIVE TRAVEL SPEEDS**

| Power | Direction of travel | NR Class[1] | SCT/LDP[2] | Class 82[3] |
|---|---|---|---|---|
| **Maximum line speed (km/hr)** | North | 115 | 115 | 80 |
| | South | 115 | 115 | 80 |
| **Average line speed (km/hr)** | North | 86 | 86 | 60 |
| | South | 86 | 86 | 60 |

**Table notes:**
1. UGL National Rail Class locomotive
2. Downer EDI SCT/LDP Class locomotive
3. Downer EDI 82 Class locomotive

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

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

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.

The following equation calculates the pollutant emissions from locomotive traffic along the entire Project 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 Table 11.6 (g/kWhr)
- $P_{total}$ is the total locomotive calculated power per hour for the 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:

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

Where:

- $ER_{idle}$ is the calculated pollutant emission rate for $NO_x$, TSP, $PM_{10}$, $PM_{2.5}$ and total VOCs (as THC) grams per second (g/s)
- $t_{loco}$ is the locomotive travel time along the Project alignment without stopping. Idling time is assumed to be 25 per cent of the total travel time along the alignment, i.e. 1/3 of the non-stopping travel time of a locomotive to travel the Project alignment
- $n_{loco}$ is the total number of locomotives of each train type
- $P_{loco}$ is the total locomotive calculated power per hour for the entire Project alignment from idling (kWhr)
- $EF_{pollutant}$ is the pollutant emission factor as per Table 11.6 (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, one hour depending on the scenario modelled. The idling emission rates were therefore derived from the hourly idling locomotive power usage presented in Table 11.10, and the locomotive emission factors presented in Table 11.6. The methodology for the assessment of crossing loops is described further in Section 11.6.4.2.

The derived pollutant locomotive diesel emission rates for typical and peak train movements are presented in Table 11.12. Air emissions as a result of the operation of the Project are directly related to the number of trains; therefore, a lower number of trains will result in a lower rate of pollutant emissions to air. Table 11.12 shows that total Project emissions for typical train movements are lower than the total Project emissions for peak train movements. This AQIA has assessed emissions for peak train movements only, as emission rates for peak train movements are higher and therefore the risk of impacts is also higher for this scenario.

Table 11.12 also presents the emission rates for locomotives idling at crossing loops, with the presented emission rates representing the cumulative emissions from the five proposed crossing loops. The methodology for the assessment of emissions from the crossing loops is explained in Section 11.6.4.2. Differences in train movements (e.g. typical or peak) do not influence the methodology used to assess emissions from the crossing loops.

**TABLE 11.12 DERIVED POLLUTANT DIESEL COMBUSTION EMISSION RATES**

| Pollutant | Total Project emissions for typical movements (g/m/s) | Total Project emissions for peak movements (g/m/s) | Short term average idling emissions (g/s) (per locomotive) [1] | Long term average idling emissions (g/s) (per locomotive) [2] |
|---|---|---|---|---|
| $NO_x$ | 6.91 x $^{10-5}$ | 8.88 x $^{10-5}$ | 0.824 | 0.206 |
| TSP | 4.30 x $^{10-6}$ | 5.52 x $^{10-6}$ | 0.021 | 0.0051 |
| $PM_{10}$ | 4.19 x $^{10-6}$ | 5.38 x $^{10-6}$ | 0.020 | 0.0050 |
| $PM_{2.5}$ | 4.03 x $^{10-6}$ | 5.17 x $^{10-6}$ | 0.019 | 0.0048 |
| Total VOCs | 6.68 x $^{10-6}$ | 1.01 x $^{10-5}$ | 0.088 | 0.022 |

**Table notes:**

1. Short-term (1 hour average): continuous idling of NR Class locomotives assumed throughout the year (refer Section 11.6.4.2)
2. 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 (refer Section 11.6.4.2)

### Cumulative impacts and modelled cumulative sources

The AQIA of the Project requires assessment of background air quality in addition to the cumulative impact of emissions from the Project in combination with emissions from existing and future sources (which will be operational at the same time as the Project).

The Commodore Mine and Millmerran Power Station are existing emission sources in the AQIA area (refer Section 11.7.3) and have been included in the modelling, as emissions from these facilities are unlikely to be adequately represented in background air quality monitoring. To include these emissions in the dispersion modelling, National Pollutant Inventory (NPI) emissions for each of the sources has been reviewed. Table 11.13 provides a summary of the reported emissions for the Commodore Mine and Millmerran Power Station for the reporting years of 2012/2013 to 2018/2019, which are the most recent available years.

It is widely understood that the emissions estimation techniques for mining activities presented in the NPI guidance documents have significant uncertainty when compared with actual dust emissions. Several studies have sought to reduce the uncertainty in emissions estimates of $PM_{10}$ and $PM_{2.5}$ by developing new emissions factors for mining activities in Australia (Roddis et al., 2015; Laing et al., 2015; Roddis et al., 2013; Richardson, Putland & Verran, 2015; Richardson 2013); however, these developed emissions factors have not been adopted by the NPI, and instead reference estimation techniques developed by the US EPA for US coal mines are used (US EPA, 1998), which generally yield over estimations of emissions from Australian coal mines.

Table 11.13 shows that there is significant variation in reported emissions for both the Commodore Mine and Millmerran Power Station. There is limited information available from the NPI website to explain the variations in reported yearly emissions for each source. Furthermore, it is noted that the Commodore Mine is the sole source of thermal coal for the Millmerran Power Station, and therefore it could be expected that emission values between the sources would correlate.

**TABLE 11.13 REPORTED NPI EMISSIONS FOR COMMODORE MINE AND MILLMERRAN POWER STATION**

| Facility | Reporting year | $PM_{10}$ (kg) | $PM_{2.5}$ (kg) | $NO_x$ (kg) |
|---|---|---|---|---|
| Commodore Mine | 2018/2019 | 880,000 | 71,000 | 1,100,000 |
| | 2017/2018 | 720,000 | 59,000 | 910,000 |
| | **2016/2017** | **605,023** | **53,656** | **820,240** |
| | 2015/2016 | 668,215 | 21,709 | 309,773 |
| | 2014/2015 | 668,389 | 21,812 | 313,853 |
| | 2013/2014 | 337,005 | 1,228 | 242,784 |
| | 2012/2013 | 277,999 | 1,101 | 241,433 |
| Millmerran Power Station | 2018/2019 | 170,000 | 42,000 | 9,400,000 |
| | 2017/2018 | 100,000 | 25,000 | 9,000,000 |
| | **2016/2017** | **91,520**[1] | **11,441**[2] | **8,891,295** |
| | 2015/2016 | 183,830 | 91,570 | 9,491,277 |
| | 2014/2015 | 54,159 | 50 | 12,614,517 |
| | 2013/2014 | 80,200 | 37,900 | 14,500,000 |
| | 2012/2013 | 90,566 | 33,000 | 18,130,000 |

**Table notes:**

1. Originally reported as 91,520 kg when first published, but altered on the NPI website to 55,000 kg in March 2020. The original reported value of 91,520 kg was used in the assessment.
2. Originally reported as 11,441 kg when first published, but altered on the NPI website to 15,000 kg in March 2020. The original reported value of 11,441 kg was used in the assessment.

As an initial investigation into emissions from the Commodore Mine and Millmerran Power Station, preliminary modelling was undertaken using the reported 2016/2017 emission values. Modelled emission rates were calculated by averaging total emissions evenly across the year. Table 11.14 presents the modelled emission rates for Commodore Mine and Millmerran Power Station based upon the 2016/2017 reported NPI emissions for each pollutant.

**TABLE 11.14 NPI EMISSIONS FOR COMMODORE MINE AND MILLMERRAN POWER STATION (2016/2017 DATA)**

| Cumulative Source | Emissions | $PM_{10}$ | $PM_{2.5}$ | $NO_x$ |
|---|---|---|---|---|
| Commodore Mine | NPI reported emissions (kg/annum) | 605,023 | 53,656 | 820,240 |
| | Total model emission rate (g/s) | 19.2 | 1.7 | 26.0 |
| Millmerran Power Station | NPI reported emissions (kg/annum) | 91,520 | 11,441 | 8,891,295 |
| | Total model emission rate (g/s) | 2.9 | 0.4 | 281.9 |

With the emission rates presented in Table 11.14, and considering the adopted background concentrations (refer Table 11.22), exceedances of the 24-hour $PM_{10}$ air quality goal were predicted at the nearest neighbouring receptor of the Commodore Mine, sensitive receptor 186, which is located approximately 1.1 km to the north of the mine on Millmerran–Inglewood Road (refer Figure 11.15a-ab). At sensitive receptor 186, the predicted maximum $PM_{10}$ 24-hour concentration was in excess of 70 μg/m$^3$.

Reviewing the results of the modelling, it was determined that the predominant contributor at sensitive receptor 186 was the Commodore Mine, with minimal contribution from the Millmerran Power Station. This result is expected due to the emission release height of the respective sources, with emissions from the mine released at, or close to, ground level, and emissions from the power station released from 200 m high exhaust stacks.

Commodore Mine and Millmerran Power Station operate under Environmental Authority (EA) permits, which state that they must take all reasonable and feasible avoidance measures so that particulate matter emissions generated do not exceed the following levels:

- Deposited dust: 120 mg/m$^2$/day averaged over one month (no allowable exceedances per year)
- $PM_{10}$: 50 μg/m$^3$ over a 24-hour averaging time (no allowable exceedances per year).

As it is part of their continual operating commitments, it is reasonable to assume that these sites are not exceeding these limits and that the modelled exceedance for $PM_{10}$ is a result of the uncertainties in the NPI emissions estimation techniques.

Therefore, to provide a more accurate estimation of the current local air quality adjacent to the Commodore Mine, modelled particulate emissions from the mine ($PM_{10}$ and $PM_{2.5}$ only) have been scaled so that compliance is predicted at its closest and most affected neighbouring sensitive receptor (sensitive receptor 186) (refer

Figure 11.15). The scaled $PM_{10}$ and $PM_{2.5}$ particulate emission rates for the mine have been used when assessing the cumulative impact of the Project. Emissions of $NO_x$ from the mine and emissions from the Millmerran Power Station have not been scaled.

NPI reported emissions of $NO_x$ (refer Table 11.13) for Commodore Mine for 2016/2017 are higher than average for the most recent seven years of reporting and therefore have not been scaled down for the assessment.

As the operation of the mine and power station are related, reported emissions for the 2016/2017 reporting period (consistent with the year used for Commodore Mine) have been used to assess the contribution from the Millmerran Power Station. Due to the release height of the emission source modelled (200 m tall stacks), emissions from the power station have limited impact at ground level and emissions have not been scaled from those presented in Table 11.13.

In addition to the Commodore Mine and Millmerran Power Station, the following proposed cumulative sources have also been included in the dispersion modelling:

- North Star to NSW/Queensland Border Project (Inland Rail)
- Gowrie to Helidon Project (Inland Rail)
- West Moreton System (existing rail line west of the junction between this Project and the Gowrie to Helidon Section of Inland Rail).

One km of the North Star to NSW/Queensland Border Project and Gowrie to Helidon Project rail sources, and 3.5 kms of the West Moreton System have been included in the dispersion modelling at their respective ends of the Project to ensure that their cumulative air quality impacts are assessed. The emission rates used for modelling were calculated based on predicted train numbers, locomotive and freight type for each section. Modelled emission rates are presented in Figure 11.14.

Emission calculation details for these background rail sources are provided in Appendix O: Air Quality Technical Report.

**TABLE 11.15 MODELLED EMISSION RATES FOR BACKGROUND RAIL SOURCES**

| Pollutant | Modelled emission rate (g/m/s) | | |
|---|---|---|---|
| | Gowrie to Helidon Project | West Moreton System | North Star to NSW/QLD Border Project |
| $NO_x$ | $1.84 \times 10^{-4}$ | $7.78 \times 10^{-5}$ | $8.88 \times 10^{-5}$ |
| TSP | $5.83 \times 10^{-5}$ | $5.17 \times 10^{-5}$ | $5.52 \times 10^{-6}$ |
| $PM_{10}$ | $3.37 \times 10^{-5}$ | $2.72 \times 10^{-5}$ | $5.38 \times 10^{-6}$ |
| $PM_{2.5}$ | $1.26 \times 10^{-5}$ | $6.38 \times 10^{-6}$ | $5.17 \times 10^{-6}$ |
| TVOC | $2.81 \times 10^{-5}$ | $1.62 \times 10^{-5}$ | $1.01 \times 10^{-5}$ |

In addition to the NPI sources (Commodore Mine and Millmerran Power Station) and the adjoining rail lines, other local emission sources will include ERAs, local commercial and industrial uses and vehicle traffic. Local commercial uses near the Project will include InterLinkSQ and the Asterion Medicinal Cannabis Facility, which are approved but not currently operational. Operation of InterLinkSQ and the Asterion Medicinal Cannabis Facility are not anticipated to generate significant emissions and do not require detailed assessment.

It is expected that emissions from ERAs, local commercial and industrial uses and vehicle traffic will be adequately represented by the assumed background concentrations, and these activities emit significantly lower quantities of pollutants than the major polluters that report to the NPI.

### 11.6.4.2 Modelling methodology

The air dispersion modelling conducted for this assessment was based on a modelling approach using The Air Pollution Model (TAPM) as a meteorological pre-processor to the air dispersion model CALPUFF. The modelling was undertaken in accordance with:

- *Approved methods for the modelling and assessment of air pollutants in NSW* (NSW EPA, 2017)
- *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* (NSW OEH, 2011)
- *CALPUFF View User Manual* (Lakes Environmental, 2017)

The data that was available for this Project and a discussion of the data processing methodologies that were required in order to implement CALPUFF are discussed in the following sections.

#### CALPUFF

The CALPUFF suite of programs, including meteorological (CALMET), dispersion (CALPUFF) and post processing modules (CALPOST), is an advanced 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, 2019d) reference is made to the guidance document *Approved methods and guidance for the modelling and assessment of air pollutants in NSW* (NSW EPA, 2017), which recommends CALPUFF. 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 (NSW OEH, 2011). As many of these features are present in the AQIA area, the CALPUFF model is preferred over the more commonly used Gaussian models of AERMOD or AUSPLUME, which perform poorly in the aforementioned conditions.

#### Meteorological data

The meteorological data used in dispersion modelling is of fundamental importance, as this data drives the predictions of the transport and dispersion of the air pollutants in the atmosphere. The most critical parameters are:

- Wind direction, which determines the initial direction 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.

Prognostic meteorological data generated by TAPM for the year 2013 was used in this assessment. Further information regarding the meteorological data used in the dispersion modelling is presented in Appendix O: Air Quality Technical Report.

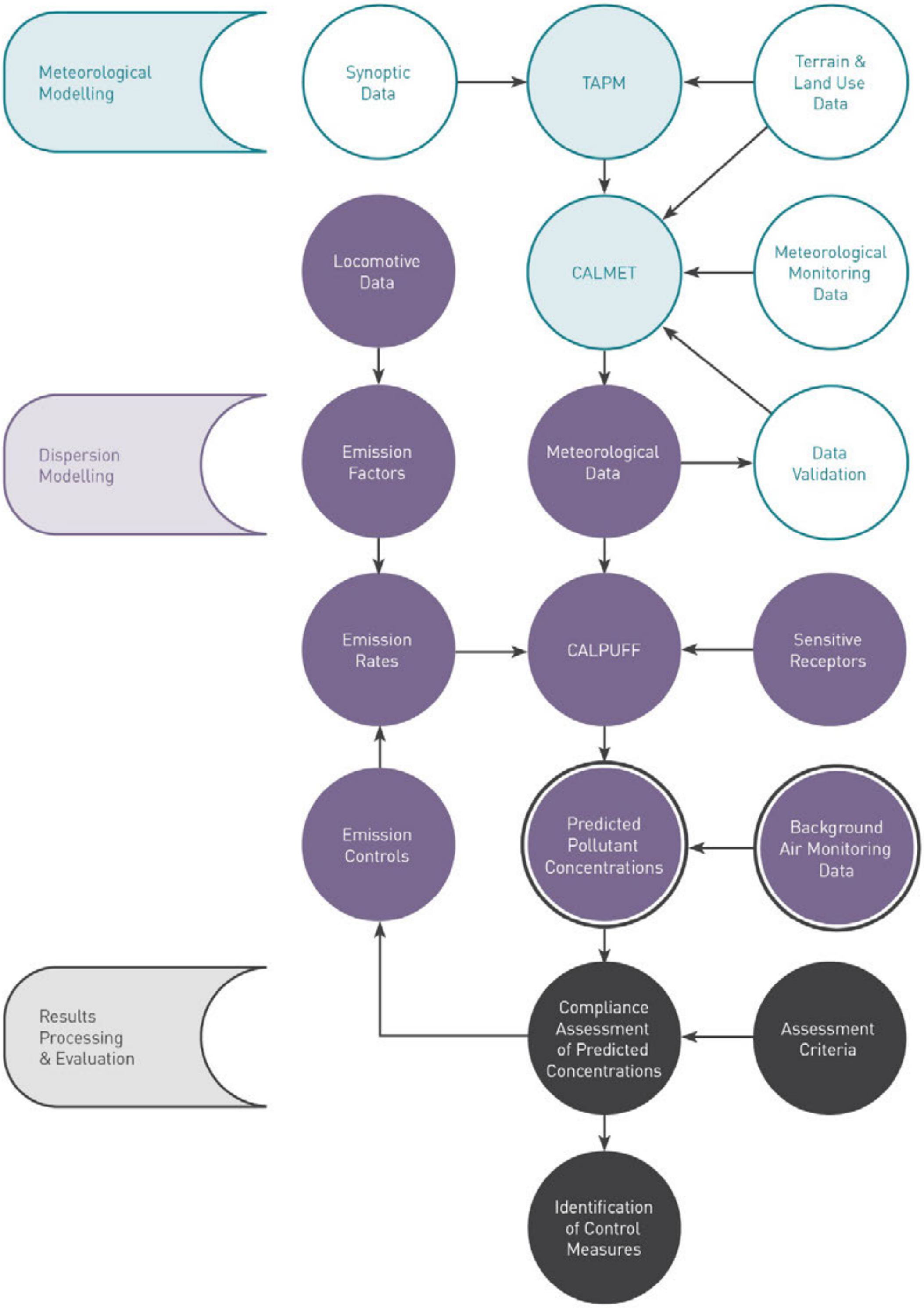



**FIGURE 11.1 DIAGRAMMATIC REPRESENTATION OF THE CALPUFF MODELLING METHODOLOGY**

### Crossing loops

Crossing loops are places on a single-line track where trains in opposing directions can pass each other. These are double ended and connected to the main track at both ends. Crossing loops are typically a little longer than any of the trains that might need to cross at that point. In operation, one train enters a crossing loop through one of the turnouts and idles at the other end, while the opposing train continues along the mainline track to pass the now stationary train.

The Project includes five new crossing loops. The proposed locations for the crossing loops are:

- Yelarbon—Ch 16.3 km to Ch 18.5 km (future-proofed to Ch 20.3 km to accommodate 3,600 m trains)
- Inglewood—Ch 50.2 km to Ch 52.4 km (future-proofed to Ch 54.2 km to accommodate 3,600 m trains)
- Kooroongarra—Ch 89.2 km to Ch 91.4 km (future-proofed to Ch 93.2 km to accommodate 3,600 m trains)
- Yandilla—Ch 129.8 km to Ch 132.0 km (future-proofed to Ch 129.3 km and to Ch 133.3 km to accommodate 3,600 m trains)
- Broxburn—Ch 174.9 km to Ch 177.1 km (future-proofed to Ch 178.9 km to accommodate 3,600 m trains).

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

- Emissions have been modelled from locomotives idling on the crossing loops. Travel around the crossing loops has not been modelled.
- Locomotives have been modelled at each end of each crossing loop as three 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 (1-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 (refer Table 11.5).
- No split of idling time has been assumed for each end of the loop to allow for the assessment of a worst-case idling for both the northbound and southbound travel directions
- The locomotive point sources have been located on the top and in the centre of buildings included in the model to account for the influence of downwash caused by the structure of the locomotives.

Fugitive odour from agricultural freight trains stopped at the crossing loops has been assessed qualitatively. The methodology for the qualitative assessment of fugitive odour is described in Section 11.6.6.

### Modelling scenarios

Peak train numbers have been considered in the AQIA in order to forecast impacts based on the worst-case scenario. Modelling of emissions from train movements along the Project alignment has been undertaken, assuming an even number of movements per day, e.g. daily train numbers and emissions from travel along the Project alignment have been modelled based on the weekly train numbers, divided by seven (refer Table 11.5).

Two different versions (short-term and long-term) of the model have been run to enable accurate assessment of emissions from the crossing loops against both short-term and long-term air quality goals (see Section 11.5). The model predictions from the short-term version have been used to assess compliance against the short-term goals (1 hour, 24 hour, etc.), with the model predictions from the long-term version used to assess compliance against annual average goals.

The modelled crossing loop versions assessed are summarised in Table 11.16.

**TABLE 11.16 CROSSING LOOP DISPERSION MODELLING SCENARIOS**

| Scenario | Crossing loop version | Crossing loop idling description | Air quality goal averaging periods assessed |
|---|---|---|---|
| **Peak train numbers 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 |

**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 $NO_2$. 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 $O_3$ to be present in the air, as $O_3$ 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 US EPA'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 $O_3$ 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 an emission plume, which can lead to overestimation of concentrations close to the source, as 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 explained in Appendix O: Air Quality Technical Report (Appendix E).

The DES monitoring station at Mutdapilly is the nearest air quality monitoring station to the Project that monitors for $O_3$. Background $O_3$ data from this station was used to convert the modelled $NO_2$ concentrations in accordance with the OLM methodology presented in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2017). Figure 11.2 presents the variation plots of background concentrations for $NO_2$ and $O_3$ for Mutdapilly for the year 2013.

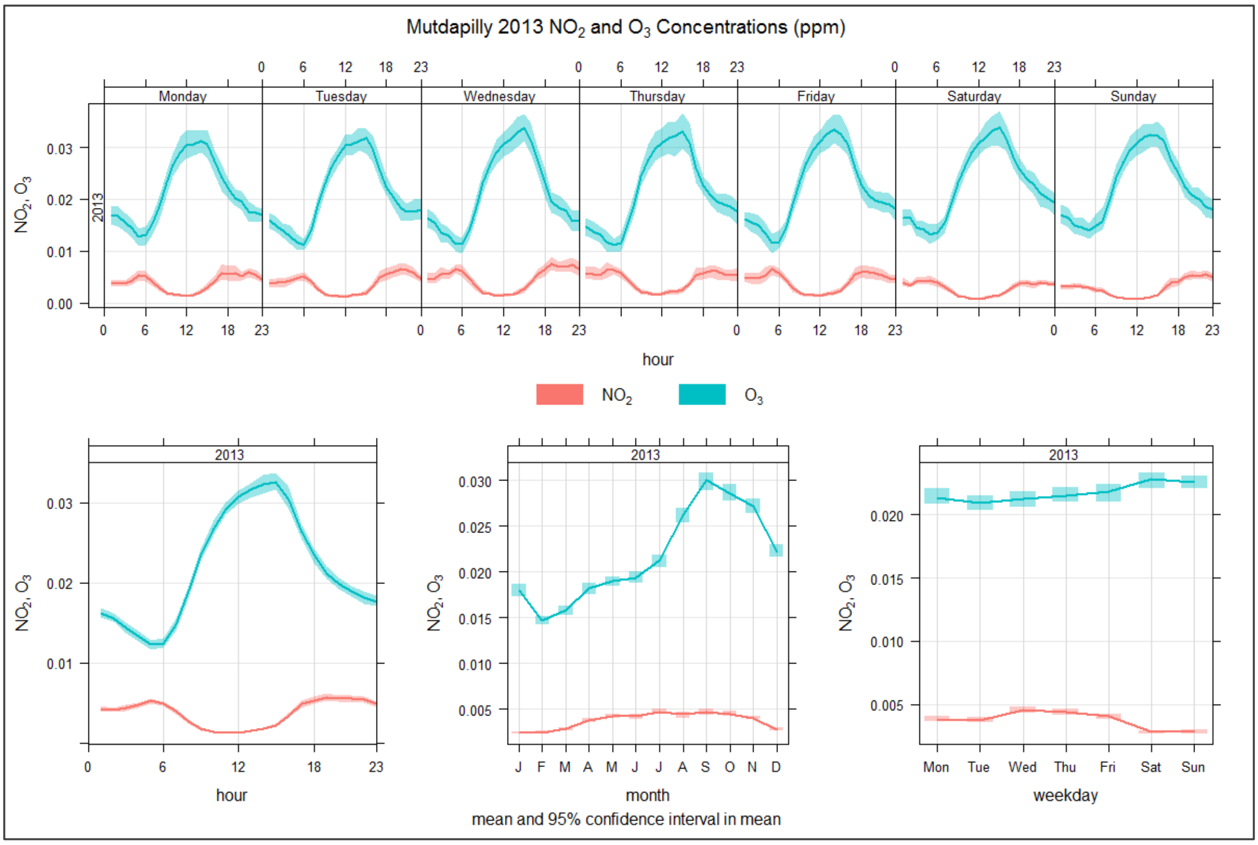



**FIGURE 11.2 VARIATION PLOTS OF CONCENTRATIONS FOR NO2 AND O3 FROM THE MUTDAPILLY DES MONITORING STATION FOR 2013**

**Limitations**

The atmosphere is a complex, physical system and the movement of air in a given location is dependent on multiple 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. The model equations involve some level of simplification of these very complex real-world processes, based on an understanding of the processes involved and their interactions, available input data, processing time and data storage limitations.

These simplifications 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 one metre per second) or for low-level, non-buoyant sources, is problematic for most dispersion models. To accommodate these known deficiencies, the model outputs tend to provide conservative estimates of pollutant concentrations at particular locations.

The models contain a large number of variables that can be modified to increase the accuracy of the predictions under any given circumstances; however, the constraints of models use in a commercial setting, as well as the paucity of data against which to compare the results in most instances, typically precludes extensive testing of the impacts of modification of these variables. With this in mind, model developers typically specify a range of default values 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.

Consequently, the results of dispersion modelling provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with high-quality 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. As stated above, however, the model predictions are typically conservative, and tend to over predict maximum pollutant concentrations at receiver locations.

This assessment was undertaken with the data available at the time of the assessment. Further assessment may be required during the detail design phase of the Project in response to localised design modifications and to the confirmation of the construction methodology.

### 11.6.5 Water tank quality

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).

#### 11.6.5.1 Assessing impacts to water tank quality

The potential for the operation of the Project to impact tank water quality collected via roof catchments has been investigated using the emissions inventory developed for assessment of impacts to air quality. Dust deposition modelling was also completed using CALPUFF to determine the impact of diesel emissions on tank water quality. Dust deposition was predicted for all modelled sensitive receptors, consistent with the assessment of impacts to air quality and as required by the ToR. The methodology for predicting the potential impact to water tank quality is summarised as follows:

- Rainwater collection systems can have first-flush devices, which take the first water captured by rooves and divert it for disposal rather than collection in a water tank. First flush systems were not assumed to be installed for any of the sensitive receptors considered.
- Annual average dust deposition rates were predicted for every modelled sensitive receptor for peak train numbers. Every sensitive receptor was assumed to have a water tank, and the roof area (collection area) for each sensitive receptor was assumed to be 200 m$^2$.
- It was assumed that all deposited dust at each sensitive receptor (200 m$^2$ roof area) was collected by a single 10,000 L rainwater tank, which was 10 per cent full, resulting in a receiving water volume of 1,000 L. This conservative assumption allows for times where there may be 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* (National Health and Medical Research Council and National Resource Management Ministerial Council (NHMRC & NRMMC), 2011), 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 and multiplying it by the assumed roof area (200 $m^2$) to determine total mass, and then speciating the predicted dust deposition level into metal concentrations using the diesel locomotive emission factors (EMEP/EEA, 2016a).
- The predicted water concentrations for each pollutant species were then assessed against the goals prescribed in the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011).

#### 11.6.5.2 Drinking water quality goals

The *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011) present guideline values on allowable contaminants within drinking water, such as from rainwater tanks. Table 11.17 presents guideline values from the *Australian Drinking Water Guidelines* for the pollutants of interest for the Project. Calculated water pollutant concentrations from diesel emission deposition modelling have been assessed against these guideline values.

TABLE 11.17 AUSTRALIAN DRINKING WATER GUIDELINES FOR THE POLLUTANTS OF INTEREST FOR THE PROJECT

| Pollutant | Guideline value (mg/$m^3$) | Environmental value |
|---|---|---|
| Arsenic | 0.01 | Health |
| Cadmium | 0.002 | Health |
| Lead | 0.01 | Health |
| Nickel | 0.02 | Health |
| Chromium as Cr (VI) | 0.05 | Health |

### 11.6.6 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 (Department of Environment and Heritage Protection (DEHP), 2018). The following factors, described using the acronym FIDOL, are widely accepted as being important dimensions of odour nuisance:

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

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

## 11.7 Existing environment

The existing values of the air environment that may be affected by the Project are described in this section. Aspects of the ambient environment relevant to this assessment include:

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

In addition to discussion of existing air quality and meteorological conditions, this section also introduces and presents the locations of sensitive receptors that have been used in assessing the impact of the Project on the air environment.

Figure 11.3 presents the location of the Project and the locations of relevant meteorological and air quality monitoring stations.

### 11.7.1 Meteorology and climate

The Project is located in the Darling Downs and spans across the Goondiwindi Regional Council (GRC) and Toowoomba Regional Council (TRC) LGAs. The Darling Downs generally experiences a sub-tropical climate with distinct wet and dry seasons.

The Bureau of Meteorology (BoM) operates a network of monitoring stations around Australia that have long-term climatic data available for analysis. Two BoM monitoring stations have been considered in this AQIA, specifically the Oakey Aero and Inglewood Forest stations.

Several air quality stations operated in South East Queensland (SEQ) by DES also record meteorological data; however, the are no operational DES monitoring stations located in areas that allow for the collection of data that would be representative of the Project. The nearest DES monitoring station is more than 150 km to the west of the Project. All monitoring stations to the east of the Project are near the coast of Queensland or below the Great Dividing Range and are therefore not representative of the climate in the AQIA area.

Locations of BoM and DES meteorological monitoring stations nearest the Project are shown in Figure 11.3.

The Project spans 216.2 km and local meteorological conditions are expected to vary across this distance, especially at areas further inland and/or away from notable terrain features. The two BoM-operated Oakey Aero and Inglewood Forest stations are considered to provide an appropriate regional coverage of climatic conditions. Another BoM-operated station located at the Toowoomba Wellcamp Airport is located nearer to the Project than the Oakey Aero and Inglewood Forest stations but the data is not publicly available at the time of this AQIA. Climate data from the Oakey Aero station is expected to be similar to that obtained at the Toowoomba Wellcamp Airport station and is deemed to provide a good alternative.

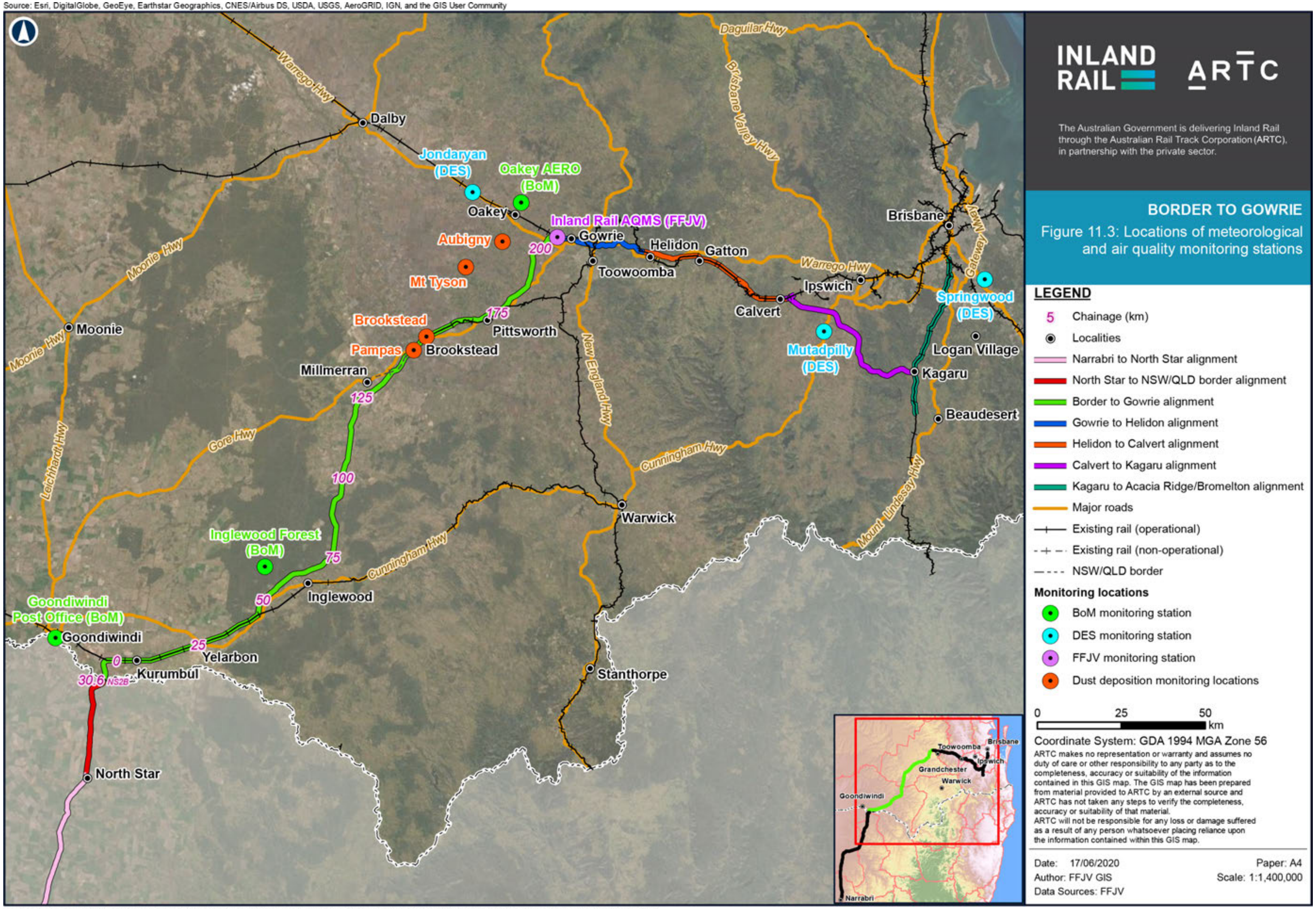
Details of the meteorological monitoring stations selected for use in the AQIA are provided in Table 11.18.

**TABLE 11.18 LOCATION OF METEOROLOGICAL MONITORING STATIONS**

| Operator | Name | Coordinates | Distance from Project (closest point, km) | Direction from Project | Period operational | Elevation (m) |
|---|---|---|---|---|---|---|
| **BoM** | Oakey Aero | -27.40, 151.74 | 13.1 | NW | 1973–Present | 406 |
| **BoM** | Inglewood Forest | -28.37, 150.95 | 7.0 | NW | 2000–2014 | 379 |

In addition to meteorological data from the BoM stations, output data from CALMET (see Section 11.6.4.2) has also been analysed and presented in this section to describe atmospheric stability and mixing height.

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




Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.3_MonitorStation_v5.mxd Date: 18/06/2020 08:45

### 11.7.1.1 Temperature

Mean minimum and maximum temperatures have been collected from the two selected BoM stations and are shown in Table 11.19. Temperatures recorded at the two stations are similar: the annual mean minimum and mean maximum temperatures are higher at Inglewood Forest by 1.6°C and 1.1°C respectively.

In winter (June, July and August), mean minimum temperatures are lower at Oakey Aero (4.2°C, 2.9°C and 3.6°C respectively) than at Inglewood Forest (6.7°C, 5.6°C and 6.9°C). Mean maximum temperatures for winter are very similar between the two sites.

In summer (December, January and February) mean minimum temperatures are higher at Inglewood Forest (17.7°C to 18.7°C) than at Oakey Aero (16.7°C to 17.9°C). The mean maximum temperatures are also higher at Inglewood Forest (31.5°C to 33.2°C) than at Oakey Aero (30.3°C to 31.0°C).

Overall, temperatures measured at the two stations and those expected across the AQIA area are consistent with a warm sub-tropical climate.

**TABLE 11.19 MEAN MINIMUM (BLUE) AND MAXIMUM (RED) MONTHLY TEMPERATURES FOR SELECTED BOM MONITORING STATIONS**

| | | Mean minimum and maximum temperature (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
| Oakey Aero[1] | Max | 31.0 | 30.1 | 28.7 | 25.9 | 22.3 | 19.1 | 18.7 | 20.5 | 24.0 | 26.7 | 28.8 | 30.3 | 25.5 |
| | Min | 17.9 | 17.7 | 15.8 | 11.8 | 7.8 | 4.2 | 2.9 | 3.6 | 7.3 | 11.4 | 14.5 | 16.7 | 11.0 |
| Inglewood Forest[2] | Max | 33.2 | 32.2 | 30.4 | 27.3 | 22.4 | 19.0 | 18.6 | 21.0 | 25.3 | 28.0 | 30.1 | 31.5 | 26.6 |
| | Min | 18.7 | 18.0 | 16.2 | 13.1 | 8.8 | 6.7 | 5.6 | 6.9 | 10.6 | 13.1 | 15.9 | 17.7 | 12.6 |

**Table notes:**
1. Mean maximum and minimum temperature values have been calculated based on data from 1973–2019 (BOM, 2019a).
2. Mean maximum and minimum temperature values have been calculated based on data from 2000–2013 (BOM, 2019a).

### 11.7.1.2 Rainfall

Mean rainfall values have been collected from the two selected BoM stations and are presented in Table 11.20. A wet (summer) and dry (winter) season is shown to be experienced by the region annually.

Table 11.20 shows that for both monitoring stations, approximately 40 per cent of average annual rainfall occurs during the three months of summer, with significantly less rainfall recorded during winter months.

**TABLE 11.20 MEAN MONTHLY AND ANNUAL RAINFALL FOR SELECTED BOM MONITORING STATIONS**

| | Mean rainfall (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Annual |
| Oakey Aero[1] | 77.7 | 78.2 | 51.1 | 29.9 | 39.5 | 30.0 | 28.8 | 25.7 | 31.0 | 57.7 | 75.2 | 91.8 | 618.2 |
| Inglewood Forest[2] | 72.3 | 54.5 | 63.5 | 27.4 | 28.6 | 33.3 | 28.7 | 24.3 | 34.0 | 49.7 | 79.9 | 97.3 | 620.0 |

**Table notes:**
1. Mean rainfall values have been calculated based on data from 1970–2019 (BOM, 2019a).
2. Mean rainfall values have been calculated based on data from 2000–2013 (BOM, 2019a).

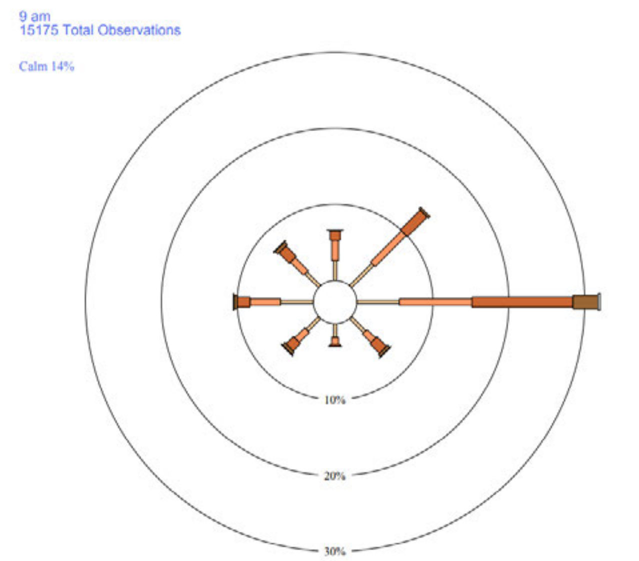
### 11.7.1.3 Wind speed and direction

Long-term annual wind roses for morning and afternoon conditions at the Oakey Aero and Inglewood Forest stations are published by BoM. The 9.00 am and 3.00 pm annual wind roses for the Oakey Aero and Inglewood Forest stations are presented in Figure 11.4.

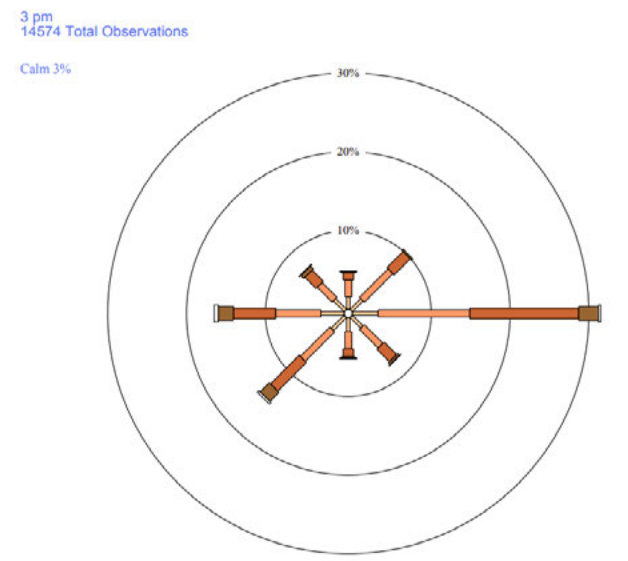
Morning winds at the Oakey Aero location blow predominantly from the east and northeast and are low-to-moderate strength when not calm. Calm conditions represent 14 per cent of 9.00 am wind observations.

Wind speeds at the Inglewood Forest station location are lower overall than those observed at the Oakey Aero station. Morning winds are most frequently from the north, northeast and east, and generally of low speed, with minimal calm conditions at 9.00 am (1 per cent). Afternoon winds have a comparatively higher speed and blow predominantly from the southwest and west.

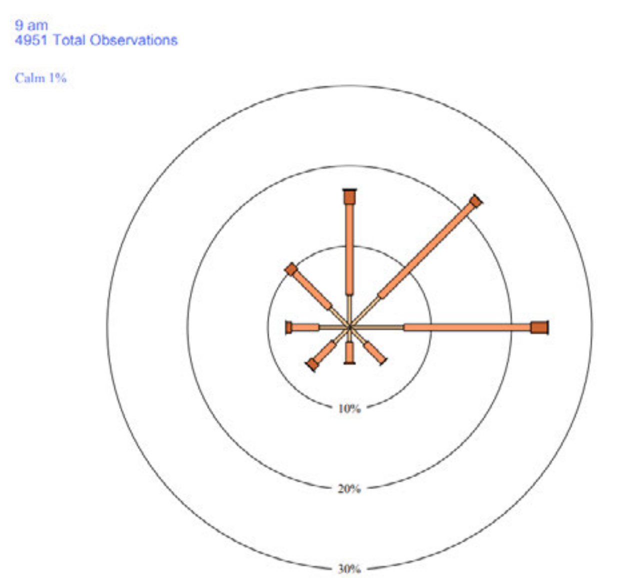
Overall, analysis of the annual wind roses for the two stations indicates that wind speed and direction is influenced on the local scale by terrain and land use. Terrain and land use are discussed further in Section 11.7.4.

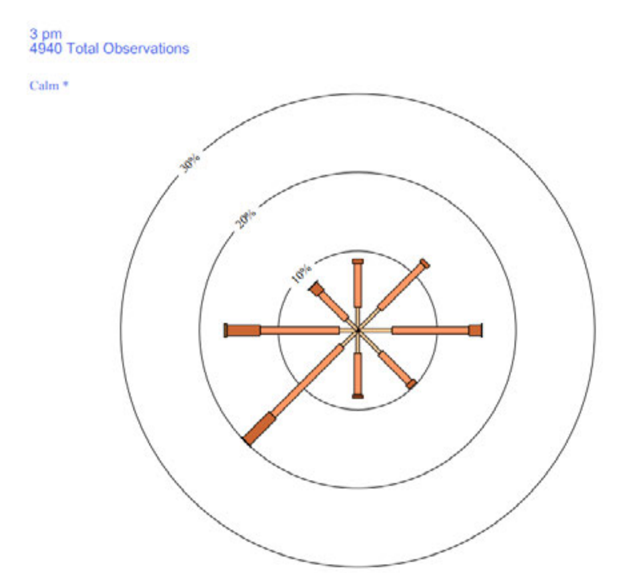

Annual 9.00 am wind rose at Oakey Aero[1]




Annual 3.00 pm wind rose at Oakey Aero[1]




Annual 9.00 am wind rose at Inglewood Forest[2]




Annual 3.00 pm wind rose at Inglewood Forest[2]



**FIGURE 11.4 WIND ROSES FOR BOM MONITORING STATIONS OAKEY AERO AND INGLEWOOD FOREST**

**Figure notes:**

1. Annual wind rose of wind direction versus wind speed based on observations from 1973–2018.
2. Annual wind rose of wind direction versus wind speed based on observations from 2000–2014.

### 11.7.1.4 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 Class 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 three extracted CALMET files has been analysed. The three CALMET files represent the northern, central, and southern modelling domains, which cover the entire Project alignment. Further details on the meteorological domains adopted for CALMET are provided in Appendix O: Air Quality Technical Report.

Figure 11.5 to Figure 11.7 show stability classes for the three domains by time of day. As expected, the stability classes indicate stable conditions during the night hours and neutral and unstable conditions during the day.

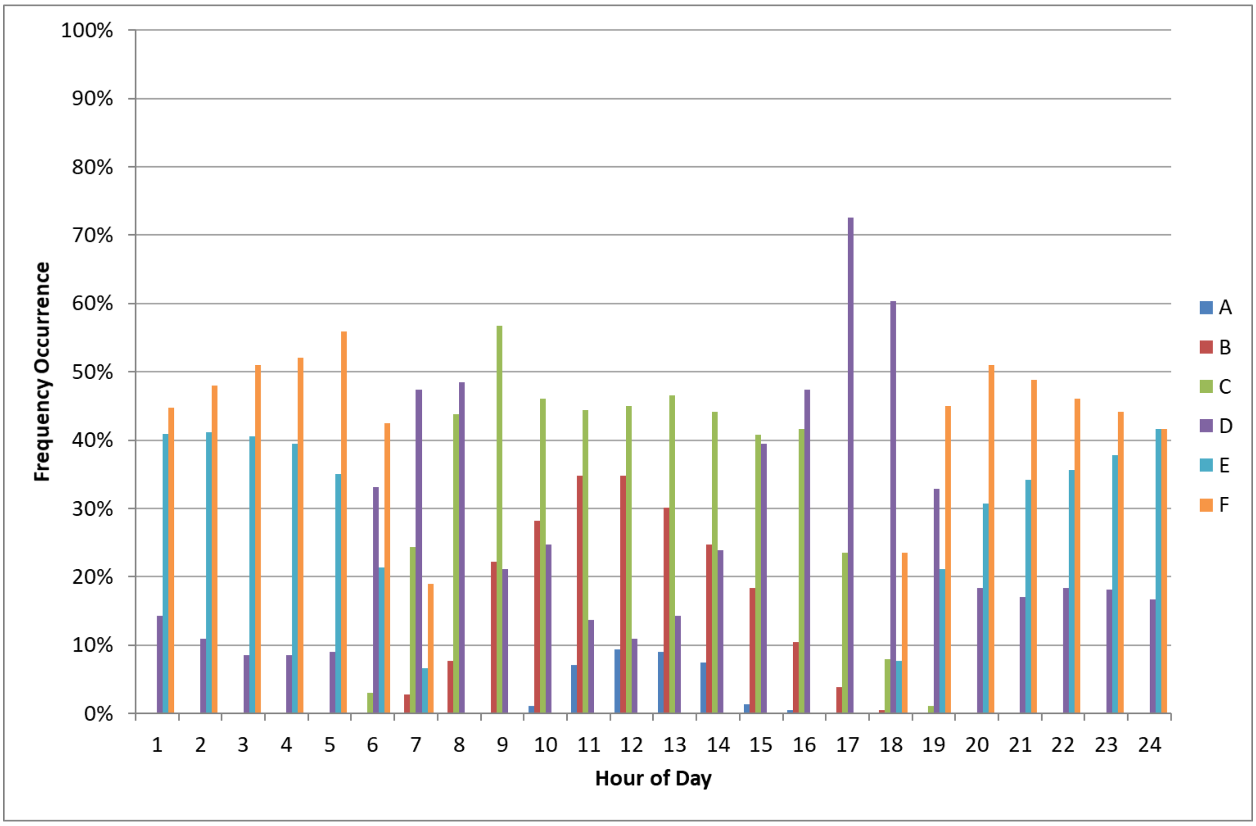



FIGURE 11.5 HOURLY STABILITY CLASS FREQUENCY FOR NORTHERN MODELLING DOMAIN

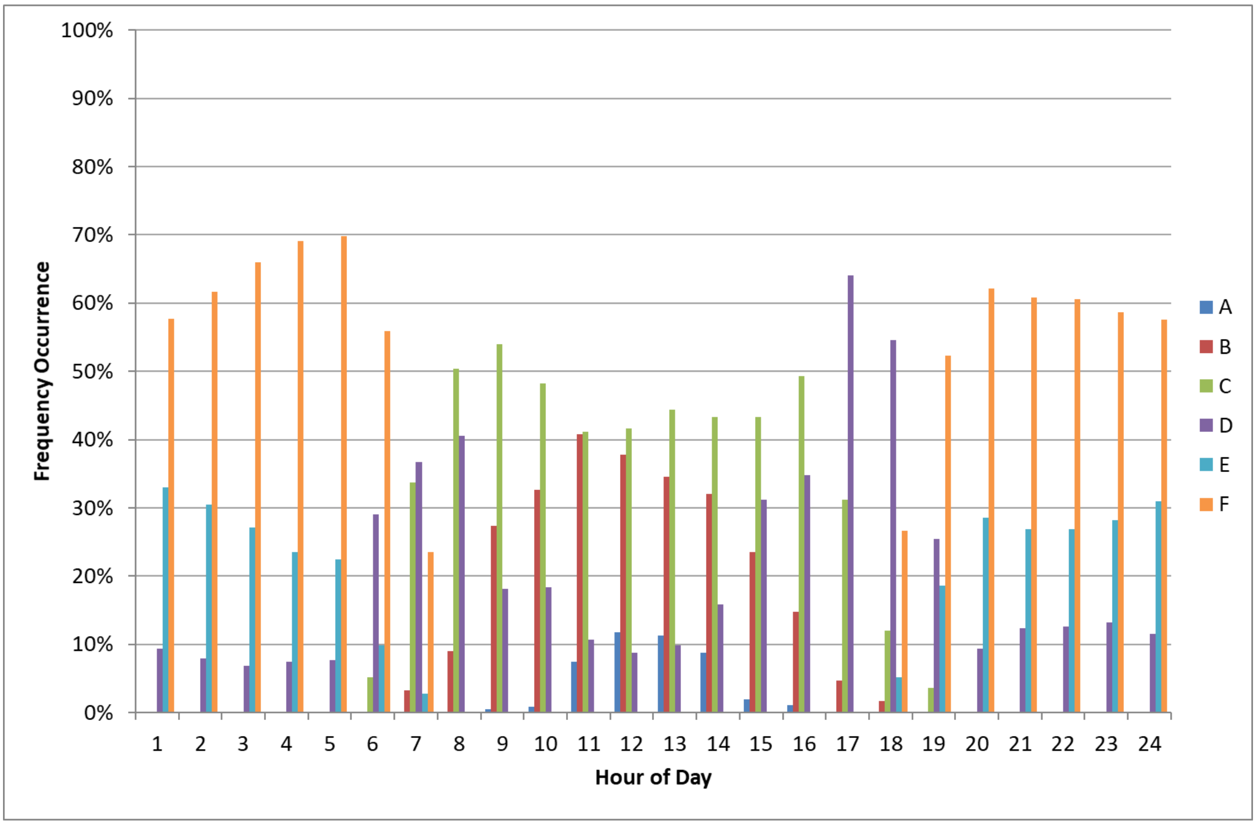



**FIGURE 11.6 HOURLY STABILITY CLASS FREQUENCY FOR CENTRAL MODELLING DOMAIN**

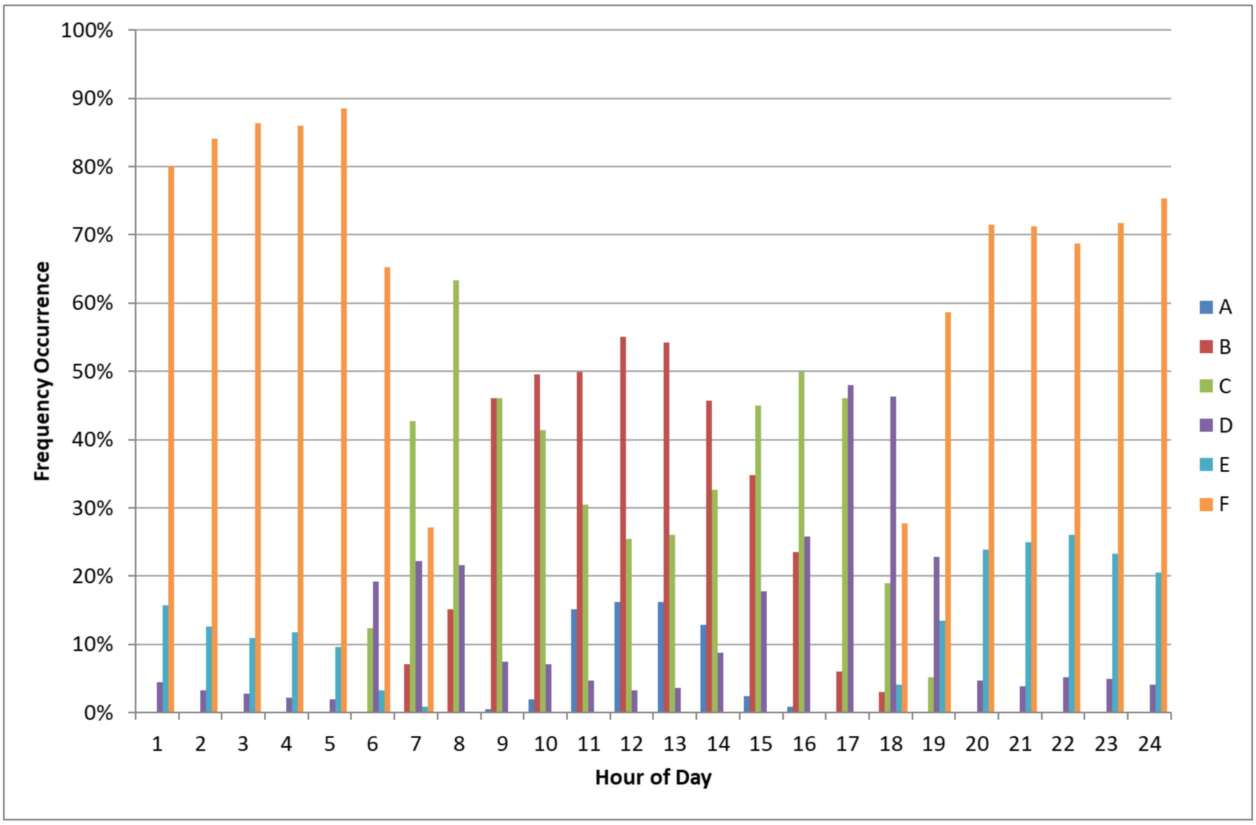



**FIGURE 11.7 HOURLY STABILITY CLASS FREQUENCY FOR SOUTHERN MODELLING DOMAIN**

Figure 11.8 to Figure 11.10 show stability classes in relation to wind speed. As expected, stable conditions are more prevalent, with lower wind speeds.

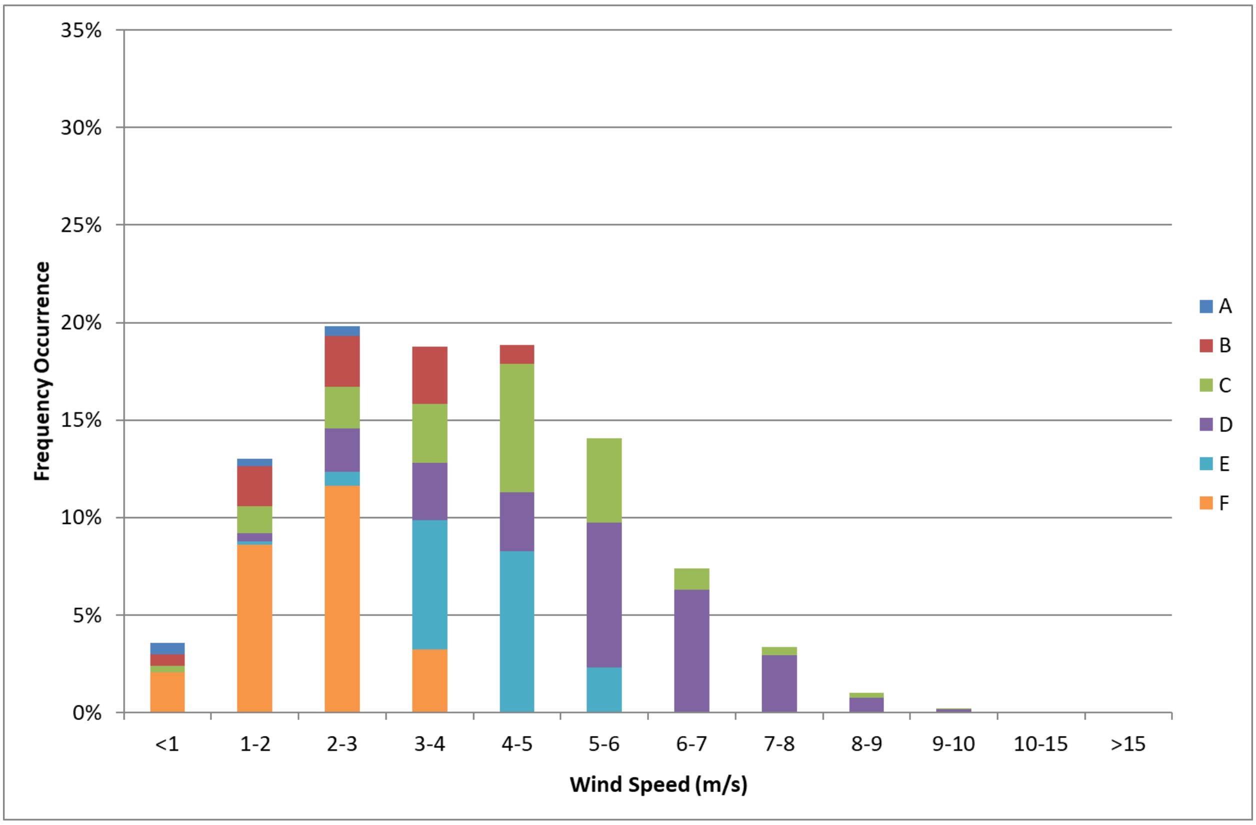



FIGURE 11.8 STABILITY CLASS FREQUENCY BY WIND SPEED FOR NORTHERN MODELLING DOMAIN

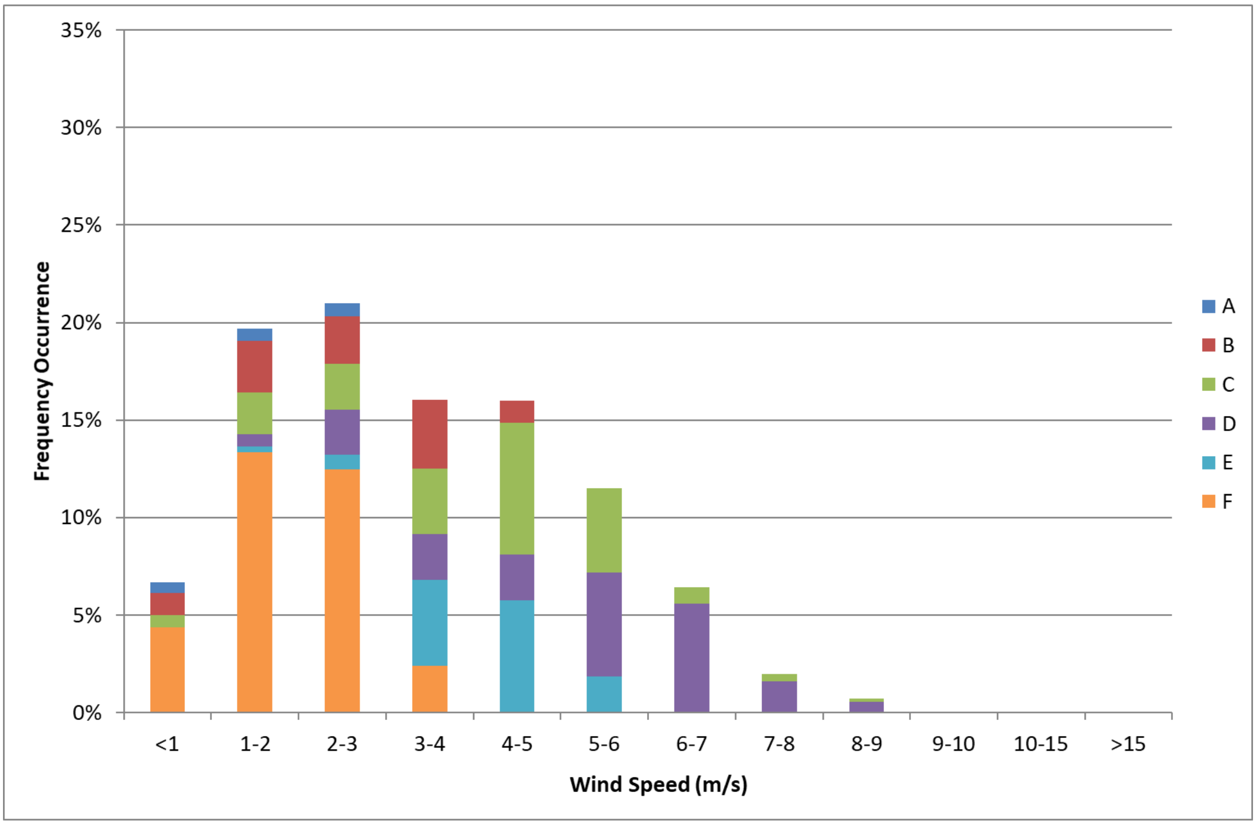



FIGURE 11.9 STABILITY CLASS FREQUENCY BY WIND SPEED FOR CENTRAL MODELLING DOMAIN

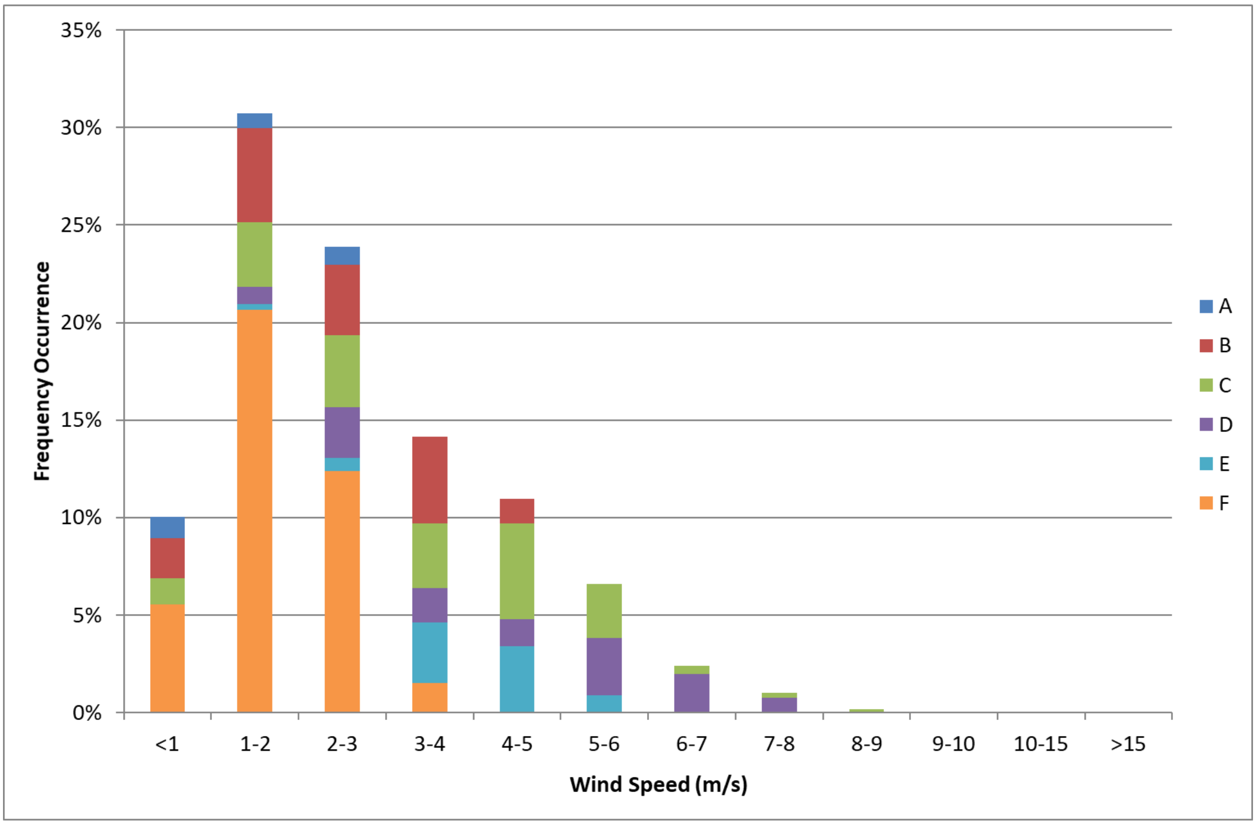



**FIGURE 11.10 STABILITY CLASS FREQUENCY BY WIND SPEED FOR SOUTHERN MODELLING DOMAIN**

### 11.7.1.5 Mixing height

The planetary boundary layer is the lowest part of the atmosphere and is directly influenced by the Earth's surface. This layer can extend up to 2,000 m above ground level. The height of this layer above ground level is referred to as the mixing height.

The mixing height is estimated within CALMET for stable and convective conditions (respectively), with a minimum mixing height of 50 m. Figure 11.11 to Figure 11.13 present average mixing height by hour of day across the meteorological dataset, as generated by CALMET. These results are consistent with general atmospheric processes that show increased vertical mixing with the progression of the day, as well as lower mixing heights during the night-time. Peak mixing heights are consistent with typical ranges.

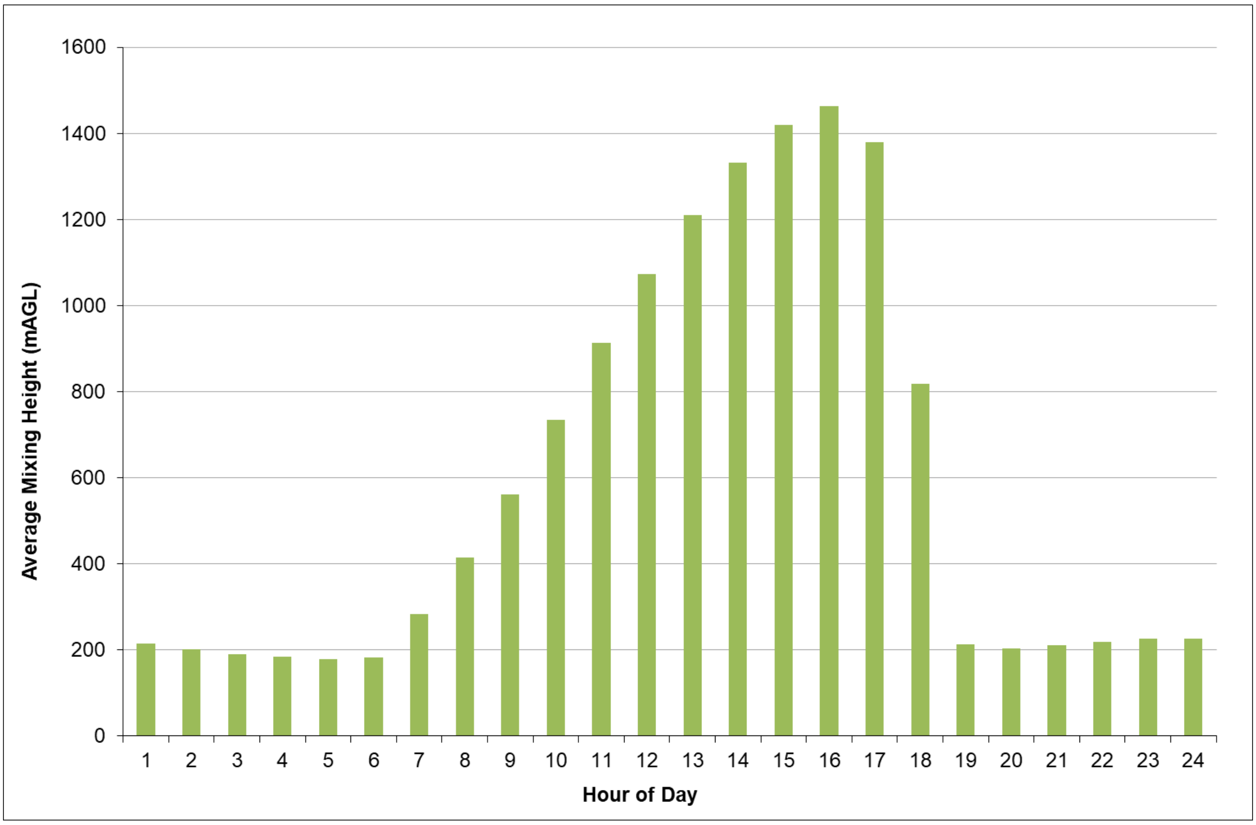



FIGURE 11.11 AVERAGE MIXING HEIGHT BY HOUR OF DAY FOR NORTHERN MODELLING DOMAIN

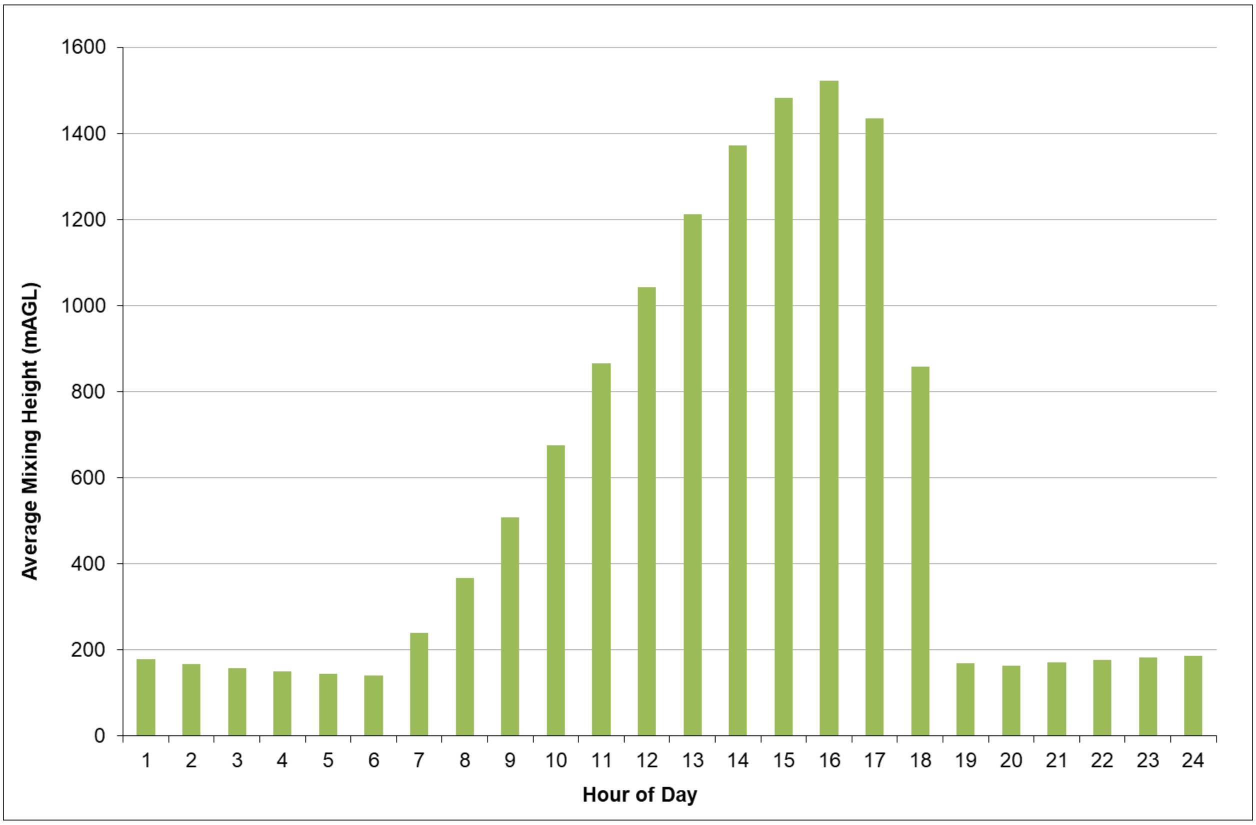



FIGURE 11.12 AVERAGE MIXING HEIGHT BY HOUR OF DAY FOR CENTRAL MODELLING DOMAIN

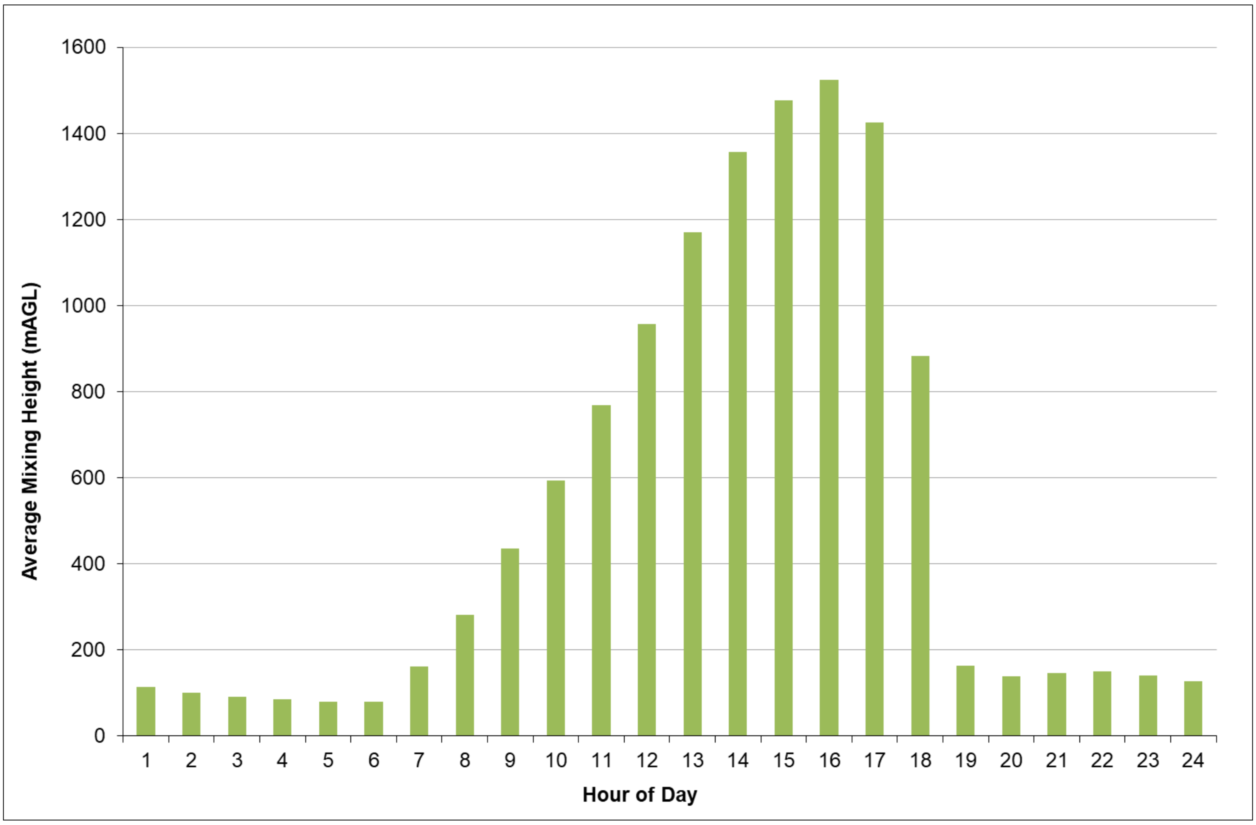



**FIGURE 11.13 AVERAGE MIXING HEIGHT BY HOUR OF DAY FOR SOUTHERN MODELLING DOMAIN**

#### 11.7.1.6 El Niño–Southern Oscillation

For Australia, the El Niño–Southern Oscillation (ENSO) has the strongest effect on year-to-year climate variability in Australia, 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. Due to differences in methodology, each of these aforementioned indices can have slightly differing results; however, using the SOI, ONI, and MEI measures for ENSO, agreeance can be seen on which years represent periods of El Niño or La Niña. The three indices show that the year 2013 was relatively neutral in terms of ENSO and has been selected as the year of assessment. Appendix O: Air Quality Technical Report includes further detail on the analysis of the ENSO measurement indices and justification of selecting 2013 as the year of assessment.

### 11.7.2 Background air quality

An air quality monitoring program was undertaken for the AQIA for the Project, which included monitoring of $PM_{10}$ and $PM_{2.5}$. For this purpose, an air quality monitoring station (Inland Rail AQMS) was established at a residential dwelling located off Draper Road, Charlton (Lot 29, SP294200), immediately adjacent to the northern end of the Project (refer

Figure 11.3). Concentrations of $PM_{10}$ and $PM_{2.5}$ measured at the Inland Rail AQMS have been used to define existing background concentrations for these pollutants for AQIA.

Background concentrations for other pollutants of interest not monitored at the Inland Rail AQMS have been estimated using monitoring data available from air quality monitoring stations operated by DES. DES has an ambient monitoring network across Queensland that monitors for controlled pollutants in areas with large population bases or heavy industry adjacent to residential areas. To determine appropriate baseline levels of each pollutant, recent data from the operational stations closest to the alignment was reviewed.

The nearest historic DES monitoring station to the Project was located at Jondaryan, 40 km north–west of Toowoomba. This station operated between March 2014 and April 2015. When operational, its purpose was to serve as a peak monitoring station and it was positioned in a location near a significant local pollution source. This station is not considered suitable to provide representative background concentrations for the AQIA area and therefore has not been considered further.

A further four monitoring stations are present in South West Queensland at Hopeland, Miles Airport, Burncluith, and Condamine. Although no exceedances of ambient air quality goals were found at these monitoring sites, it was concluded in the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Gas Industry Social and Environmental Research Alliance investigation by Lawson et al. (2018) that coal seam gas (CSG) activities are a likely contributor to the local air shed in this region. As the area surrounding the Project has no CSG activity, monitoring data from these stations is not considered an accurate representation of the background air environment for the Project and has not been used in this assessment.

A DES monitoring station was previously located in North Toowoomba but this station ceased operation in 2010 and its data is not considered representative of current conditions in the AQIA area.

The next nearest operational DES monitoring station to the Project is located at Mutdapilly, approximately 90 km to the east. Not all pollutants of interest are measured at the Mutdapilly station, therefore, data from the Springwood DES station was also reviewed. Springwood is the only DES station in South East Queensland that provides measurements of air toxics such as benzene and toluene. The details of the stations considered for review, including pollutants monitored, are presented in Table 11.21, with the locations of the stations shown in Figure 11.3.

**TABLE 11.21 MONITORING STATIONS CONSIDERED IN THE AQIA**

| Station name | Location relative to Project alignment | Pollutants monitored |
|---|---|---|
| Mutdapilly | 90 km to east | $NO_x$ and $O_3$ |
| Springwood | 135 km to east–north–east, in the grounds of a high school | $NO_x$, $O_3$, $SO_2$, $PM_{10}$, $PM_{2.5}$ and air toxics (organic pollutants, e.g. benzene, toluene) |
| Inland Rail AQMS | <0.1 km north—at a residential dwelling located off Draper Road, Charlton (Lot 29, SP294200) | $PM_{10}$ and $PM_{2.5}$ |

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, 2017c). The monitoring was conducted at four sites and undertaken in accordance with AS/NZS 3580.10.1:2003. The locations of the four monitoring sites are presented in Figure 11.3. The highest measured rate of 50 mg/m$^2$/day (measured at Site 3 during May/June 2016) has been adopted as the background dust deposition level for the AQIA.

Table 11.22 summarises the existing environmental background concentrations and deposition levels adopted for the AQIA. Where appropriate, the measured 70$^{th}$ percentile concentration was selected as the adopted background concentration. Further information regarding air quality monitoring data availability and validity is detailed in Appendix O: Air Quality Technical Report.

**TABLE 11.22 ADOPTED POLLUTANT CONCENTRATIONS AND DUST DEPOSITION LEVELS**

| Pollutant | Averaging time and statistic | Air quality goal (µg/m³) | Adopted background (µg/m³) | Monitoring location |
|---|---|---|---|---|
| Deposited dust | 30 days, maximum | - | 50 mg/m²/day | Four locations along the Project alignment (Y2G Preliminary Environmental Assessment) |
| $NO_2$ | 1 hour, maximum | 250 | 57.5 | Mutdapilly |
| | Annual average | 62 | 7.8 | |
| TSP | Annual average | 90 | 42.8[1] | Inland Rail AQMS |
| $PM_{10}$ | 24 hours, 70th percentile | 50 | 17.4 | |
| | Annual average | 25 | 17.1 | |
| $PM_{2.5}$ | 24 hours, 70th percentile | 25 | 7.6 | |
| | Annual average | 8 | 6.5 | |
| Benzene | Annual average | 5.4 | 5.2 | Springwood |
| Toluene | 1 hour, 70th percentile | 1100 | 23 | |
| | 24 hours, 70th percentile | 4100 | 21.7 | |
| | Annual average | 400 | 18.5 | |
| Xylenes | 24 hours, 70th percentile | 1200 | 31.5 | |
| | Annual average | 950 | 26 | |

**Table notes:**

1. Calculated from $PM_{10}$ concentrations measured at Inland Rail AQMS using a ratio of 2.5 which is based on a $PM_{10}$:TSP ratio of 0.4 as reported by the Australian Coal Association Research Program (ACARP, 1999).

The assimilative capacity of the receiving air environment can be quantified through the difference between these adopted background concentrations and the air goals defined in Table 11.4. For most pollutants and averaging times, the background concentrations represent less than half of the air quality goal, indicating a moderate assimilative capacity of the receiving environment. Pollutants that show lower levels of assimilative capacity include the following:

- $PM_{10}$ 17.1 µg/m³ annual average, representing 68 per cent of the 25 µg/m³ air quality goal
- $PM_{2.5}$ 6.5 µg/m³ annual average, representing 81 per cent of the 8 µg/m³ air quality goal
- Benzene 5.2 µg/m³ annual average, representing 96 per cent of the 5.4 µg/m³ air quality goal.

### 11.7.3 Existing emission sources

The NPI (Department of Agriculture, Water and Environment (DAWE), 2020) is regulated by the Australian Government. The purpose of the NPI is to track pollution sources across Australia and ensure that the community has access to information about the emission and transfer of toxic substances that may affect them locally.

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 and the source and location of these emissions. These substances have been identified as important due to their possible effect on human health and the environment. The data comes from facilities such as mines, power stations and factories, as well as other sources. NPI data tends to be a conservative estimate of industry emissions for sites such as quarries and mines due to the broad and generalised assumptions made during the emission estimations.

An NPI search conducted for the AQIA area shows eight facilities are required to report emissions annually. The location of these facilities is shown in

Figure 11.14. A description of each existing emission source and its approximate distance from the Project alignment is presented in Table 11.23.

**TABLE 11.23 NPI LISTED FACILITIES IN THE AQIA AREA**

| Facility name | Industry | Distance from Project alignment (km) | Direction from alignment |
|---|---|---|---|
| Commodore Mine | Coal mining | <1 | East |
| Millmerran Power Station | Power generation | 4.5 | Southeast |
| Sapphire Feedlot | Sheep, beef cattle and grain farming | <1 | South |
| Yarranbrook Feedlot | Sheep, beef cattle and grain farming | <1 | Northwest |
| Doug Hall Enterprises | Poultry farming | 1.0 | West |
| Pittsworth | Poultry farming | 1.6 | South |
| Inghams TF3 Breeder Farm Toowoomba | Poultry farming | 4.0 | East |
| Boral Asphalt Charlton | Hot mix asphalt manufacturing | 3.6 | Southeast |

Pollutant emissions of concern for the Commodore Mine and Millmerran Power Station include particulate matter, $NO_x$, CO and $SO_2$. Due to the distance from air quality monitoring stations considered (see Section 11.7.2), it is unlikely that emissions from the Commodore Mine and Millmerran Power Station are represented in the background concentrations adopted. Based on this, NPI-reported emissions for pollutants of interest for the mine and power station were included in the dispersion model developed for the assessment.

The primary pollutant of concern for the feedlots and poultry farms listed in Table 11.23 is ammonia, which is the only pollutant reported to the NPI by these facilities. Ammonia is not a pollutant of concern for the Project and emissions from these four facilities were not included in the cumulative model.

Boral Asphalt Charlton is 3.6 km southeast of the Project alignment and reports emissions of particulate matter, total VOCs, CO, $NO_x$, and $SO_2$ to the NPI. Emissions of all pollutants other than total VOCs are relatively minor and are not considered likely to contribute to a cumulative impact at sensitive receptors near the Project. There is the possibility of minor concentrations of VOCs from the asphalt plant reaching sensitive receptors near the Project; however, these concentrations are likely to be well below those measured at the DES Springwood monitoring station, which is influenced by large volumes of traffic emissions. Inclusion of the Springwood background values is considered conservative and the Boral emissions were not included in the model on this basis.

In addition to these operational cumulative NPI regulated sources, the following emission sources have been included in the dispersion model for the assessment due to their potential to contribute to cumulative air quality impacts at receptors in the AQIA area:

- North Star to NSW/Queensland Border Project (Inland Rail)
- Gowrie to Helidon Project (Inland Rail)
- West Moreton System (existing rail line west of the junction between the Project and the Gowrie to Helidon Section of Inland Rail).

Emissions from other local anthropogenic and non-anthropogenic sources, such as local traffic, wind-blown dust, etc., have not been modelled individually as they are assumed to be adequately represented by the assumed background concentrations presented in Section 11.7.2.

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
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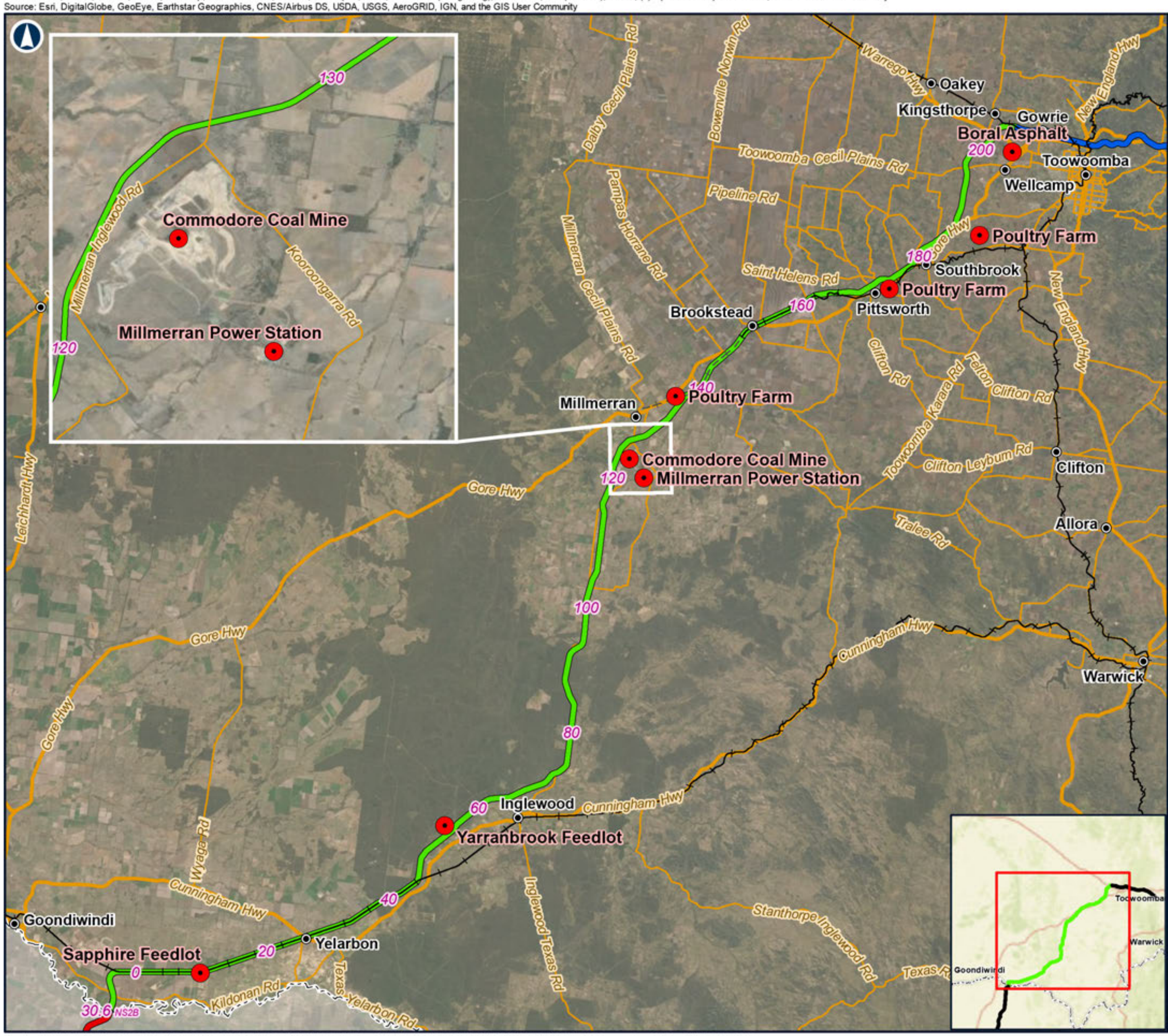


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BORDER TO GOWRIE
Figure 11.14:
Existing emission sources

**LEGEND**
- Localities
- 5 Chainage (km)
- Existing emission source
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- NSW/QLD border

0 20 40 km

Coordinate System: GDA 1994 MGA Zone 56

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Paper: A4
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### 11.7.4 Terrain and land use

Terrain features and land use can influence meteorological conditions on both a local and regional scale. There are five distinctive regions within the impact assessment area:

- Low-lying alluvial floodplains of the Macintyre River (typically 200 m Australian height datum (AHD) to 250 mAHD)
- Forested sandstone hills of the Macintyre Brook catchment (typically 250 mAHD to 350 mAHD)
- Undulating grazing lands and peaks near Millmerran (typically 300 mAHD to 650 mAHD)
- Broad cultivated alluvial plains of the Condamine River (typically 300 mAHD to 350 mAHD)
- Basaltic uplands and isolated peaks of the Toowoomba plateau (typically 325 mAHD to 700 mAHD).

The landscape between Kurumbul near the NSW border and Gowrie Junction is typically a sparsely settled rural landscape characterised by generally flat irrigated and non-irrigated croplands and undulating pastures, interspersed by a network of vegetated watercourses associated with the Dumaresq, Macintyre and Condamine Rivers and set against a backdrop of forested low hills and isolated volcanic peaks. It is, for the most part, a highly modified landscape, as a result of historical clearing practices for agriculture and grazing, the establishment of linear infrastructure (railways, highways and powerlines) and other development activity (e.g. Commodore Mine, Toowoomba Wellcamp Airport and surrounds). Several small townships exist within 5 km of the Project alignment; these include Yelarbon, Inglewood, Millmerran, Brookstead, Pittsworth, Southbrook, Kingsthorpe and Gowrie.

The influence of terrain on wind flows and dispersion has been considered in the meteorological modelling undertaken for the assessment, as discussed in Section 11.6.4.2. The effect of land use on surface roughness and dispersion has also been included in the meteorological model developed for the assessment. The height of the train emission source included in the model was based on the proposed design elevations for the alignment.

### 11.7.5 Sensitive receptors

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

- A dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises
- A motel, hotel or hostel
- A kindergarten, school, university or other educational institution
- A medical centre or hospital
- A protected area under the NC Act, the *Marine Parks Act 2004* (Qld) or a World Heritage Area
- A public park or garden
- A place used as a workplace, including an office for business or commercial purposes.

There are no World Heritage Areas or areas protected under the NC Act or the *Marine Parks Act 2004* (Qld) located within 1 km of the Project alignment.

The primary sensitive receptor type for the Project of interest for air quality assessment are rural and semi-rural dwellings; a large number of which are sparsely distributed within the AQIA area. As per the ToR, surfaces that lead to potable water tanks in the vicinity of the Project are also considered sensitive receptors.

Figure 11.15a–ab shows the location of sensitive receptors considered for the AQIA. The sensitive receptors were identified via a desktop review of aerial imagery and no site verification was undertaken. Only sensitive receptors within 1 km of the Project alignment centreline were included in the modelling for the operational-phase impact assessment.

In addition to existing sensitive receptors, the Project includes allowance for three non-resident workforce accommodation facilities to accommodate the construction workforce. These workforce accommodation facilities will be occupied during the construction of the Project and have therefore been included as sensitive receptors for the construction phase impact assessment. These accommodation facilities will not be occupied during the operation of the Project and therefore are not considered in the operational phase impact assessment. The locations of the accommodation facilities are not shown in Figure 11.15a-ab

Figure 11.15a–ab, but are specified in detail in Chapter 5: Project Description.

The number of sensitive receptors included in this assessment is based on the Project footprint established to accommodate the reference design and the land required to safely and efficiently construct and maintain the Project. As a result, the number and location of sensitive receptors of relevance for air quality impacts may change during the detail design phase of the Project and as the construction approach is finalised.

Due to the large-scale nature of the Project, it has been assumed that receptors within the temporary footprint will not be occupied during construction works and have therefore not been considered further. The extent of sensitive receptor impacts will be re-assessed through the detail design process once the Project footprint and construction methodology has been confirmed. The location and classification of sensitive receptors in proximity to the finalised Project footprint will be confirmed as part of the re-assessment process.

Discrete receptors points have been included for sensitive receptors and have been modelled at ground level (0 m above ground) as per the requirements of the DES guideline *Application requirements for activities with impacts to air* (DES, 2019d). 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 concentration contours.

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
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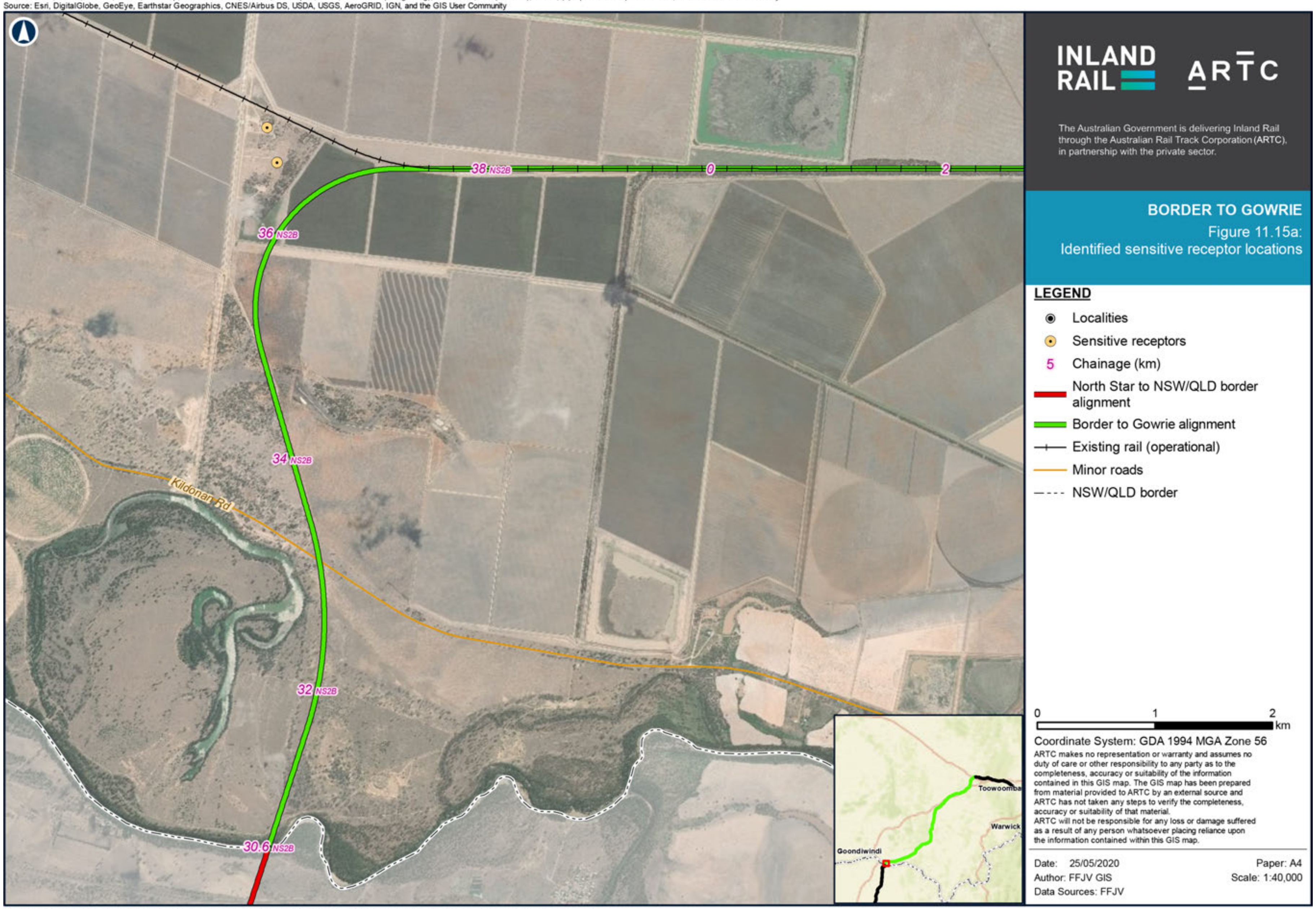


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**BORDER TO GOWRIE**

Figure 11.15b:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- NSW/QLD border

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

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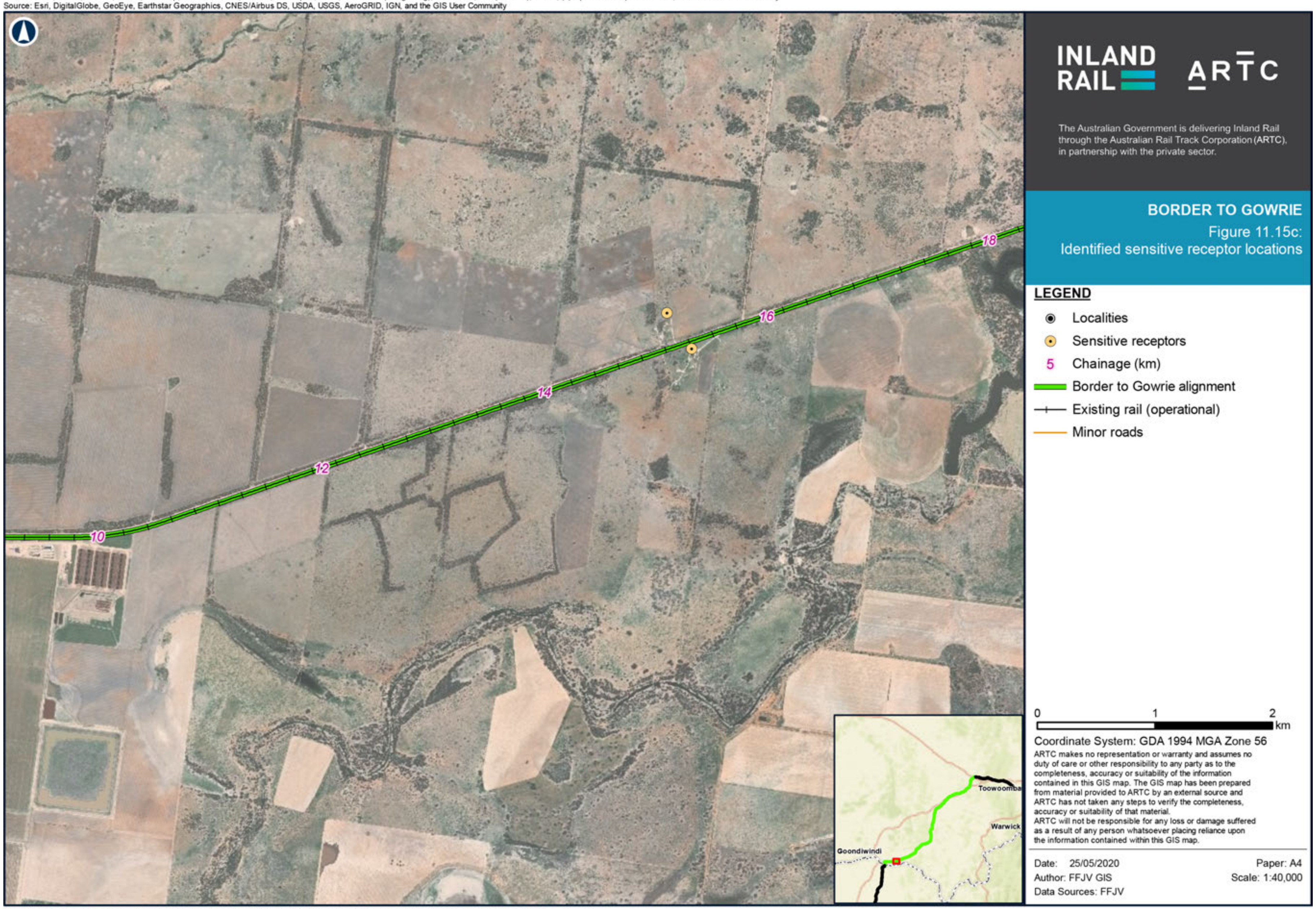


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## BORDER TO GOWRIE

Figure 11.15d:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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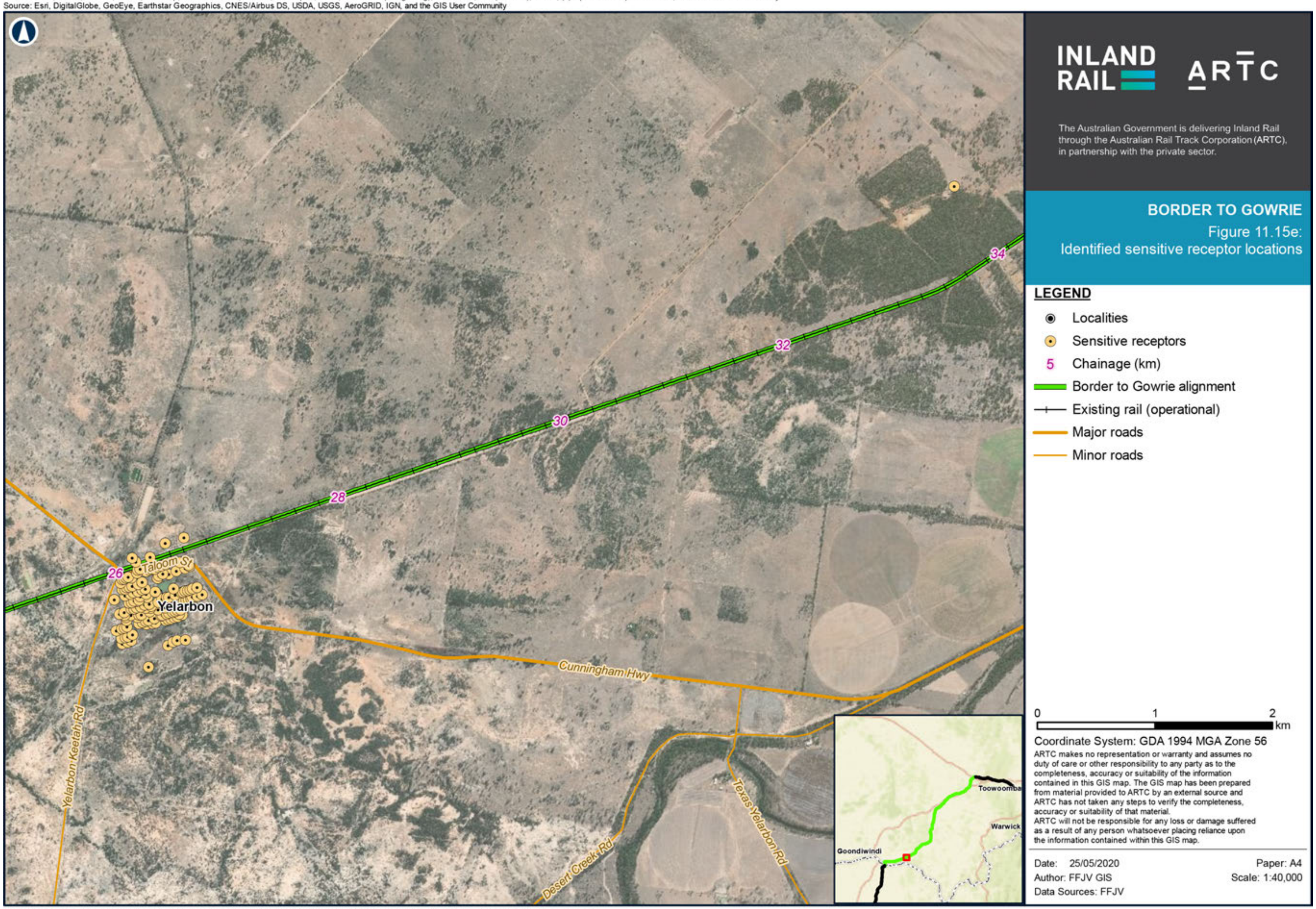


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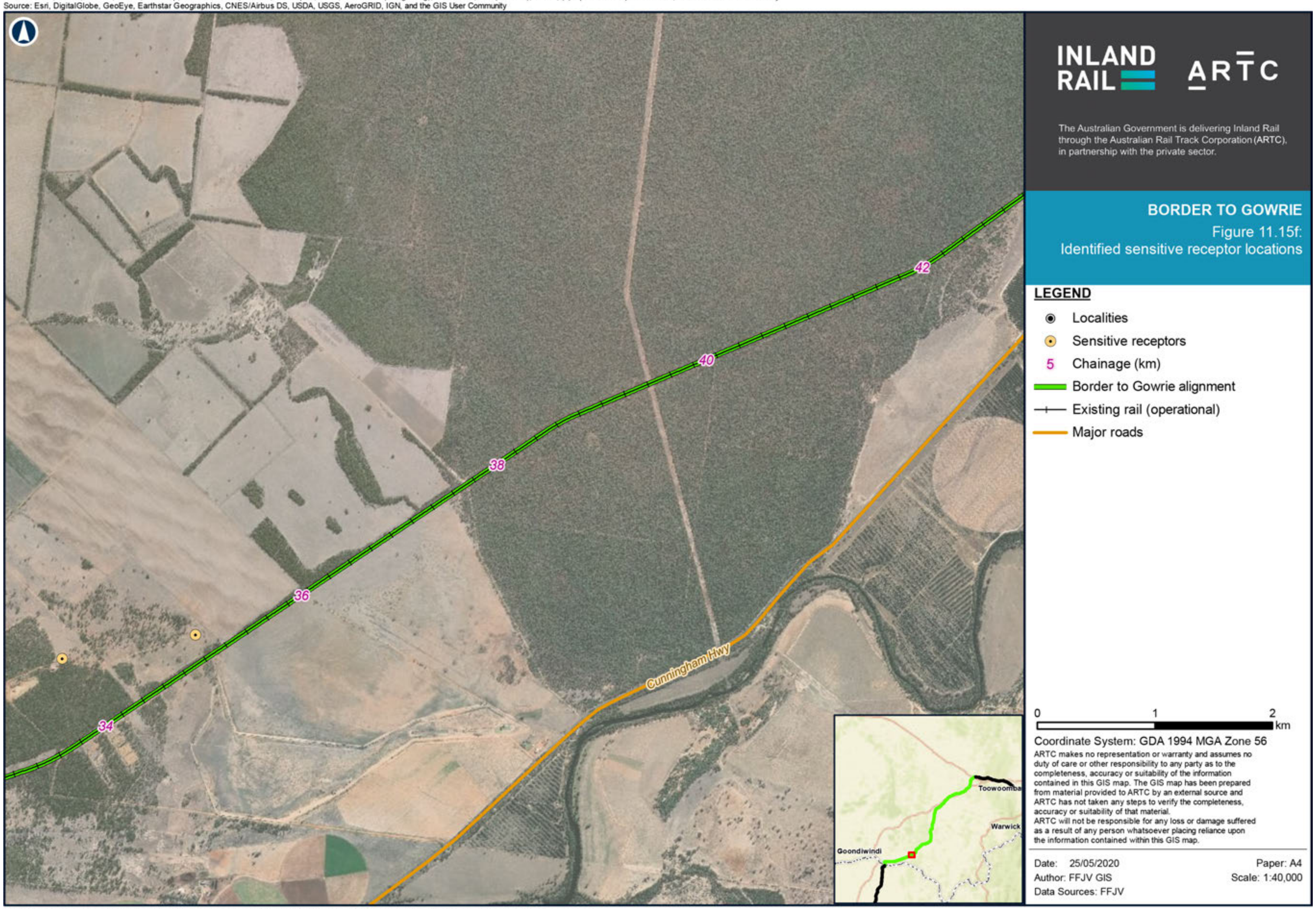


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**BORDER TO GOWRIE**

Figure 11.15g:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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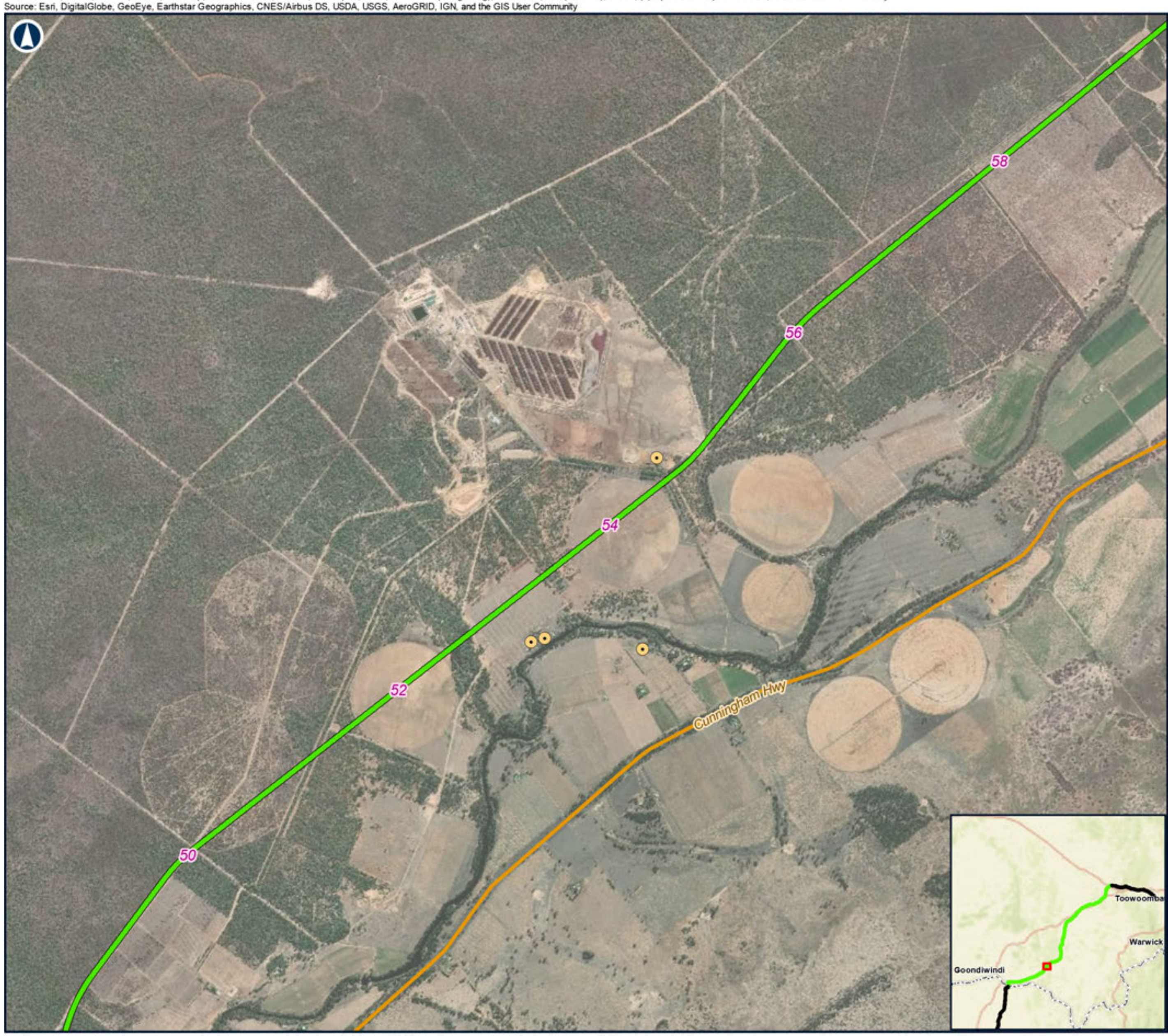


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**BORDER TO GOWRIE**

Figure 11.15h: Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

0 1 2 km

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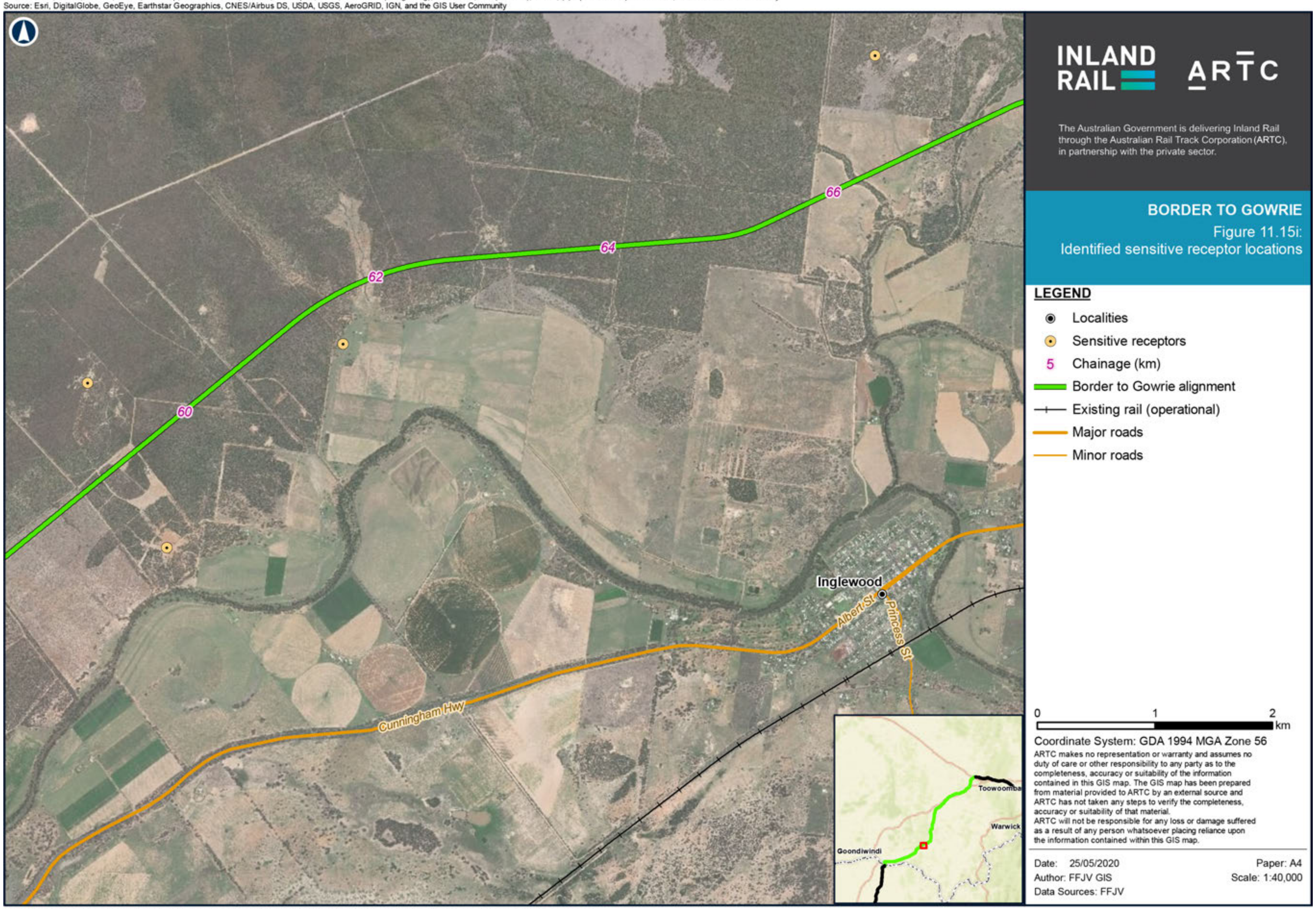


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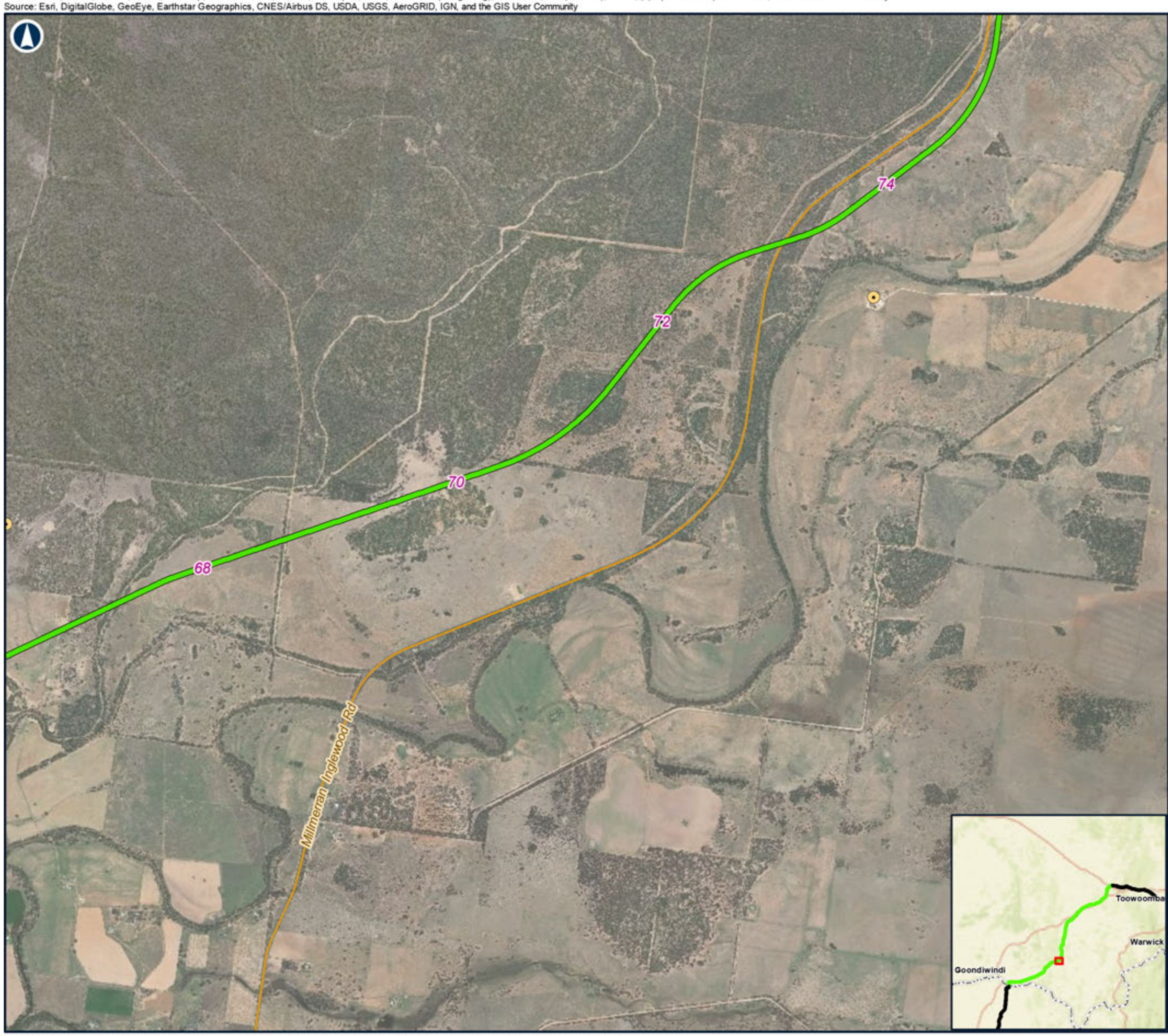


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**BORDER TO GOWRIE**

Figure 11.15j:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

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## BORDER TO GOWRIE

Figure 11.15k:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

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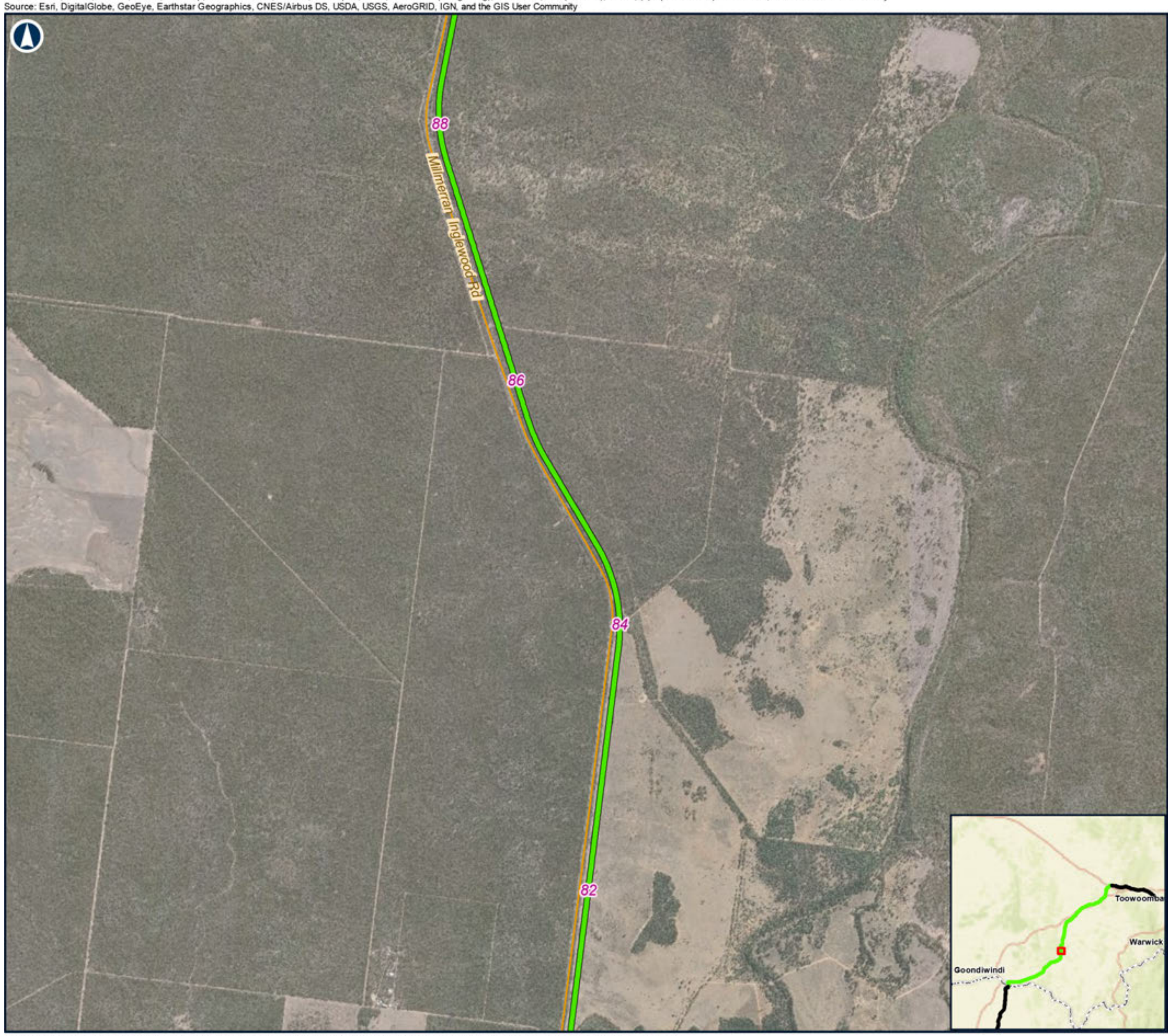


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**BORDER TO GOWRIE**

Figure 11.15l:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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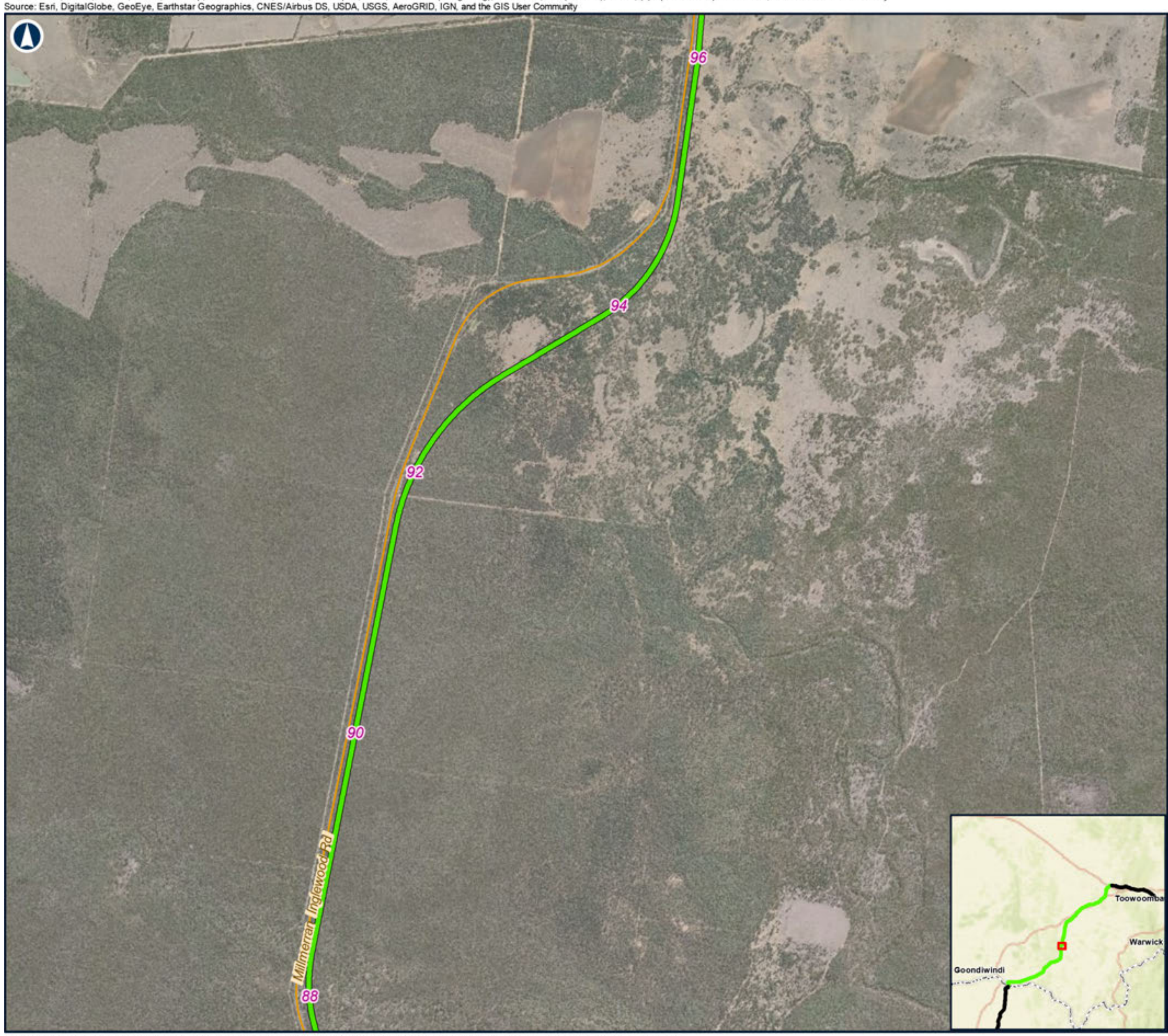


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**BORDER TO GOWRIE**

Figure 11.15m:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

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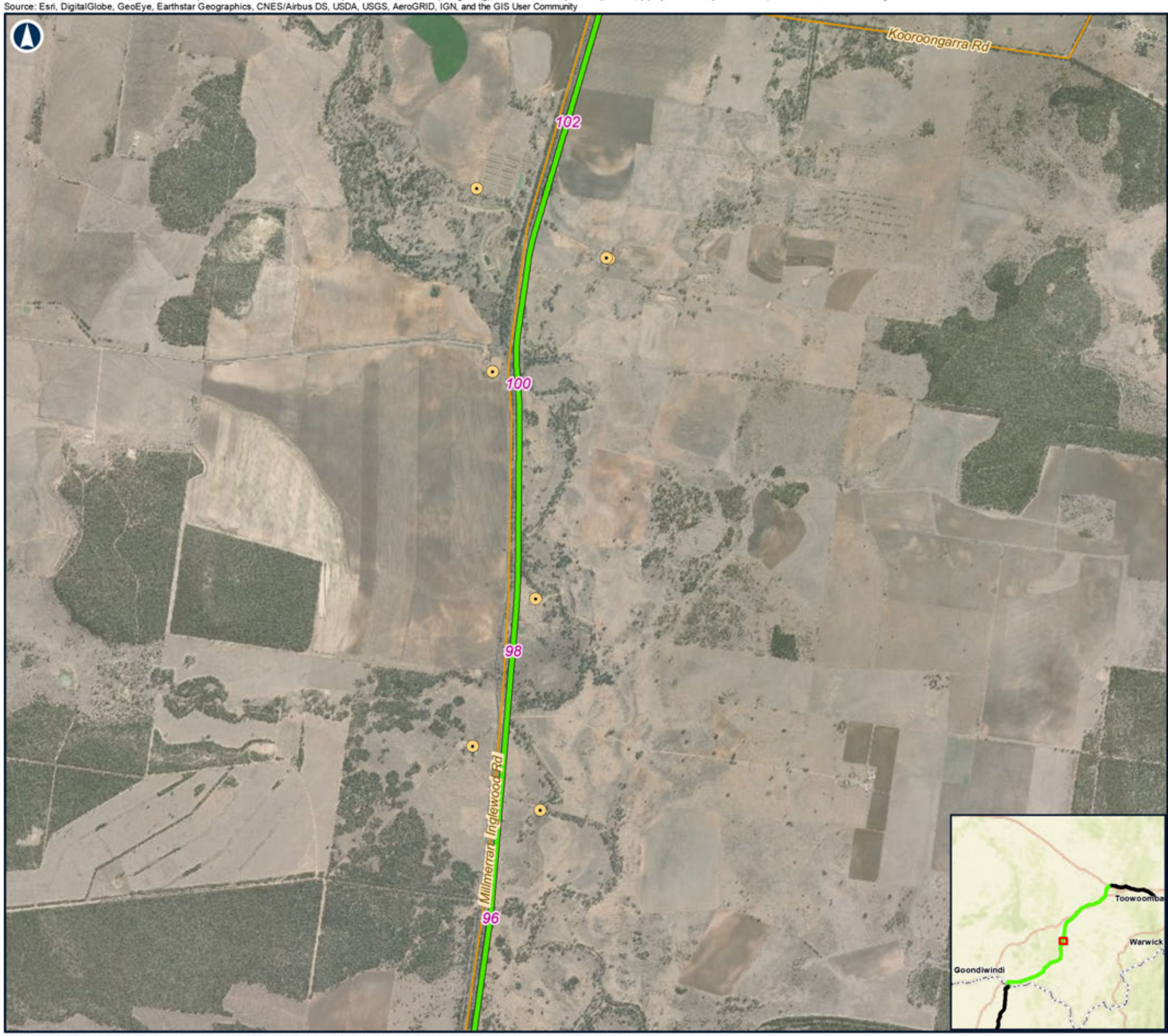


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**BORDER TO GOWRIE**

Figure 11.15n: Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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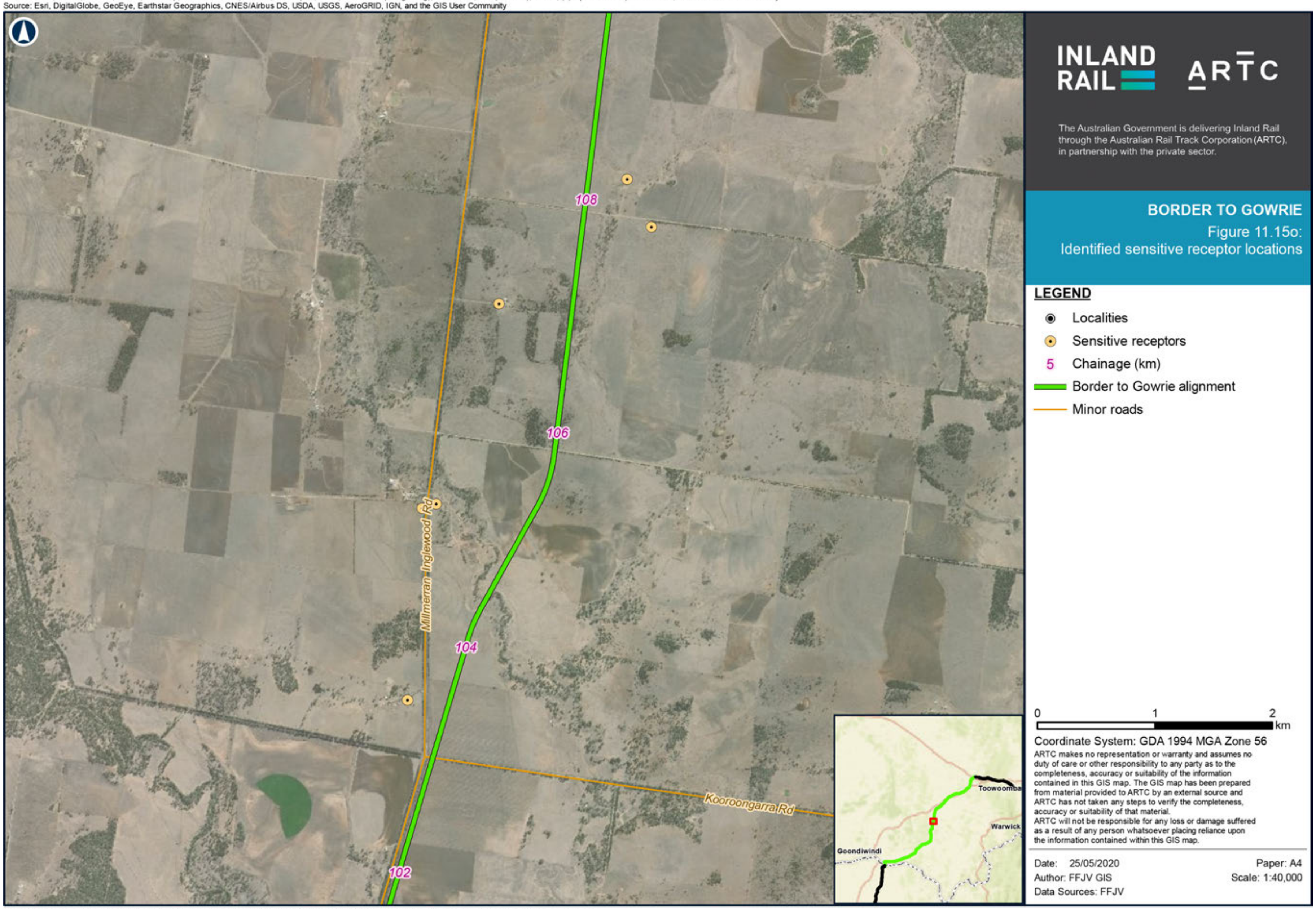


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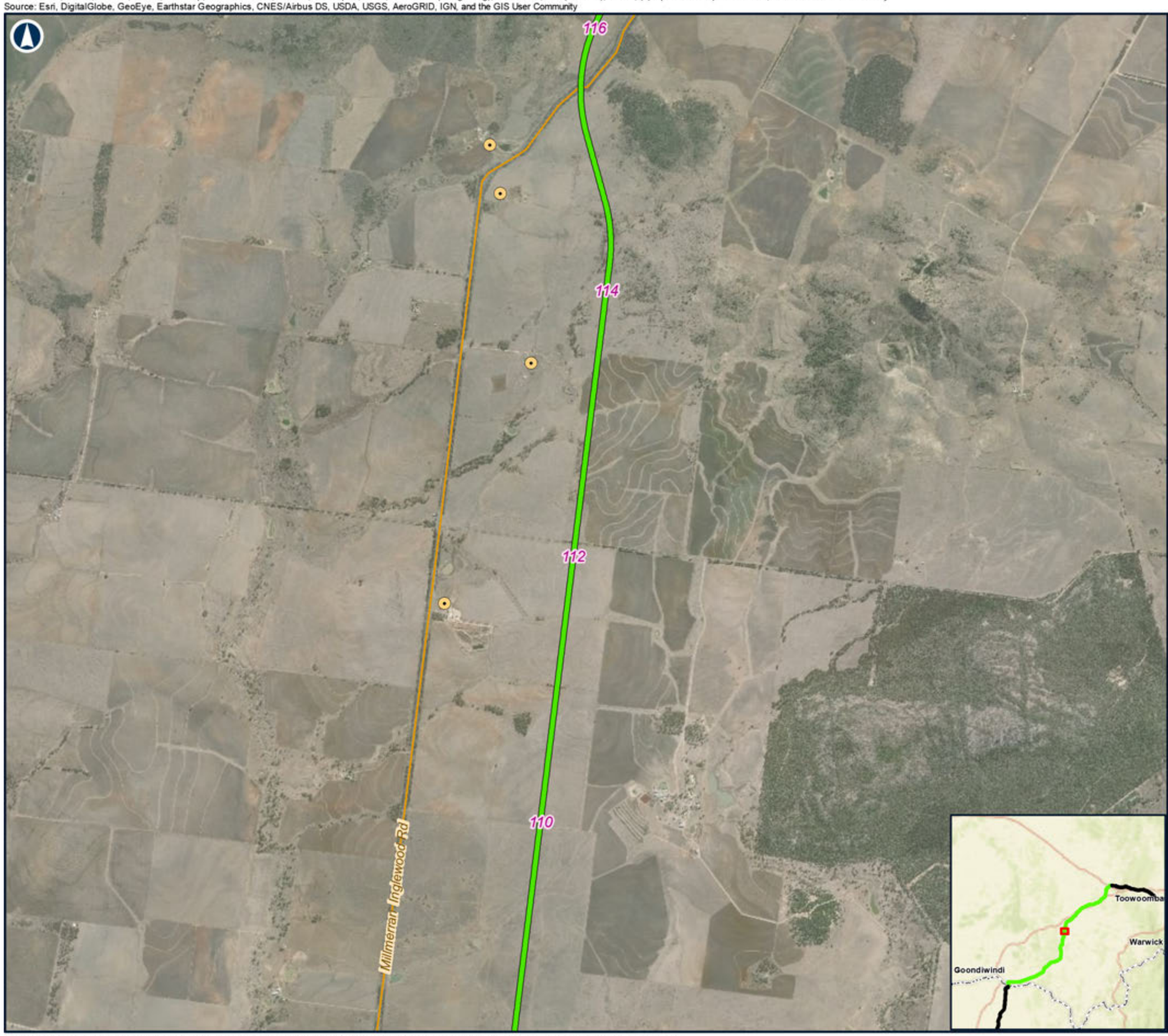


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**BORDER TO GOWRIE**

Figure 11.15p: Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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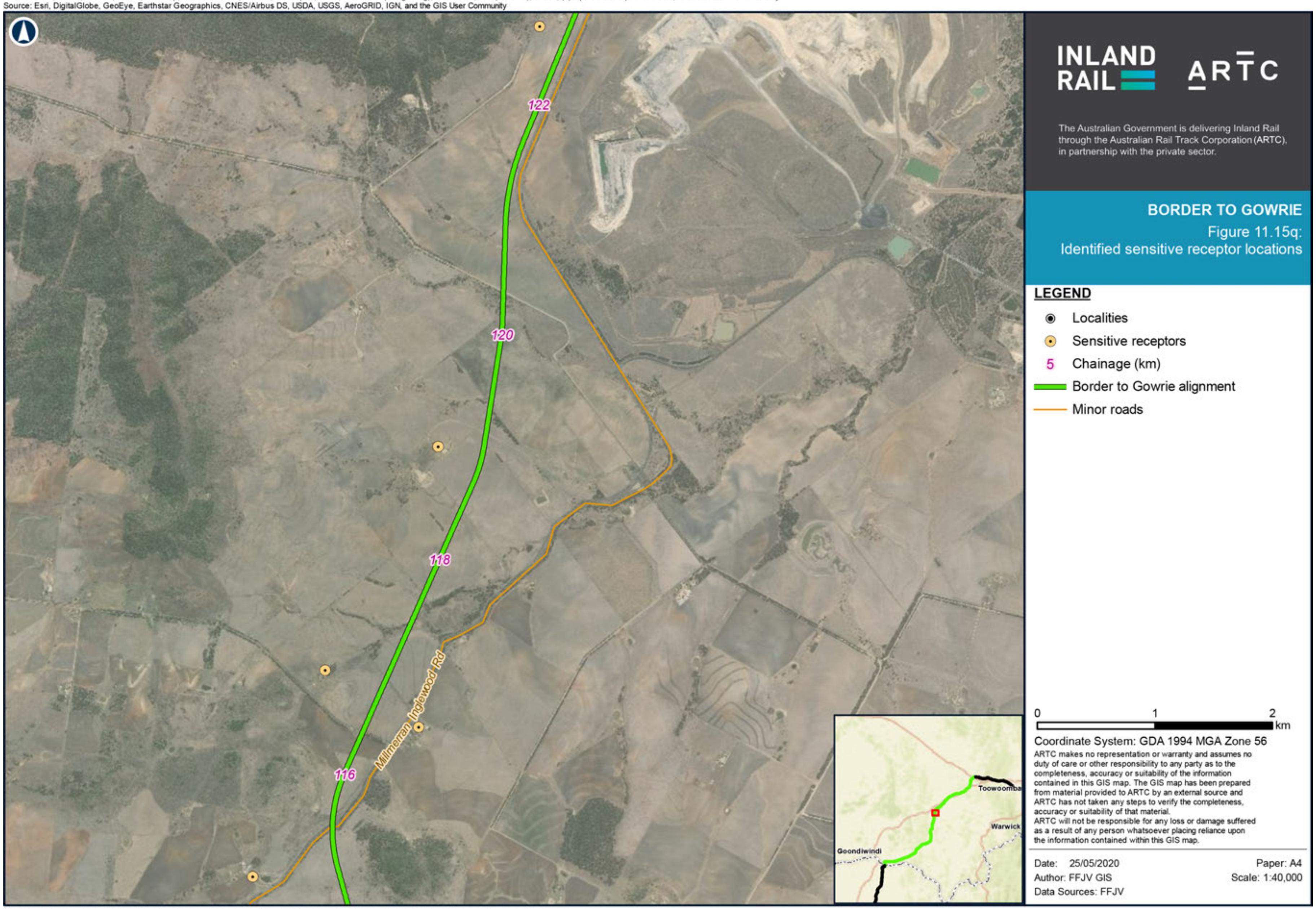


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**BORDER TO GOWRIE**

Figure 11.15r:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads

0 1 2 km

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**BORDER TO GOWRIE**

Figure 11.15s: Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads

0 1 2 km

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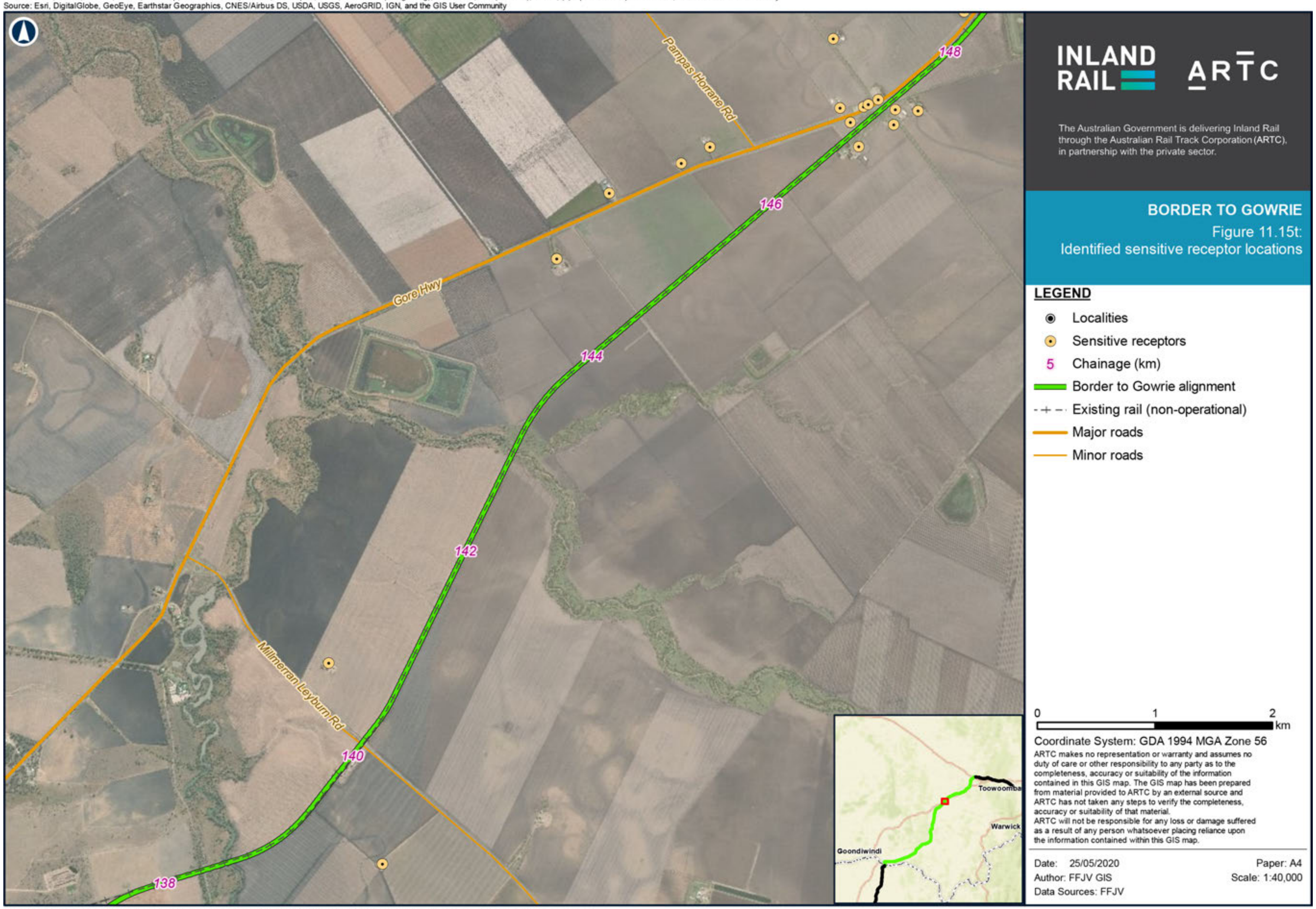


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**BORDER TO GOWRIE**

Figure 11.15u:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads

0 1 2 km

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**BORDER TO GOWRIE**

Figure 11.15v:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

0 1 2 km

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**BORDER TO GOWRIE**

Figure 11.15w:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

0 1 2 km

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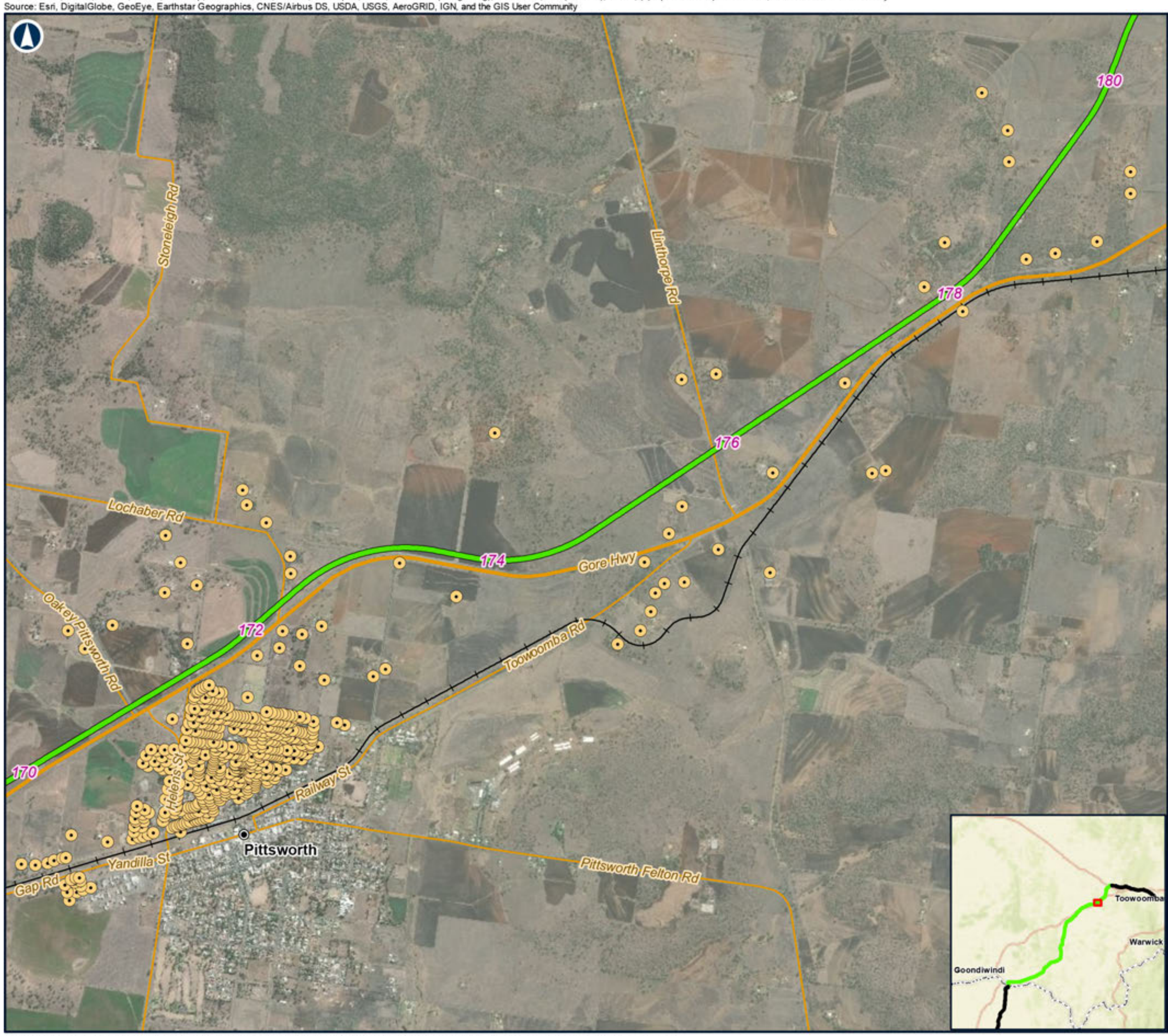


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**BORDER TO GOWRIE**

Figure 11.15x: Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

0 1 2 km

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Data Sources: FFJV

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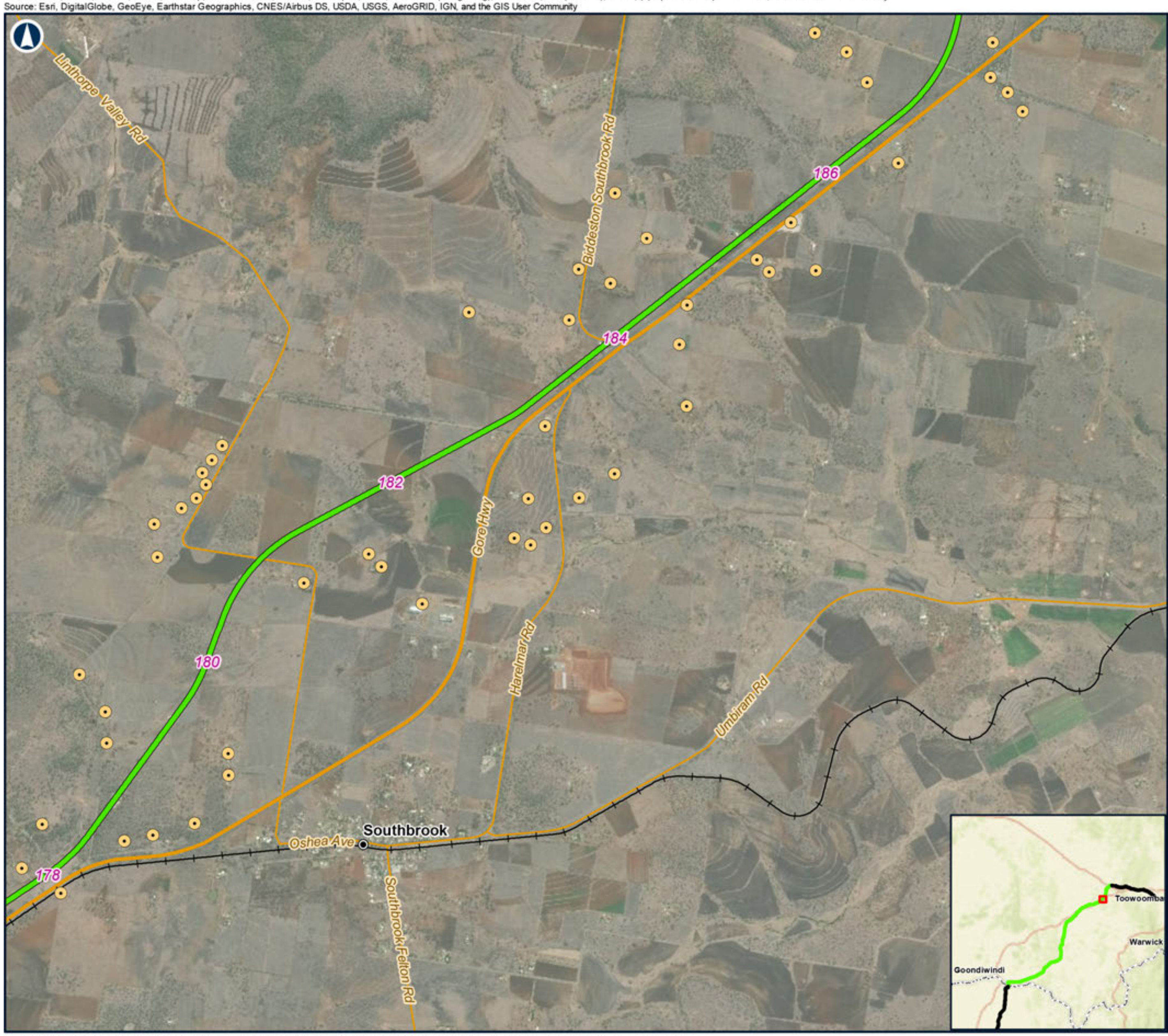


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**BORDER TO GOWRIE**

Figure 11.15y:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

0 1 2 km

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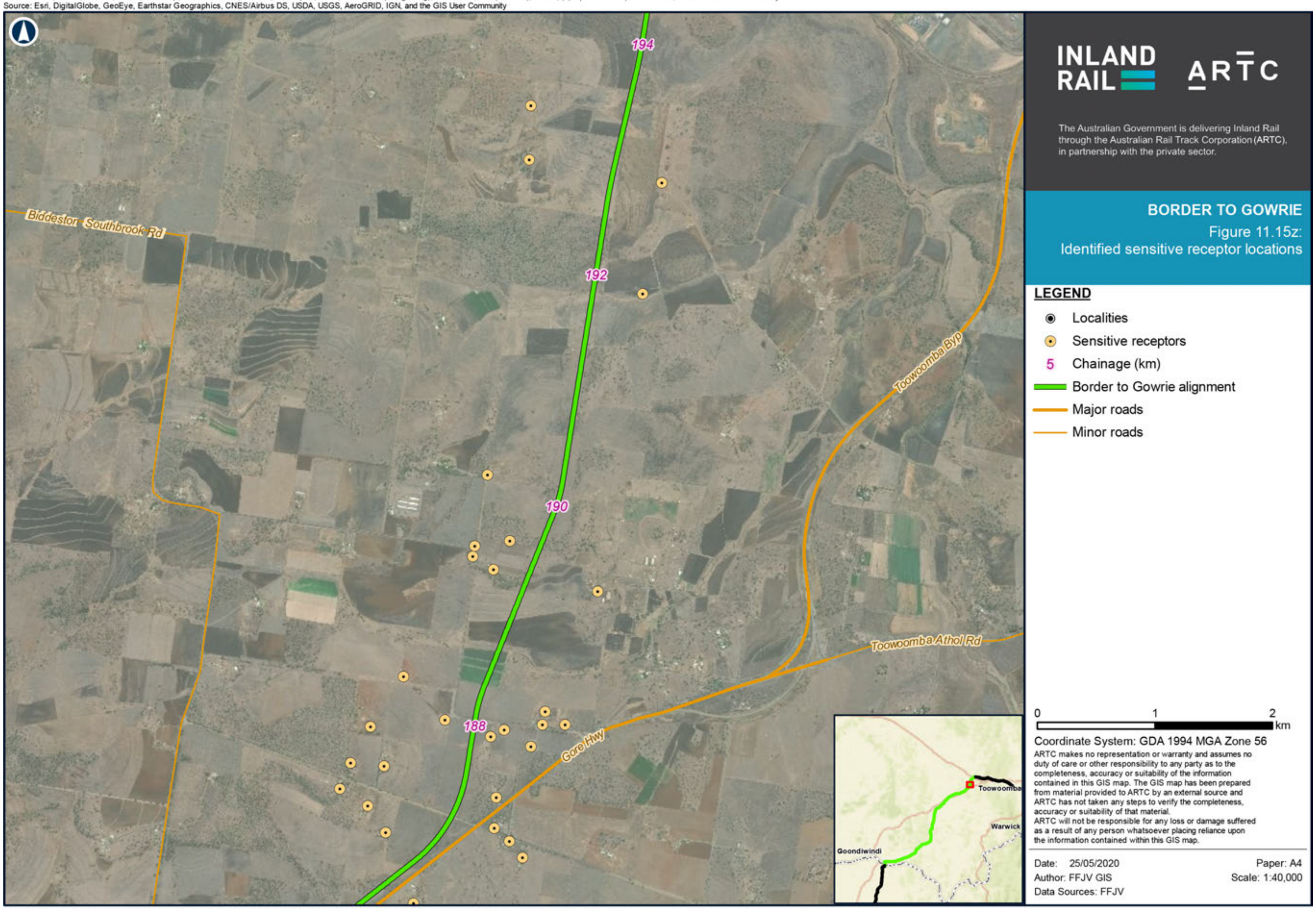


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**BORDER TO GOWRIE**

Figure 11.15aa:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Major roads
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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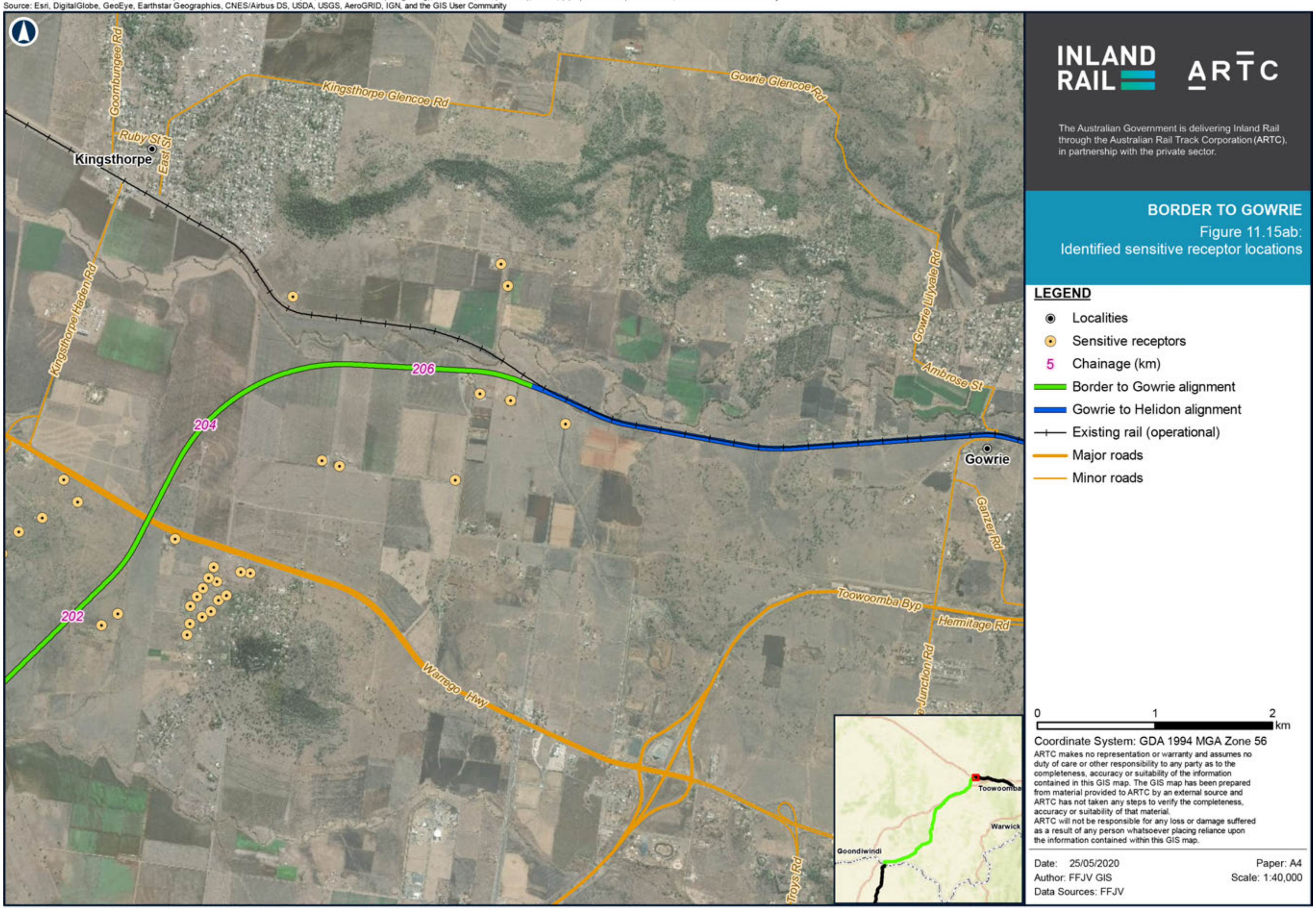


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## 11.8 Potential impacts

The following sections summarise the potential air quality impacts that may arise as a result of the construction, commissioning and operation of the Project.

### 11.8.1 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 (TSP) 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, it does not directly impact human health.

$PM_{2.5}$ 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 considered unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors and therefore have not been assessed for the construction phase.

In addition to construction dust, odour may be emitted from the sewage treatment plants if they are required for non-resident workforce accommodation. The assessment of odour from these facilities is presented in Section 11.8.1.2.

Odour and VOCs will also be emitted as fugitive emissions from fuel tanks located at laydown areas. Impacts from fuel storage have been assessed in Section 11.8.1.3.

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

#### 11.8.1.1 Construction dust

A qualitative impact assessment of the construction of the Project was completed using the *Guidance on the assessment of dust from demolition and construction* (EPA) (UK IAQM, 2014). As previously discussed, the main pollutant of concern during the construction phase is particulates, predominantly airborne $PM_{10}$ and TSP. The risk of dust soiling and human health impacts due to particulate matter were determined based on the scale of activities and proximity to sensitive receptors. Dust soiling arises from the deposition of dust in all size factions on surfaces within an impacted area, for example rooves of buildings, vehicles and vegetation, including crops.

The IAQM method uses a four-step process to assess dust impacts:

- Step 1: Screening based on distance to nearest sensitive receptors
- Step 2: Assess risk of dust impacts from activities based on:
    - Scale and nature of the works, which determines the potential dust emission magnitude
    - Sensitivity of the area.
- Step 3: Determination of site-specific mitigation for dust-emitting activities
- Step 4: Reassess risk of dust impacts after mitigation has been considered.

Each of these steps is described in the following sections.

**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 up to 500 m from the site entrance.

The number of sensitive receptors identified within the AQIA area is 909. Their respective distances from the Project are summarised in Table 11.24. The three temporary workforce accommodation facilities for the Project are included in the numbers presented in Table 11.24.

**TABLE 11.24 SUMMARY OF SENSITIVE RECEPTORS**

| Distance from construction element (m) | Number of receptors proximal to construction elements of the Project | | |
|---|---|---|---|
| | Access tracks | Laydown areas | Project footprint[1.] |
| 0 | 0 | 1 | 8 |
| <20 | 0 | 10 (11)[2.] | 24 (32)[2.] |
| 21 to 50 | 1 | 10 | 38 |
| 51 to 100 | 0 | 34 | 53 |
| 101 to 350 | 15 | 184 | 221 |
| >350 | 893 | 671 | 573 |
| **Total** | | **909** | |

**Table notes:**
1. Temporary and permanent footprint
2. It is assumed that the eight receptors that fall within the permanent footprint and the one receptor that falls within the temporary footprint will not be occupied at the time of construction and thus will no longer be sensitive receptors.

As there are sensitive receptors located within 350 m of the Project footprint, further assessment of construction impacts to these sensitive receptors is required.

As stated in Section 11.7.5, it has been assumed that receptors identified within the Project footprint and the one receptor that is located within the footprint of a laydown area will not be occupied once construction works have commenced and have therefore not been considered further. The location of laydown areas and access tracks, relative to sensitive receptors, will be confirmed through the detail design process once the construction approach is finalised.

#### Step 2—Dust risk assessment

Step 2 in the IAQM method is a risk assessment designed to appraise the potential for dust impacts due to unmitigated dust emissions from a construction project. 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 dust impacts. Each of these steps are discussed below.

##### 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 >50,000m$^3$, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level.*
- *Medium: Total building volume 20,000m$^3$ to 50,000m$^3$, potentially dusty construction material, demolition activities 10 to 20 m above ground level.*
- *Small: Total building volume <20,000 m$^3$, 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 m$^2$, 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 m$^2$ to10,000 m$^2$, moderately dusty soil type (e.g. silt), 5 to10 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 m$^2$ – 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 m$^3$, on site concrete batching, sandblasting.*
- *Medium: Total building volume 25,000 m$^3$ to 100,000 m$^3$, potentially dusty construction material (e.g. concrete), on site concrete batching.*
- *Small: Total building volume <25,000 m$^3$, construction material with low potential for dust release (e.g. metal cladding or timber).*

*Track-out: Factors which 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 track-out into one of the dust emission magnitude categories. Example definitions for track-out 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.*

Dust emission magnitudes for Project construction activities were estimated based on the IAQM examples listed above. The factors used in determining the magnitudes and justification for each are presented in Table 11.25.

The construction program will generally be based on the following worksite hours:

- General construction activities:
  - Monday to Friday—6.30 am to 6.00 pm
  - Saturday—6.30 am to 1.00 pm
  - No work planned on Sundays or public holiday.
- Track possessions may occur on a 24-hour/7-day calendar basis, subject to agreement with Queensland Rail (QR).

There may be circumstances where work outside the above standard hours, including night works, will be required, e.g. the delivery of materials. Work outside standard hours will only be undertaken where consultation with the local community has been undertaken.

The construction schedule will require multiple work fronts to be in progress at any one time along the Project alignment.

TABLE 11.25 CONSTRUCTION ACTIVITIES AND DUST EMISSION MAGNITUDE JUSTIFICATION

| Activity | Potential dust emission magnitude | Justification |
|---|---|---|
| Demolition | Small | ▸ Existing buildings likely to be demolished, all assumed to be small homesteads<br>▸ Buildings assumed to be primarily of low dust potential material (wood/cladding). Materials to be confirmed prior to demolition.<br>▸ Total building volumes presently unknown, although assumed to be <10,000 $m^3$<br>▸ Possible demolition and realignment of existing roads—to be confirmed in the detail design phase of the Project. |
| Earthworks | Large | ▸ Multiple work fronts at any one time along the alignment<br>▸ Vegetation clearing along the proposed alignment corridor 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 (216.2 km) will be stripped (approximate depth of 0.3 m) and stockpiled. Wherever possible and appropriate, material will be reused within Project footprint.<br>▸ 74 laydown areas along the Project alignment with the ability to provide locations for excavation stockpiling. Stockpiles to be located as close as possible to the excavation source.<br>▸ Total cut of 12,525,037 $m^3$ and total fill of 13,347,369 $m^3$<br>▸ Utility relocations<br>▸ Earthworks material likely to be dusty especially during dry season. Soil types along corridor location to 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 216.2 km of railway, using steel rail, sleepers, ballast and concrete. Concrete and ballast present high dust risk<br>▸ Construction of 34 new bridge structures—steel material low dust risk but concrete high dust risk<br>▸ Temporary site offices and parking facilities likely to be constructed at each laydown area<br>▸ Construction of 13 fuel storage facilities: two approximately <20,000 L, and 11 approximately <10,000 L<br>▸ Laydown areas to also include temporary parking facilities for construction workers<br>▸ Construction of flash-butt welding facility<br>▸ Construction of temporary and permanent fencing—total lengths to be determined during detail design phase. |
| Track-out | 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 from sources, and between laydown area and ballast handling facility, via 18 tonne (t) dump trucks<br>▸ After construction, access tracks are expected to only be 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. |

### Step 2B—Sensitivity of surrounding area

The IAQM methodology allows the sensitivity of an area to dust soiling and human health impacts due to particulate matter 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 soiling 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, e.g. 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, e.g. 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 11.26 details the IAQM guidance sensitivity levels for dust soiling effects on people and property.

**TABLE 11.26 IAQM SURROUNDING AREA SENSITIVITY TO DUST SOILING IMPACTS**

| | | Distance from the source | | | |
|---|---|---|---|---|---|
| **Receptor sensitivity** | **Number of receptors** | **<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 |

As detailed in Step 1, the total number of receptors identified in the impact assessment area is 909. All 909 receptors are classified as high sensitivity as they are expected to be used for residential purposes.

Of the 909 receptors:

- 349 are located within 350 m of a construction dust source
- 121 of the 349 are located less than 100 m away
- 66 of the 349 receptors are located less than 50 m away
- 27 of the 349 receptors are located less than 20 m away.

As there are more than 10 receptors located within 20 m of active construction areas, the IAQM guidance would determine the sensitivity level to dust soiling effects from the Project to be 'high' (refer Table 11.26); however, the length of the Project is 216.2 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 primarily rural setting of the AQIA area, a rating of high for sensitivity to dust soiling is considered overly conservative, and a rating of 'medium' is considered more appropriate. For this reason, a rating of 'medium' has been used for the sensitivity of receptors to dust soiling impacts.

A modified version of the IAQM guidance for assessing the sensitivity of an area to human health impacts is shown in Table 11.27. For high and medium sensitivity receptors, the IAQM methods considers the existing background concentrations of $PM_{10}$ (as an annual average) experienced in the area of interest. The IAQM method effectively considers the assimilative capacity of the environment through consideration of background concentrations.

As the UK air quality goals for $PM_{10}$ differ from the ambient air quality goals adopted for use in this assessment (EPP (Air) objectives and other Australian air quality goals) the annual mean concentration categories used in the assessment (see Table 11.27) have been modified from those presented in the IAQM method. This approach is consistent with the IAQM guidance, which notes that in using the tables to define the sensitivity of an area, professional judgement may be used to determine alternative sensitivity categories.

**TABLE 11.27 SURROUNDING AREA SENSITIVITY TO HUMAN HEALTH IMPACTS**

| Receptor sensitivity | Annual mean $PM_{10}$ concentration [1] | Number of receptors | Distance from the source <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:**

1. The annual mean $PM_{10}$ concentration categories have been modified from the IAQM guidance to adjust for assessment of a site in Queensland.

Table 11.27 provides the modified IAQM guidance sensitivity levels for human health impacts for four annual mean $PM_{10}$ background categories, including below 17 µg/m³ and between 17 to 21 µg/m³. As detailed in Table 11.22, the background annual average $PM_{10}$ concentration at the Inland Rail AQMS monitoring station for the period of September 2018 to August 2019 was 17.1 µg/m³. Although the measured concentration at the Inland Rail AQMS was 17.1 µg/m³, the risk matrix for the lowest concentration category (below 17 µg/m³) has been adopted due to the marginal exceedance of the 17 µg/m³ cut-off.

There are 27 high-sensitivity receptors within 20 m of the Project footprint and, therefore, based on the IAQM risk matrix in Table 11.27, the sensitivity of the AQIA area to human health impacts is considered to be 'low'.

### Step 2C—Unmitigated risk of impacts

The dust emission magnitudes for each activity as determined in Step 2A were combined with the sensitivity of the AQIA area (in Table 11.26 and Table 11.27) to determine the risk of construction dust air quality impacts, with no mitigation measures applied. The risk of impacts for each activity is assessed according to the IAQM risk matrix for each activity, which is presented in Table 11.28. The risk of dust impacts for each construction activity, without the application of mitigation measures, are summarised in Table 11.29.

TABLE 11.28 IAQM RISK MATRIX FOR IMPACTS FROM DUST EMISSIONS

| 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 |
| Track-out | High | High risk | Medium risk | Low risk |
| | Medium | Medium risk | Low risk | Negligible |
| | Low | Low risk | Low risk | Negligible |

TABLE 11.29 DUST RISK IMPACTS FOR PROJECT CONSTRUCTION ACTIVITIES, WITHOUT MITIGATION MEASURES

| Activity | Surrounding area sensitivity | Demolition | Earthworks | Construction | Track-out |
|---|---|---|---|---|---|
| Scale of Activity[1] | | Small | Large | Large | Large |
| **Dust soiling** | Medium[2] | Low | Medium | Medium | Medium |
| **Human health** | Low[3] | Negligible | Low | Low | Low |

**Table notes:**
1. Refer Table 11.25
2. As per Table 11.26
3. As per Table 11.27

The result of the qualitative air quality risk assessment shows that unmitigated air emissions from the construction of the Project pose a 'low' risk of human health impacts but a 'medium' risk of dust soiling.

### Step 3—Management strategies

The outcome of Step 2C is used to determine the level of management that is required to ensure that dust impacts on surrounding sensitive receptors are maintained at an acceptable level. The IAQM guidance states that a high- or medium-level risk rating means that suitable management measures will need to be implemented during construction to reduce the risk of significant impacts.

The implementation of mitigation measures and controls specified in Section 11.9 is expected to enable the risk of dust impacts to sensitive receptors surrounding the Project footprint to be appropriately avoid or minimised during construction.

### Step 4—Reassessment

The final step of the IAQM methodology is to determine whether there are likely to be significant residual impacts, post-mitigation, arising from a proposed development.

Mitigation measures and controls proposed to be implemented during the construction phase of the Project are specified in Section 11.9.2. An assessment of the residual risk of impact from construction with the implementation of these proposed mitigation measures is presented in Section 11.10.

### 11.8.1.2 Non-resident workforce accommodation

Construction personnel who do not live within a safe commutable distance to the Project will be housed in temporary non-resident workforce accommodation. Each facility will be required to hold 300 staff during the peak between weeks 50 and 70. The average occupancy of the facilities outside of the peak period will be approximately 150 people per facility. There are currently three workforce accommodation facilities proposed for the Project. Locations for these facilities have been identified in the vicinity of the townships of Yelarbon, Inglewood and Millmerran (Turallin).

It is anticipated that each non-resident workforce accommodation facility will be self-contained, including the provision of onsite temporary package sewage treatment plants. Sewage treatment plants with a capacity of 300 equivalent persons (EP) will be required to service each non-resident workforce accommodation facility. Odour impacts are possible even from small scale sewage treatment plants, such as those proposed.

The EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013) provides guidance on suitable separation distances between wastewater treatment facilities and neighbouring sensitive receptors. Table 11.30 presents the calculation methods and derived separation distances for a 300 EP sewage treatment plant.

**TABLE 11.30 SEPARATION DISTANCES FOR SEWAGE**

| Type of installation | EPA Victoria separation distance equation | Separation distance required for 300 EP sewage treatment plant (m) |
|---|---|---|
| Mechanical/biological wastewater plants | $10\ n^{1/3}$ | 67 |
| Aerobic pondage systems | $5\ n^{1/2}$ | 87 |
| Facultative ponds | $10\ n^{1/2}$ | 173 |

**Table notes:**
n = equivalent population

Mechanical or biological wastewater treatment systems are likely to be used and therefore a minimum separation distance of 67 m should be maintained from neighbouring sensitive receptors to minimise odour impacts for neighbouring sensitive receptors.

### 11.8.1.3 Tank fuel storage

Fuel tank storage is proposed at 11 locations along the Project footprint during construction. Table 11.31 presents the proposed construction areas that will include diesel fuel storage areas, the storage volumes proposed, and distances to the closest identified sensitive receptors.

**TABLE 11.31 FUEL TANK STORAGE LOCATIONS**

| Construction area ID | Chainage (km) | Location | Fuel storage proposed (L) | Distance from boundary of construction footprint to closest sensitive receptor |
|---|---|---|---|---|
| B2G-LDN006.3 | 6.3 | Yelarbon–Kurumbul Road | 10,000 | 15 m |
| B2G-LDN025.9 | 25.9 | Yelarbon–Kurumbul Road (South) | 10,000 | 95 m |
| B2G-LDN054.2 | 54.2 | Cremascos Road | 10,000 | 160 m |
| B2G-LDN074.0 | 74.0 | Millmerran–Inglewood Road | 10,000 | 680 m |
| B2G-LDN081.0 | 81.0 | Millmerran–Inglewood Road | 10,000 | 3.45 km |
| B2G-LDN116.5 | 116.0 | Millmerran–Inglewood Road | 20,000 | 120 m |
| B2G-LDN161.0 | 161.0 | Pittsworth–Tummaville Road | 20,000 | 250 m |
| B2G-LDN175.5 | 175.5 | Linthorpe Road Bridge | 10,000 | 95 m |
| B2G-LDN188.2 | 188.2 | Athol School Road | 10,000 | 80 m |
| B2G-LDN192.3 | 192.3 | Athol School Road & Toowoomba–Cecil Plains Road | 10,000 | 575 m |
| B2G-LDN206.3 | 206.3 | Leesons Road | 10,000 | 70 m |

For the largest fuel storage tanks of 20,000 L, the distance to the closest receptor is approximately 120 m, while for the smaller tanks of 10,000 L, the distance to the closest receptor is 15 m.

EPA Victoria (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 2000 t, 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 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 acceptable separation distances based on annual fuel throughput. For service stations with an annual fuel throughput of less than 1.2 ML the acceptable separation distance is 10 m, while for service stations with annual fuel throughput of between 1.2 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 considered conservative for diesel.

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 10,000 L tanks would need to be refilled more than twice per day (900 times per year). It is considered improbable 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 with the exception of B2G–LDN006.3 have a separation distance from the nearest boundary to the closest receptor of greater than 50 m; however, the dimensions of B2G–LDN006.3 are approximately 300 m x 27 m, and therefore the fuel tank in this laydown area is able to be located at a position that is further than 50 m from the nearest receptor.

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

### 11.8.2 Commissioning

Air emissions during the commissioning phase of the Project are anticipated to be minor and 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 and are considered unlikely to generate nuisance or risk exceedance of the Project's air quality goals and therefore have not been assessed.

### 11.8.3 Operation

The following sections outline the results of the operational phase air quality impact assessment, including impacts to air quality, drinking water and fugitive agricultural odour impacts.

#### 11.8.3.1 Impacts to air quality

The results of the dispersion modelling are presented in this section according to the increments presented in Table 11.32.

**TABLE 11.32 MODELLING INCREMENT DESCRIPTIONS**

| Increments | Description |
|---|---|
| Project-only contribution | Represents the predicted concentrations from modelled Project locomotive emissions for peak train movements. Different versions of the model have been run to accurately assess emissions from the crossing loops as discussed in Section 11.6.4.2. |
| Background concentration | Adopted background concentrations as per Section 11.7.2. |
| Project-only contribution + background concentration | The summation the Project-only contribution and background concentration. |
| Non-Project contribution | The modelled non-Project cumulative emission sources adjacent to the alignment, which include the Commodore Mine and Millmerran Power Station. |

| Increments | Description |
|---|---|
| Non-Project contribution + background concentration | The summation of the non-Project contribution and background concentration. |
| Total cumulative concentration | The cumulative concentration from Project-only contribution, non-Project contribution, and background concentration. |

Table 11.33 presents the highest total cumulative ground level concentrations at the worst impacted sensitive receptor for each pollutant, for peak operation train numbers (2040). The predicted ground level concentrations have been compared against the relevant air quality goals (refer Section 11.5). The air quality goals adopted for the assessment are prescribed to protect the environmental values of health and wellbeing and protecting the aesthetic environment, which includes avoiding nuisance.

The results in Table 11.33 show that compliance has been predicted at all modelled sensitive receptors for all pollutants and all averaging periods for peak operational train numbers, with the exception of 24-hour average $PM_{10}$.

Exceedance of the 24-hour average $PM_{10}$ air quality goal is predicted at sensitive receptor 186, located approximately 1.1 km to the north of the existing Commodore Mine and to the north of the Project alignment (refer

Figure 11.15). Table 11.33 shows that the predicted $PM_{10}$ 24-hour cumulative concentration at sensitive receptor 186 is 50.1 µg/m$^3$, which represents a 0.1 µg/m$^3$ exceedance of the air quality goal of 50 µg/m$^3$.

As discussed in Section 11.6.4.1, emission rates for the Commodore Mine were estimated using NPI emission data and scaled down for $PM_{10}$ and $PM_{2.5}$ based on achieving compliance with their EA permit at existing sensitive receptors, specifically compliance with the $PM_{10}$ 24-hour goal of 50 µg/m$^3$ at sensitive receptor 186. Therefore, based on the assessment methodology applied, the contribution of the Project to the exceedance at this receptor is considered to be minor.

There is uncertainty regarding emissions from the Commodore Mine due to the uncertainty in the NPI emission estimation methods and the absence of ambient monitoring data for the area local to the mine and Millmerran Power Station; therefore, there is also uncertainty regarding the accuracy of the predicted cumulative concentrations at receptors near the mine, including at sensitive receptor 186.

To improve the understanding of background air quality in the area local to the mine, an air quality monitoring station has been installed at a residential dwelling on Millmerran–Inglewood Road, Millmerran (sensitive receptor 188), which is located approximately 1.4 km to the north of the Commodore Mine and approximately 300 m north of sensitive receptor 186. This location is considered representative of receptors near the mine and power station. Monitoring data from this location will improve understanding of ambient air quality and emissions from the mine and will be used to guide the detail design and finalisation of the construction approach for the Project. Further discussion of the monitoring at this location is provided in Section 11.9.4.

The data in Table 11.33 shows that sensitive receptor 785 is predicted to be the worst affected by emissions from the Project (Project emissions, plus background air quality). The predicted $PM_{10}$ 24-hour concentration at this location, without contribution from the modelled cumulative sources, is 24.9 µg/m$^3$. This is compliant with the air quality goal of 50 µg/m$^3$.

Based on the results of the modelling, the operation of the Project is not expected to significantly adversely impact environmental values of the air environment. The assessment has considered background air quality in the prediction of cumulative concentration and deposition levels at sensitive receptors and has therefore considered the assimilative capacity of the air environment in determining the impact of the Project.

The assessment of operation phase impacts has considered peak train numbers in the year 2040 (refer Table 11.5). As typical train numbers will be lower than peak volumes, predicted concentrations and dust deposition levels and the impact to sensitive receptors would be reduced for the typical number of train movements.

Predicted cumulative pollutant concentration contours are presented in Figure 11.16a-ab, Figure 11.17a–ab, and Figure 11.18 for $PM_{10}$ (24 hour), $PM_{2.5}$ (annual) and $NO_2$ (1 hour). The concentration contours presented are cumulative and include the influence of emissions from the Commodore Mine, Millmerran Power Station, the West Moreton System and the adjoining Inland Rail projects. As the concentration contours are cumulative, the concentrations can be compared directly against the adopted air quality goals (refer 11.5).

**TABLE 11.33 HIGHEST PREDICTED GROUND LEVEL CONCENTRATIONS AT SENSITIVE RECEPTORS FOR PEAK OPERATIONAL TRAIN NUMBERS IN 2040**

| Pollutant | Average period | Highest predicted ground level pollutant concentration at identified sensitive receptor locations for peak operational train numbers in 2040 | | | | | Highest Project contribution (A) sensitive receptor ID | Highest total cumulative concentration (A + B + C) sensitive receptor ID | Air quality goal (refer Section 11.5) | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Project-only contribution (A) | Background concentration (B) | Project-only contribution + Background concentration (A + B) | Non-Project contribution (C) | Total cumulative concentration (A + B + C)[d] | | | | |
| TSP | Annual average | 0.5 | 42.8 | 43.3 | 14.7 | 57.5 | R142 | R183 | 90 | μg/m$^3$ |
| Deposited dust | 30 day | 0.1 | 50.0 | 50.1 | 0.1 | 50.2 | R785 | R184 | 120 | mg/m$^2$/day |
| $PM_{10}$ | 24 hour, maximum | 7.5 | 17.4 | 24.9 | 32.6 | **50.1** | R785 | R186 | 50 | μg/m$^3$ |
| | Annual average | 0.5 | 17.1 | 17.6 | 4.9 | 22.1 | R142 | R184 | 25 | μg/m$^3$ |
| $PM_{2.5}$ | 24 hour, maximum | 7.1 | 7.6 | 14.7 | 2.8 | 14.7 | R785 | R785 | 25 | μg/m$^3$ |
| | Annual average | 0.5 | 6.5 | 7.0 | 0.4 | 7.0 | R142 | R183 | 8 | μg/m$^3$ |
| $NO_2$ | 1 hour, maximum | 100.4 [a.] | 57.5 [a.] | -[a] | -[a] | 157.9 [a.] | R785 | R785 | 250 | μg/m$^3$ |
| | Annual average | 6.5 [a.] | 7.8 [a.] | -[a] | -[a] | 14.3 [a.] | R142 | R142 | 62 | μg/m$^3$ |
| Arsenic and compounds | Annual average | 4.7 x $10^{-5}$ | -[b.] | -[b.] | -[c.] | -[b.] | R142 | R142 | 6 | ng/m$^3$ |
| Cadmium and compounds | Annual average | 0.003 | -[b.] | -[b.] | -[c.] | -[b.] | R142 | R142 | 5 | ng/m$^3$ |
| Chromium III and compounds | 1 hour, maximum | 0.0006 | -[b.] | -[b.] | -[c.] | -[b.] | R785 | R785 | 9 | μg/m$^3$ |
| Chromium VI and compounds | 1 hour, maximum | 0.0006 | -[b.] | -[b.] | -[c.] | -[b.] | R785 | R785 | 0.1 | μg/m$^3$ |
| | Annual average | 1.5 x $10^{-5}$ | -[b.] | -[b.] | -[c.] | -[b.] | R142 | R142 | 0.01 | μg/m$^3$ |
| Lead and compounds | Annual average | 1.4 x $10^{-5}$ | -[b.] | -[b.] | -[c.] | -[b.] | R142 | R142 | 0.5 | μg/m$^3$ |
| Nickel and compounds | Annual average | 2.2 x $10^{-5}$ | -[b.] | -[b.] | -[c.] | -[b.] | R142 | R142 | 22 | ng/m$^3$ |
| Dioxins and furans | Annual average | 1.8 x $10^{-13}$ | -[b.] | -[b.] | -[c.] | -[b.] | R785 | R785 | 3 x $10^{-08}$ | μg/m$^3$ |
| Polycyclic aromatic hydrocarbon (as benzo[a]pyrene) | Annual average | 0.006 | -[b.] | -[b.] | -[c.] | -[b.] | R785 | R785 | 0.3 | ng/m$^3$ |
| 1,3-butadiene | 1 hour, maximum | 0.07 | -[b.] | -[b.] | -[c.] | -[b.] | R785 | R785 | 2.4 | μg/m$^3$ |
| Benzene | Annual average | 0.0007 | 5.2 | 5.2 | 0.0003 | 5.2 | R785 | R785 | 5.4 | μg/m$^3$ |

| Pollutant | Average period | Highest predicted ground level pollutant concentration at identified sensitive receptor locations for peak operational train numbers in 2040<br>Project-only contribution (A) | Background concentration (B) | Project-only contribution + Background concentration (A + B) | Non-Project contribution (C) | Total cumulative concentration (A + B + C)[d] | Highest Project contribution (A) sensitive receptor ID | Highest total cumulative concentration (A + B + C) sensitive receptor ID | Air quality goal (refer Section 11.5) | Units |
|---|---|---|---|---|---|---|---|---|---|---|
| Toluene | 30-minute maximum [e.] | 0.009 | 23.0 | 23.0 | 0.001 | 23.0 | R785 | R785 | 1,100 | µg/m³ |
| | 24 hour, maximum | 0.003 | 21.7 | 21.7 | 0.0002 | 21.7 | R785 | R785 | 4,100 | µg/m³ |
| | Annual average | $9.3 \times 10^{-5}$ | 18.5 | 18.5 | $4.5 \times 10^{-5}$ | 18.5 | R785 | R785 | 400 | µg/m³ |
| Xylenes | 24 hour, maximum | 0.4 | 31.5 | 31.9 | 0.03 | 31.9 | R785 | R785 | 1,100 | µg/m³ |
| | Annual average | 0.01 | 26.0 | 26.0 | 0.006 | 26.0 | R785 | R785 | 950 | µg/m³ |

**Table notes:**

Cells shaded red denote exceedance of adopted air quality goal (refer Section 11.5)

a) The OLM was used to determine $NO_2$ concentrations. The OLM method is complex as it uses modelled hourly $NO_x$ concentrations and hourly varying background $NO_2$ and $O_3$ monitoring data from the Mutdapilly DES monitoring station for 2013. Due to the complexity of this process, the emission sources included in the model, including cumulative sources, were modelled in the same model run and were not modelled individually. As a result, the individual contribution from Project and non-Project sources cannot be determined; however, based on the location of the worst-affected receptors (R785 and R142) the predominant source at the worst-affected receptors presented in Table 11.33 is considered to be the Project. The 'Project-only contribution (A)' listed in Table 11.33 has been calculated based on the predicted total cumulative concentration, minus the measured $NO_2$ background concentrations for Mutdapilly for 2013 ('Background concentration (B)').

b) No background monitoring data is available for this modelled pollutant.

c) Compound not listed as an NPI pollutant from modelled non-Project emission sources, and therefore nil value presented.

d) The highest Project-only contribution (A) and the highest non-Project contribution (C) may be predicted at different sensitive receptors and therefore the total cumulative concentrations do not necessarily equal the sum of the values A, B and C presented in this table.

e) 30-minute averages calculated from 1 hour modelling results as per (Turner, 1970).

### 11.8.3.2 Tank water impacts

Impacts to tank water have been assessed using the methodology described in Section 11.6.5. Table 11.34 presents the highest predicted pollutant concentrations for the water tank of the sensitive receptor worst affected by the Project. Table 11.34 also presents the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

Table 11.34 shows that at the worst-affected receptor for the peak train number scenario in 2040, compliance is predicted for all pollutants by a significant margin. As typical train numbers will be lower than the peak numbers applied, impacts to tank water would generally be less than that predicted.

As compliance with the drinking water guideline values is predicted by a significant margin, the residual impact to drinking water as a result of the Project is expected to be insignificant.

**TABLE 11.34 HIGHEST PREDICTED WATER TANK CONCENTRATIONS AT SENSITIVE RECEPTORS**

| Pollutant | Receptor | Maximum predicted annual deposition rate ($\mu g/m^2/s$) | Estimated roof area ($m^2$) | Maximum predicted total deposited mass ($\mu g$) | Tank water volume (L) | Highest predicted concentration (mg/L) | Guideline value (mg/L) |
|---|---|---|---|---|---|---|---|
| Arsenic | R785 | $1.4 \times 10^{-10}$ | 200[a.] | 0.9 | 1000[b.] | $8.7 \times 10^{-7}$ | 0.01 |
| Cadmium | | $9.6 \times 10^{-9}$ | | 60.7 | | $6.1 \times 10^{-5}$ | 0.002 |
| Lead | | $4.1 \times 10^{-10}$ | | 2.6 | | $2.6 \times 10^{-6}$ | 0.01 |
| Nickel | | $6.3 \times 10^{-8}$ | | 398.6 | | $4.0 \times 10^{-4}$ | 0.02 |
| Chromium VI | | $4.5 \times 10^{-8}$ | | 285.9 | | $2.9 \times 10^{-4}$ | 0.05 |

**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.

### 11.8.3.3 Agricultural train odour impacts

The impacts from agricultural train odour have been assessed using the methodology described in Section 11.6.6. Odour emissions from agriculture freight train pass-bys are expected to be highly 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 considered unlikely to cause significant nuisance impact.

Table 11.35 presents an assessment of odour impacts from livestock freight trains using the FIDOL factors described in Section 11.6.6. Livestock trains are considered to be the agriculture freight with the highest potential to impact sensitive receptors (greater potential than grain, for example) and therefore have been adopted for the assessment of odour.

**TABLE 11.35 SUMMARY OF FIDOL FACTORS FOR ODOUR GENERATED BY AGRICULTURAL TRAINS**

| FIDOL factor | Livestock trains |
|---|---|
| Frequency (F) | During peak operations, it is expected that a maximum of six livestock trains per week will travel the Project rail alignment. As such, the frequency of the event is low, with an average of less than one livestock train per day during peak periods. |
| 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 train pass-by (2 minutes 42 seconds for a 3,600 m train travelling at 80 km/h). At crossing loops, the exposure is expected to be longer (estimated average of approximately one hour) 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 agricultural and residential for the larger town centres of Yelarbon, Inglewood, Millmerran, Pittsworth, Southbrook, Kingsthorpe and Gowrie. Due to the land use of the receiving environment, intermittent odour from agricultural activities and livestock is likely 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 intermittent odour from agricultural uses is unlikely to be uncommon to the existing ambient air environment. Based on the reasoning provided, odour emissions from agriculture freight are considered unlikely to result in significant impact to neighbouring sensitive receptors.

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
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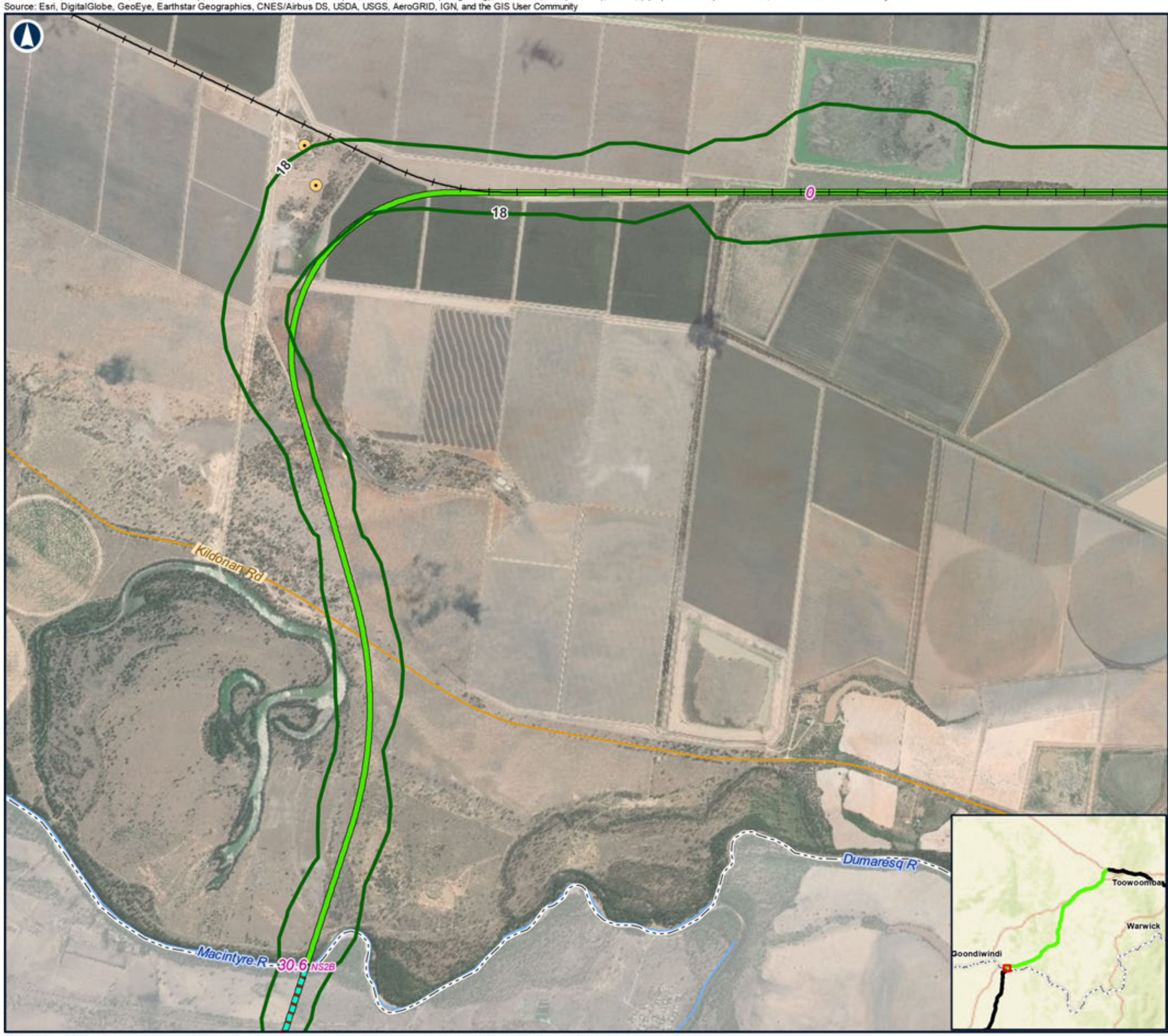


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**BORDER TO GOWRIE**

Figure 11.16a: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Cumulative rail sources
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- Watercourses
- NSW/QLD border

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m³ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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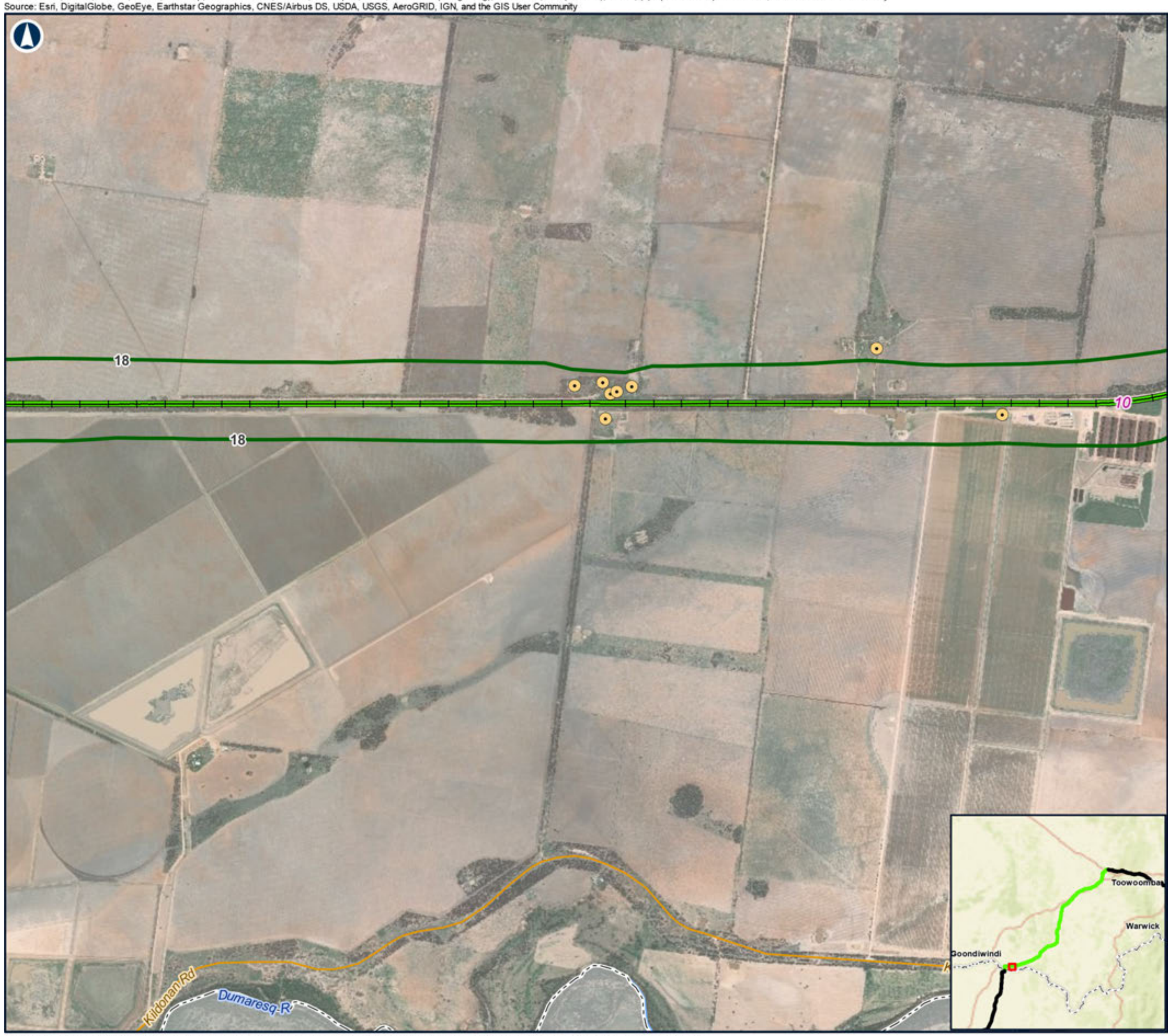


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## BORDER TO GOWRIE

Figure 11.16b: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- Watercourses
- NSW/QLD border

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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**BORDER TO GOWRIE**

Figure 11.16c: Predicted maximum cumulative PM $_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads

**Predicted maximum cumulative PM $_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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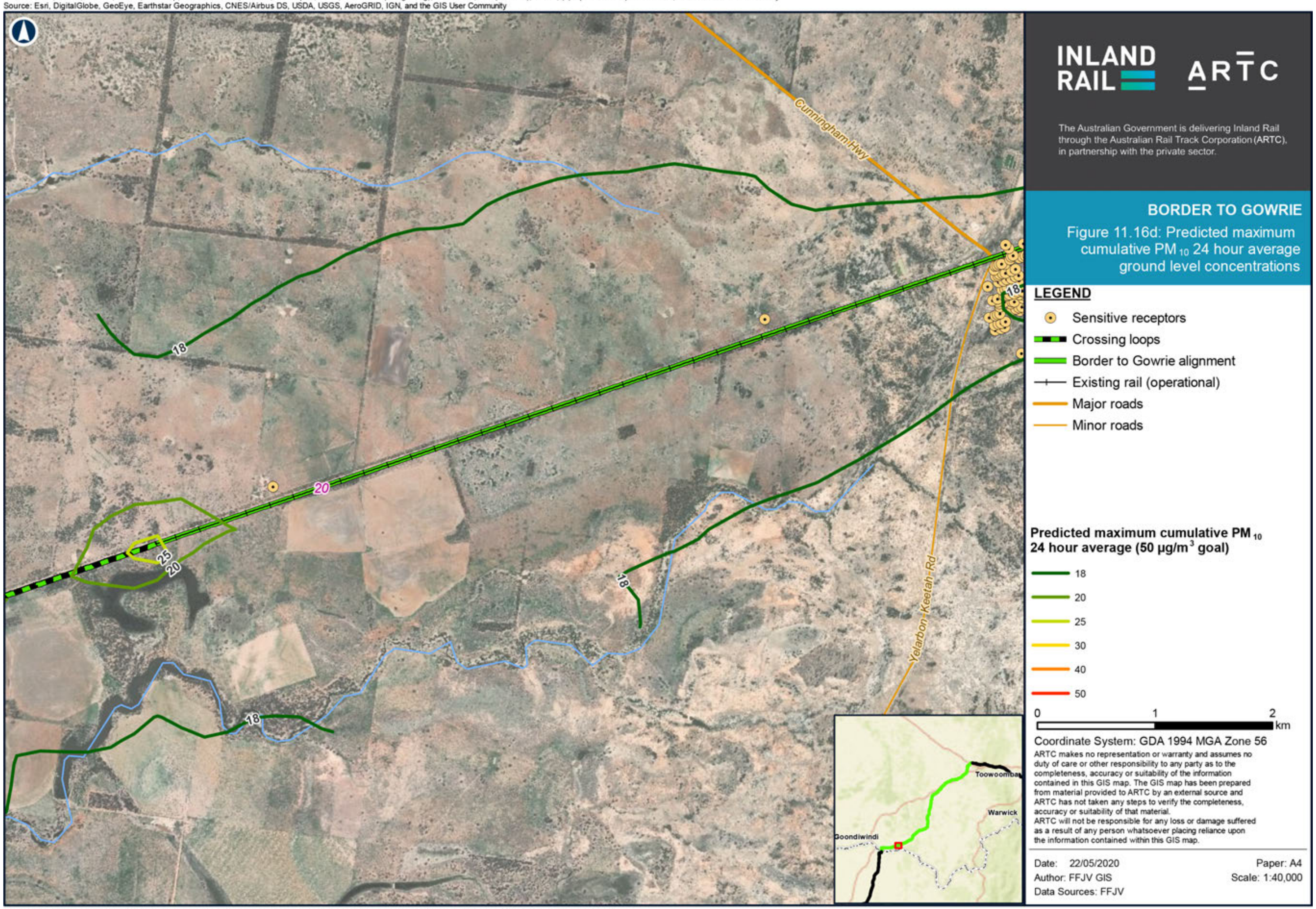


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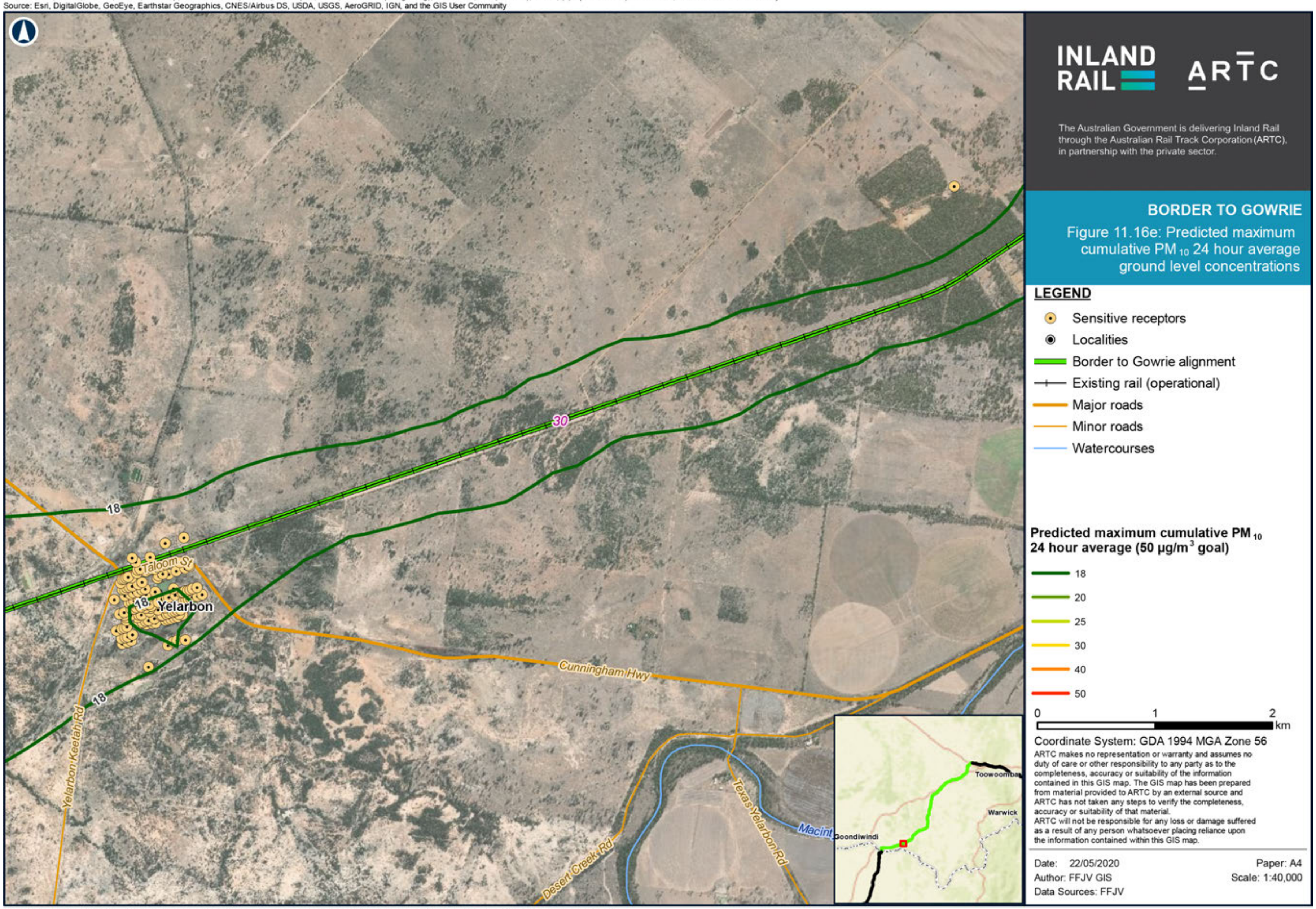


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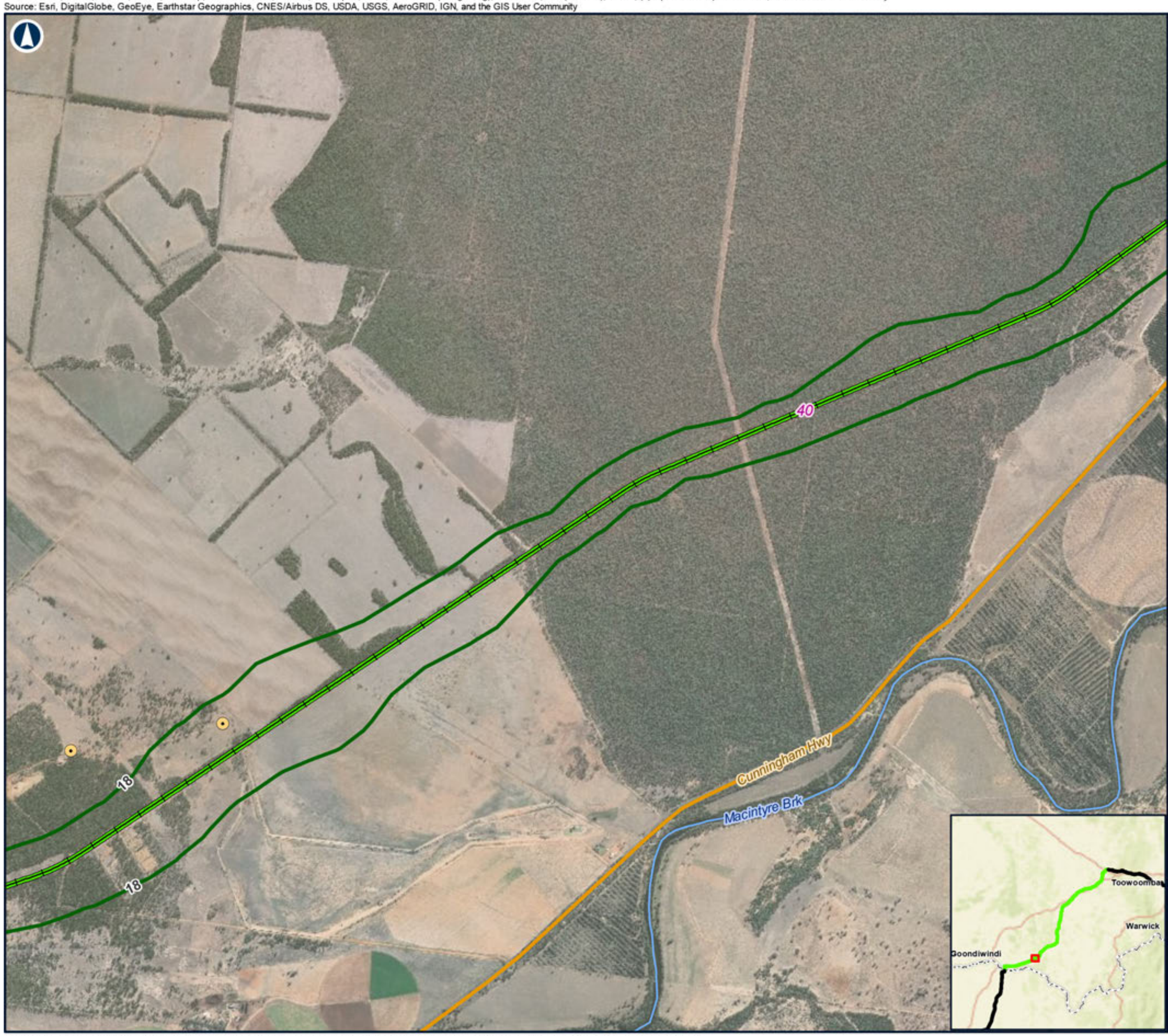


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## BORDER TO GOWRIE

Figure 11.16f: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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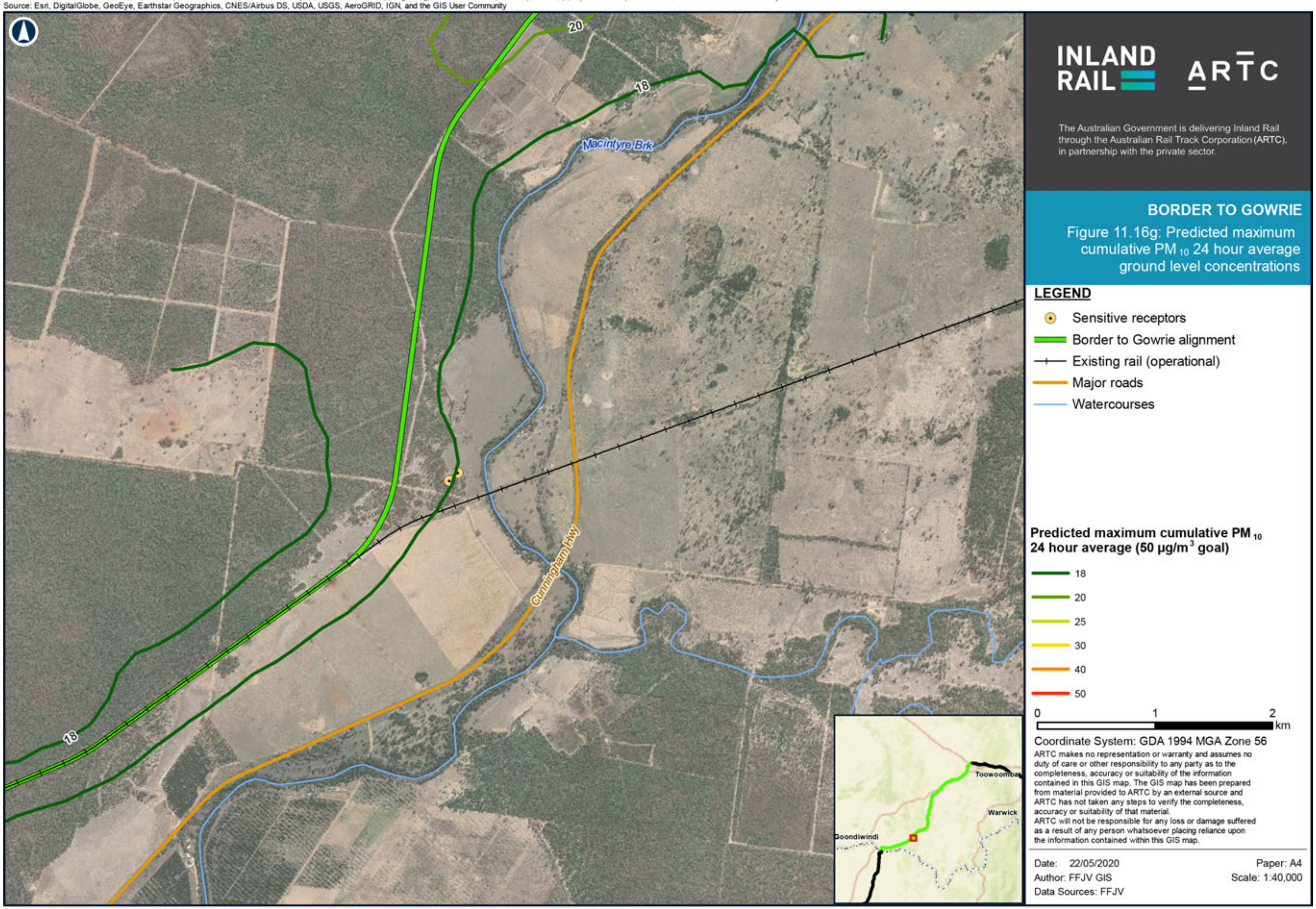


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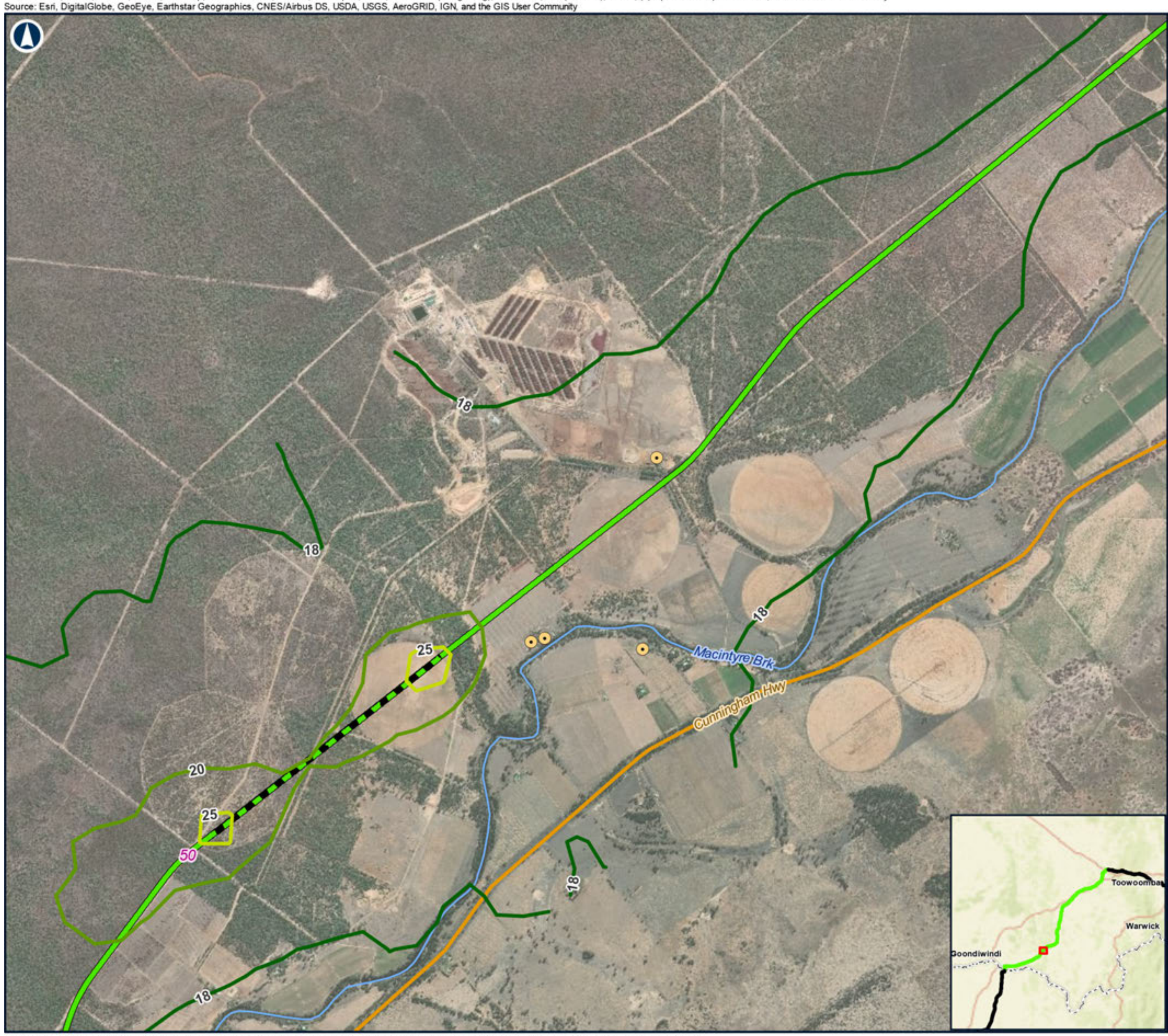


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## BORDER TO GOWRIE

Figure 11.16h: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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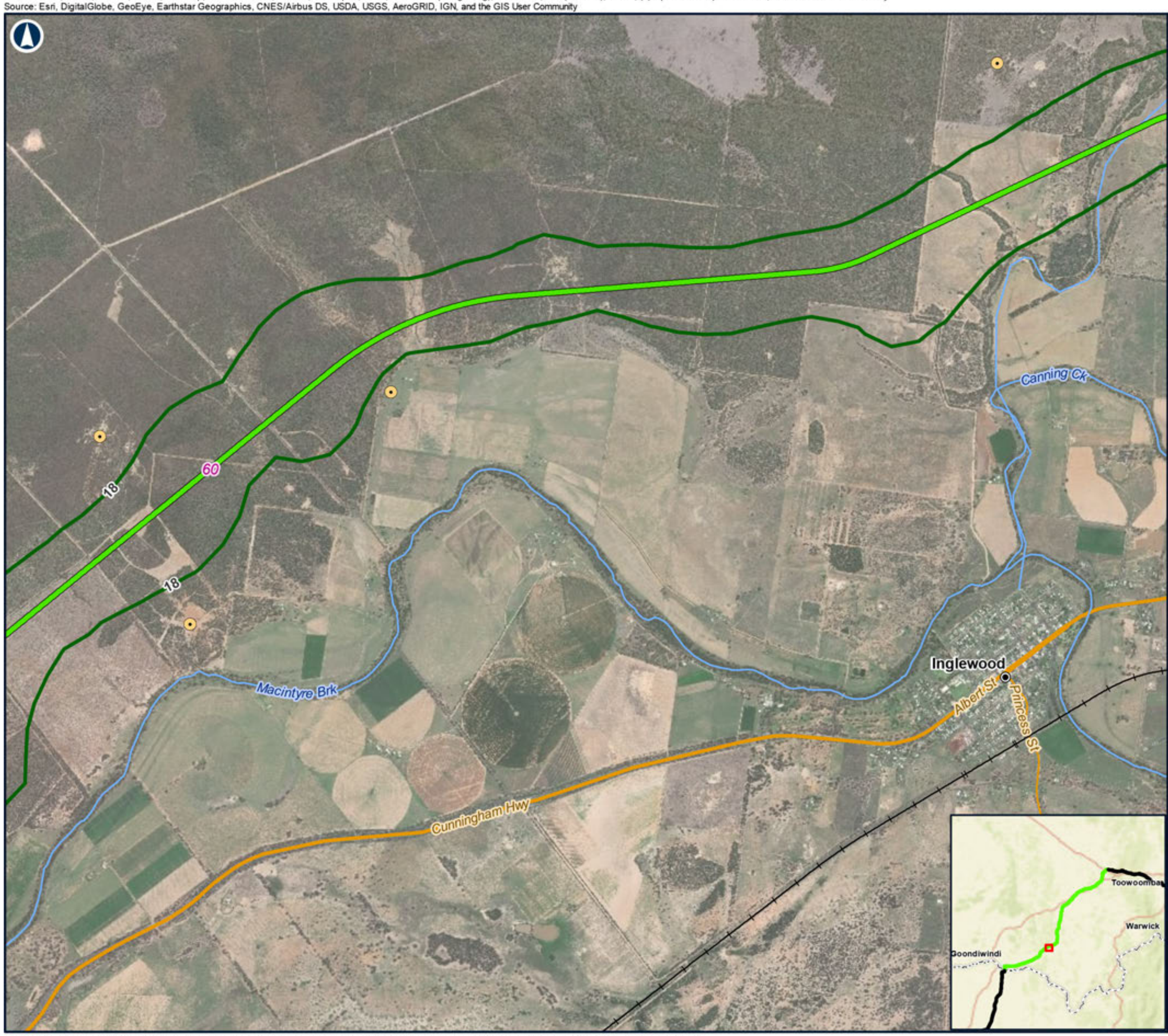


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**BORDER TO GOWRIE**

Figure 11.16i: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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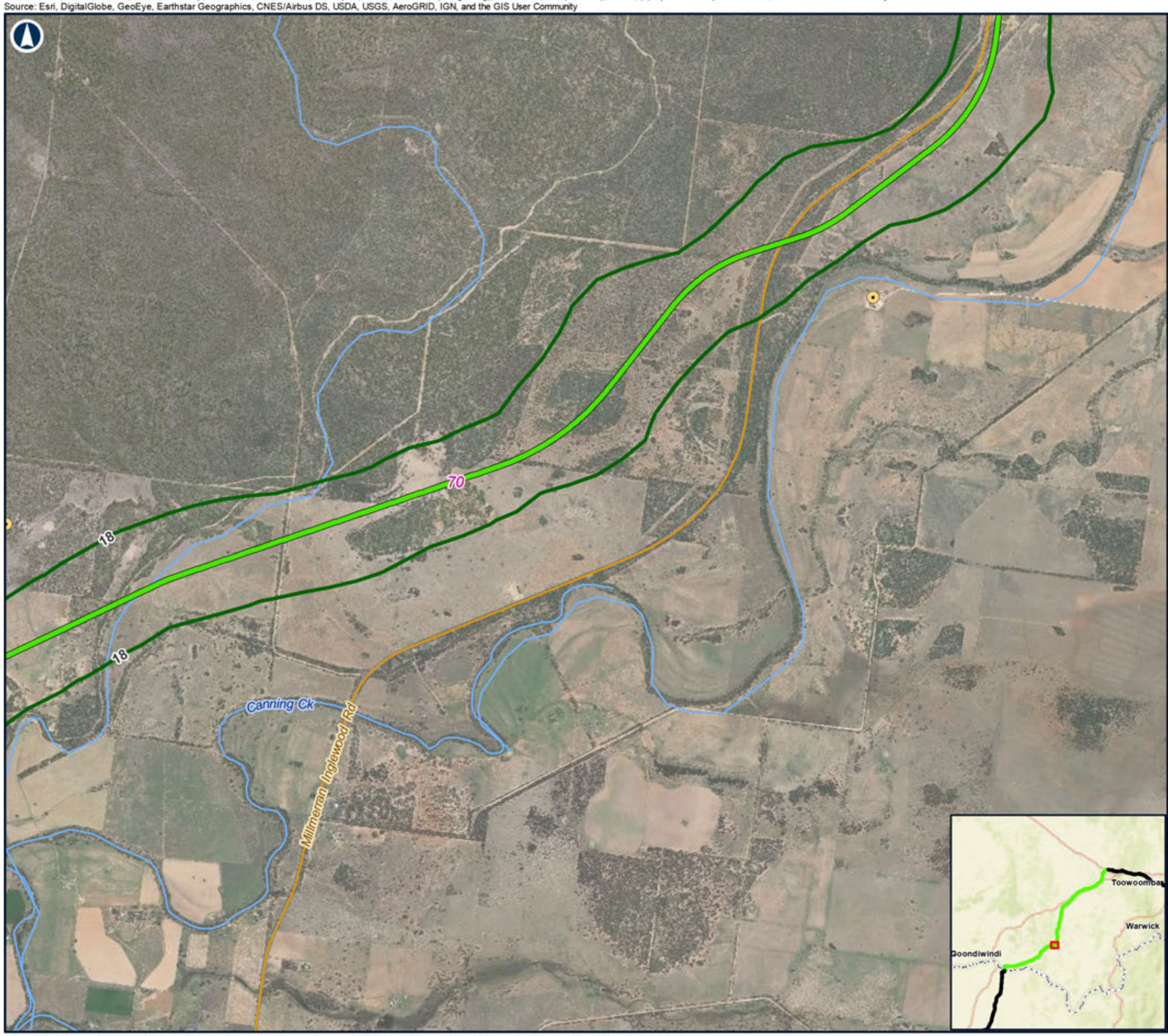


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**BORDER TO GOWRIE**

Figure 11.16j: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 μg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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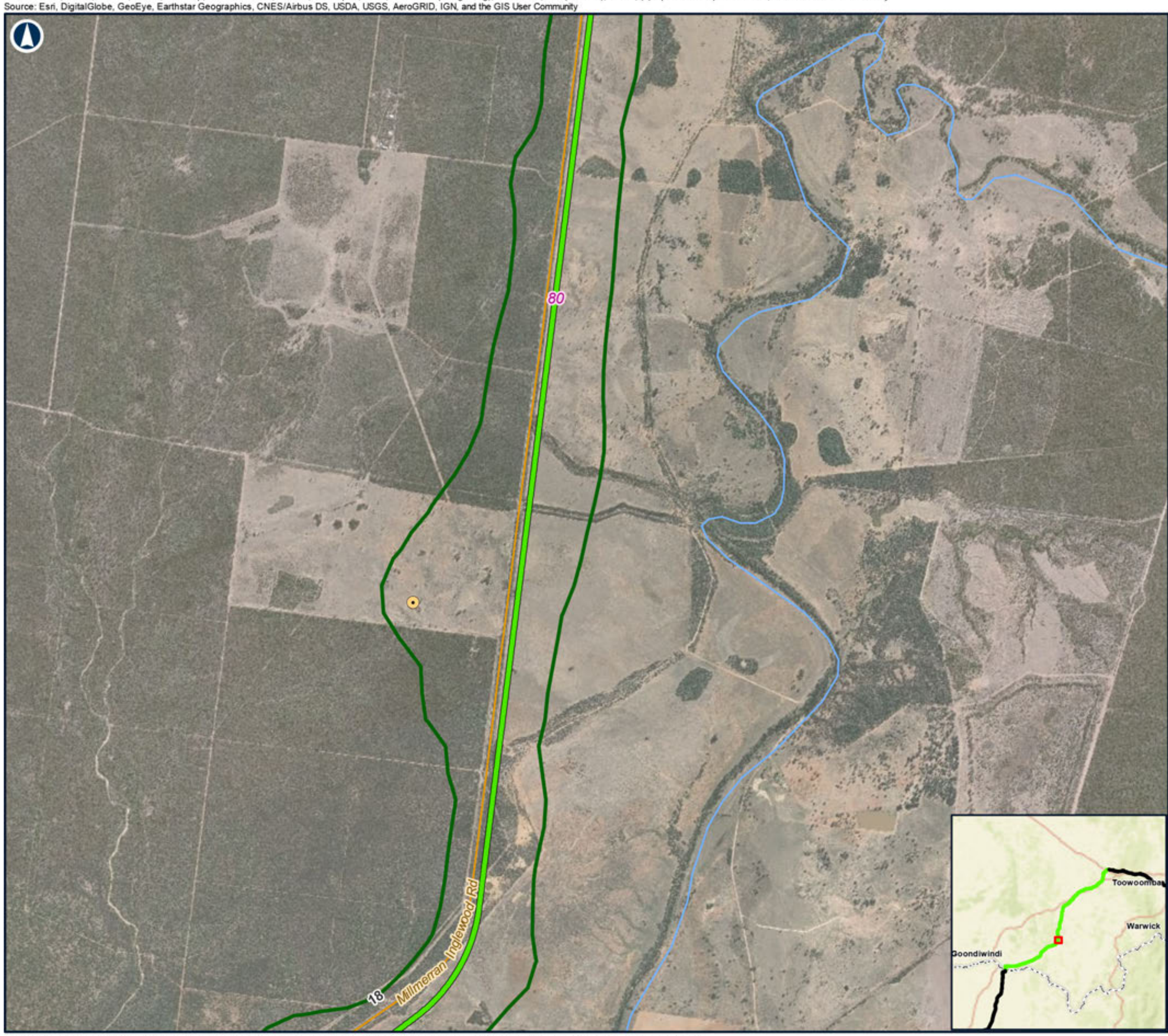


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## BORDER TO GOWRIE

Figure 11.16k: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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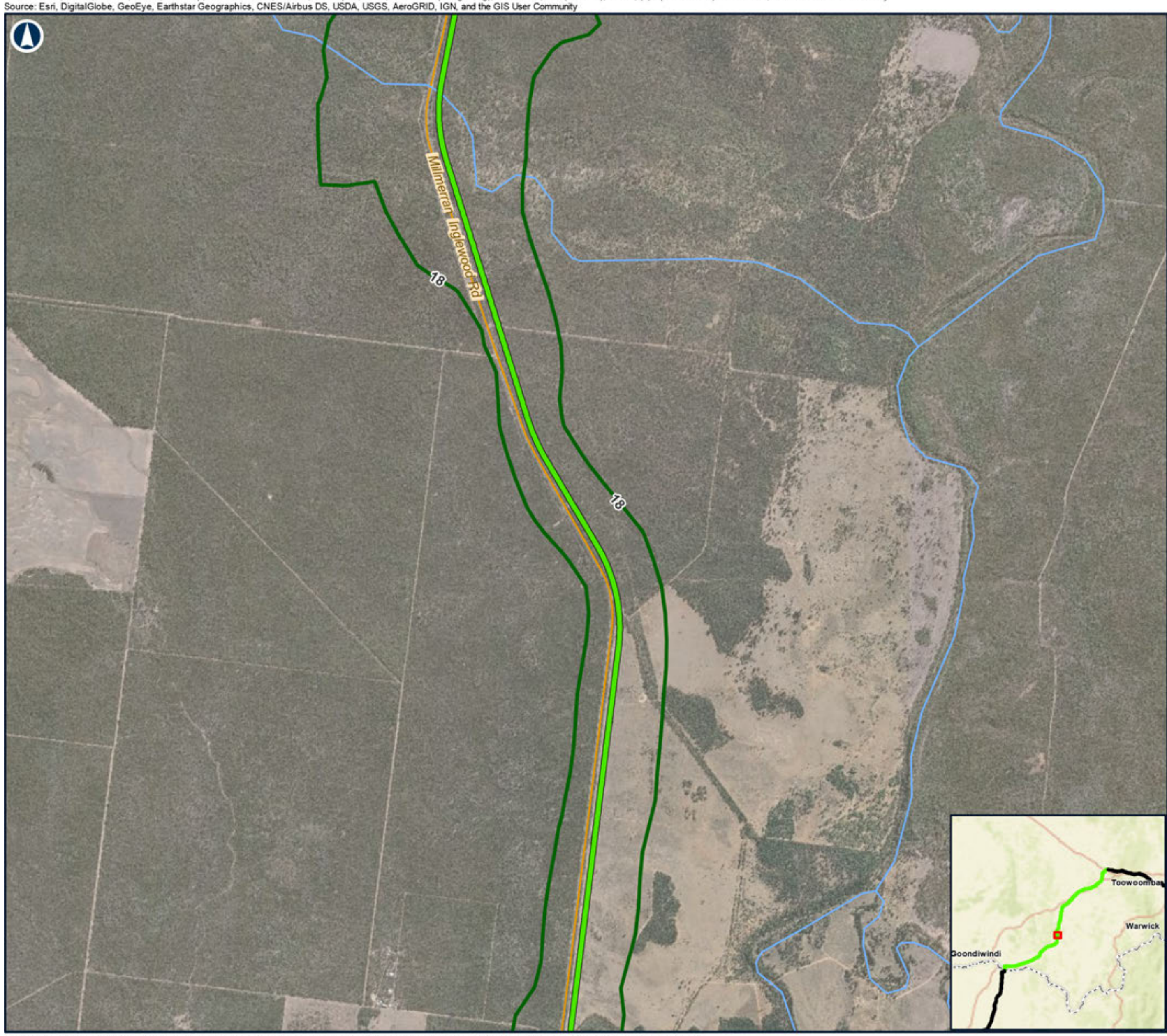


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**BORDER TO GOWRIE**

Figure 11.16l: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

Border to Gowrie alignment

Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

18

20

25

30

40

50

0 1 2 km



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Data Sources: FFJV

Paper: A4
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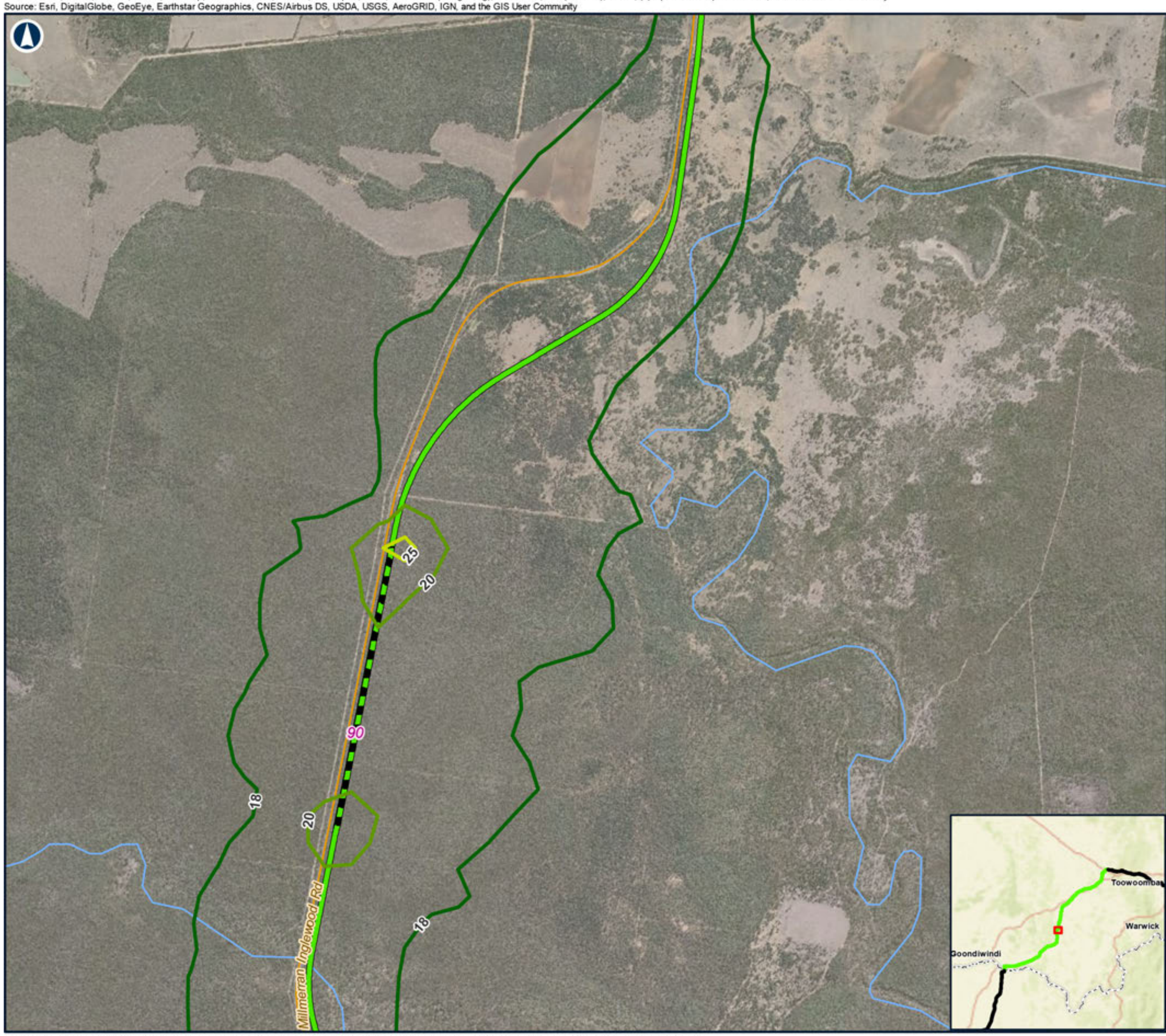


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## BORDER TO GOWRIE

Figure 11.16m: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Crossing loops
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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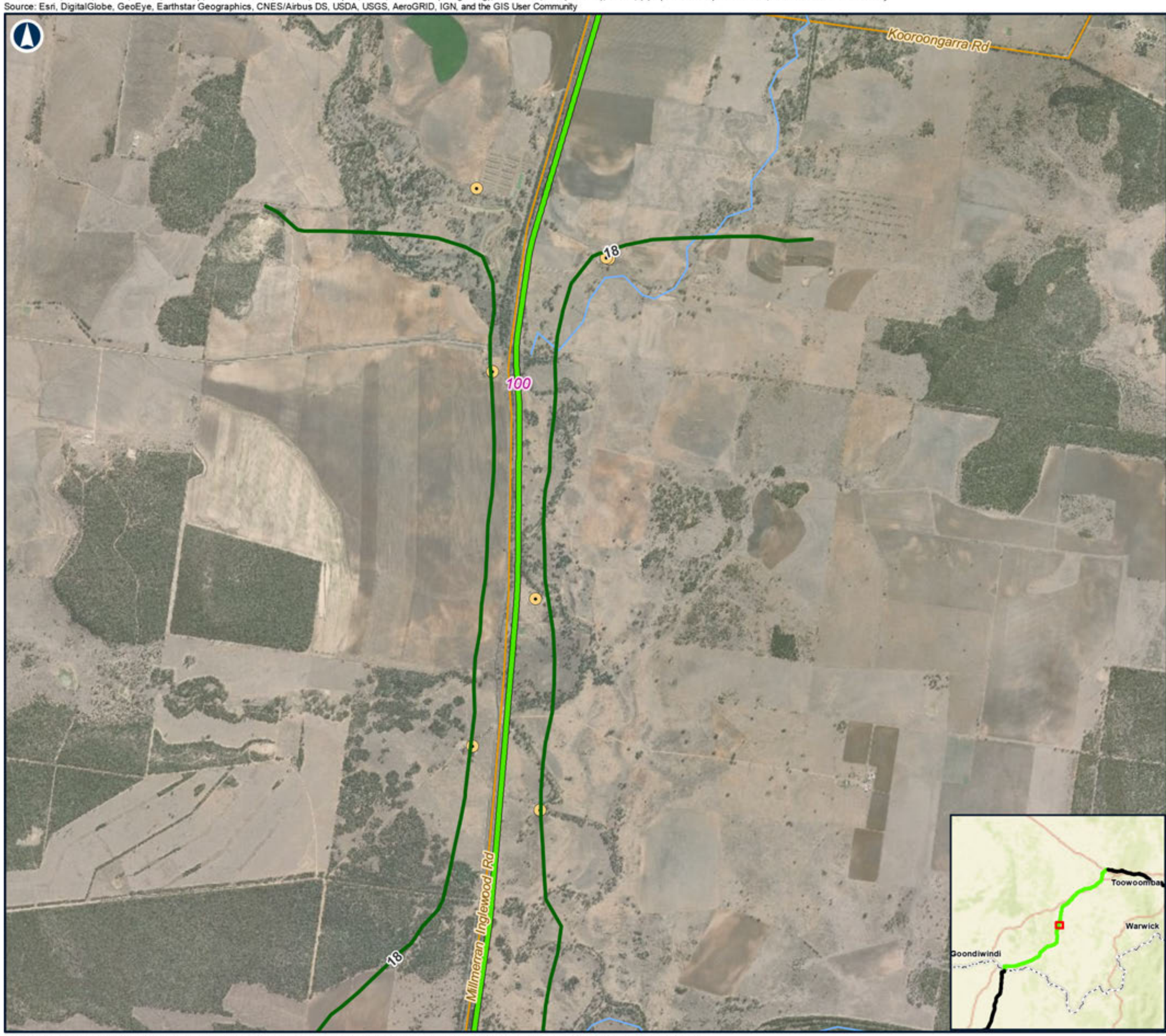


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## BORDER TO GOWRIE

Figure 11.16n: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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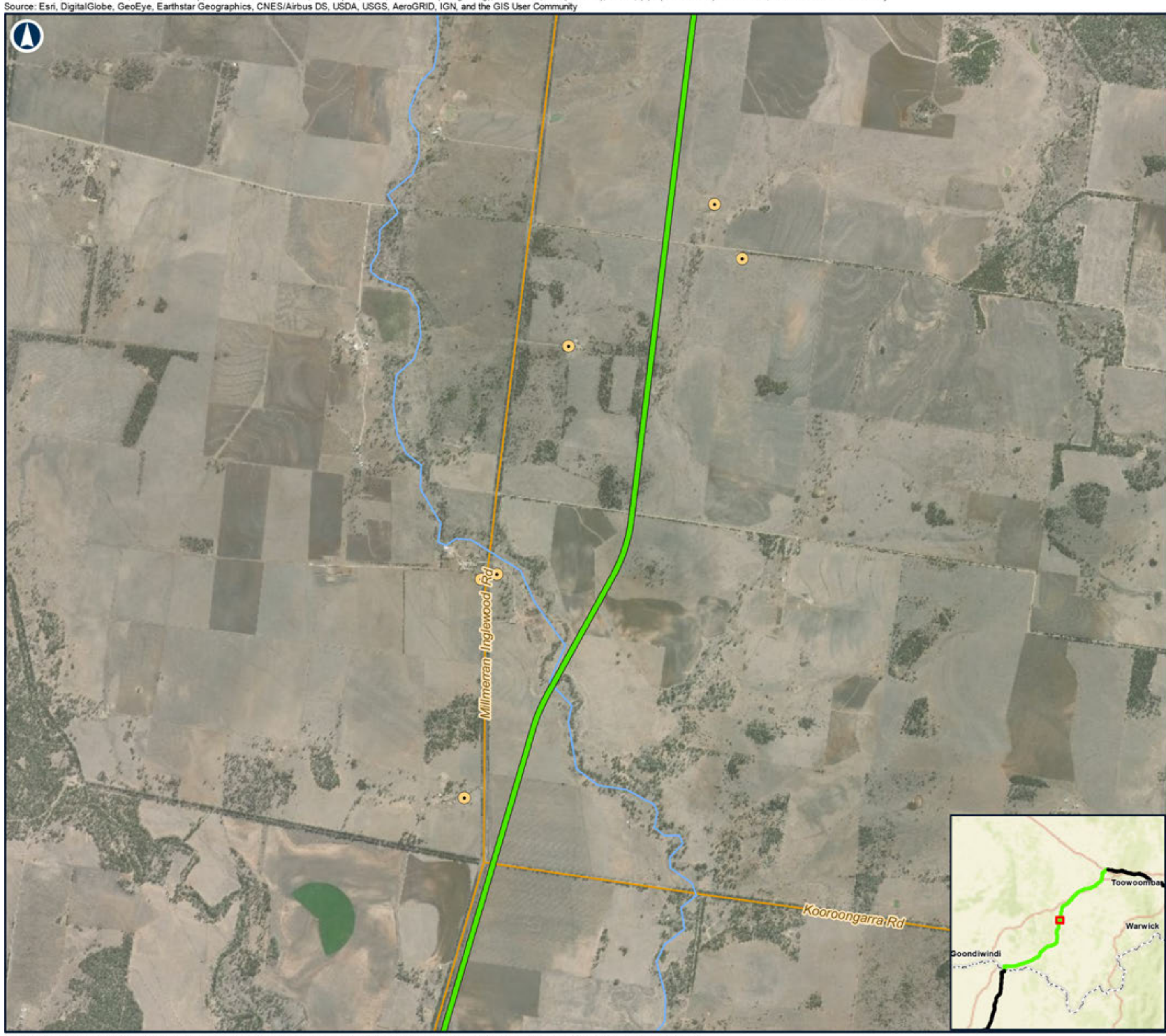


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**BORDER TO GOWRIE**

Figure 11.16o: Predicted maximum cumulative PM $_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative PM $_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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## BORDER TO GOWRIE

Figure 11.16p: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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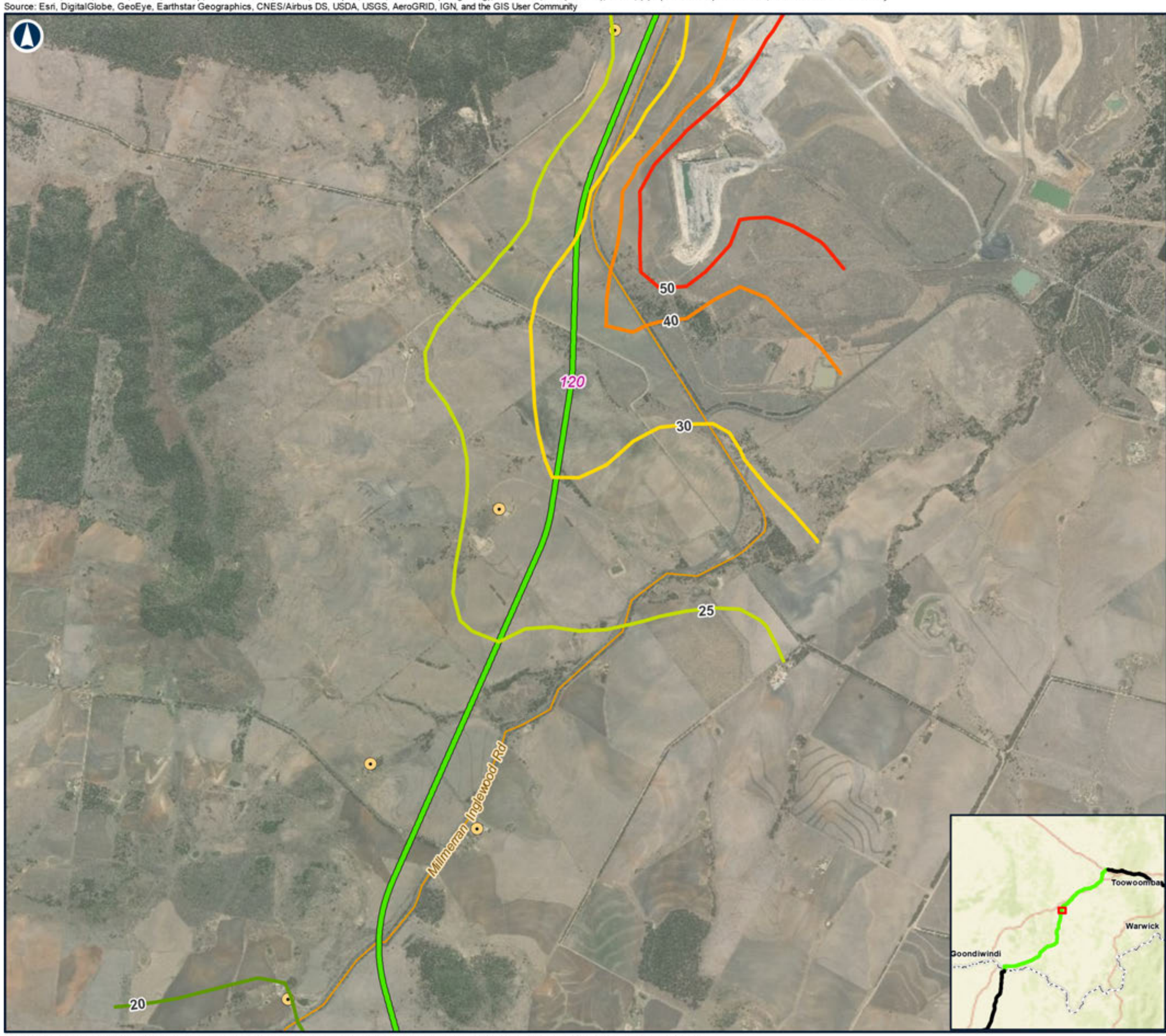


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**BORDER TO GOWRIE**

Figure 11.16q: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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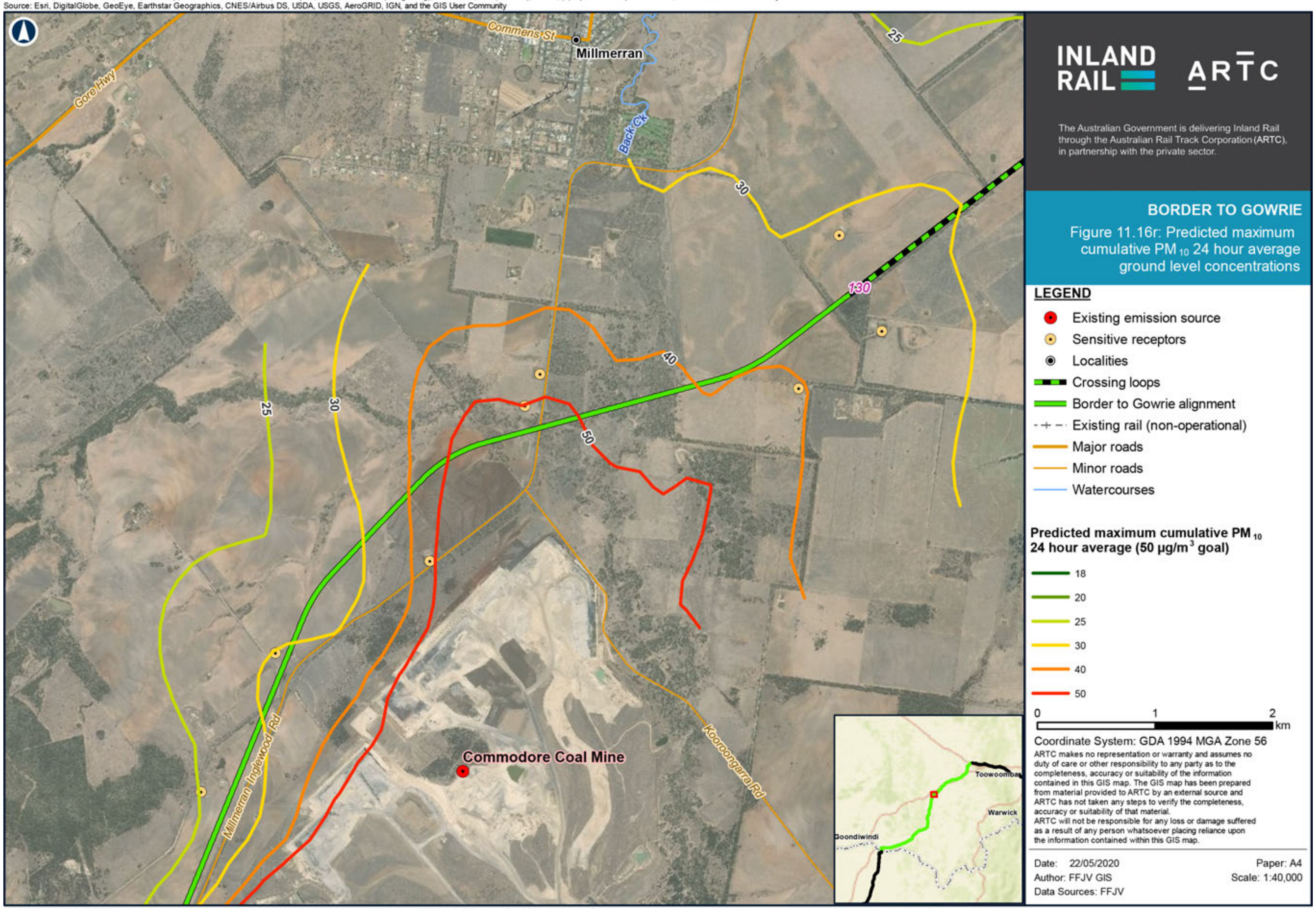


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## BORDER TO GOWRIE

Figure 11.16s: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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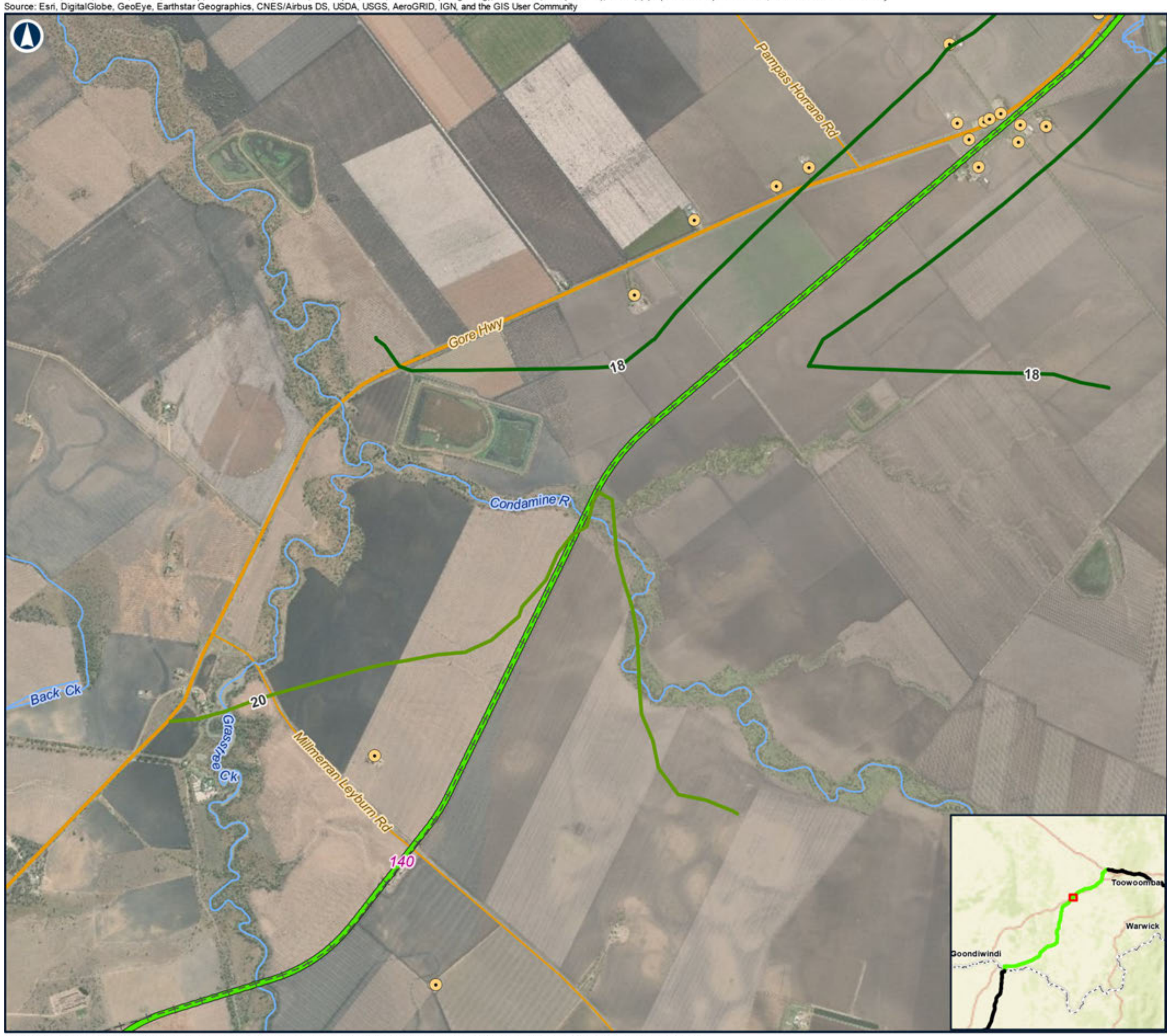


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**BORDER TO GOWRIE**

Figure 11.16t: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 μg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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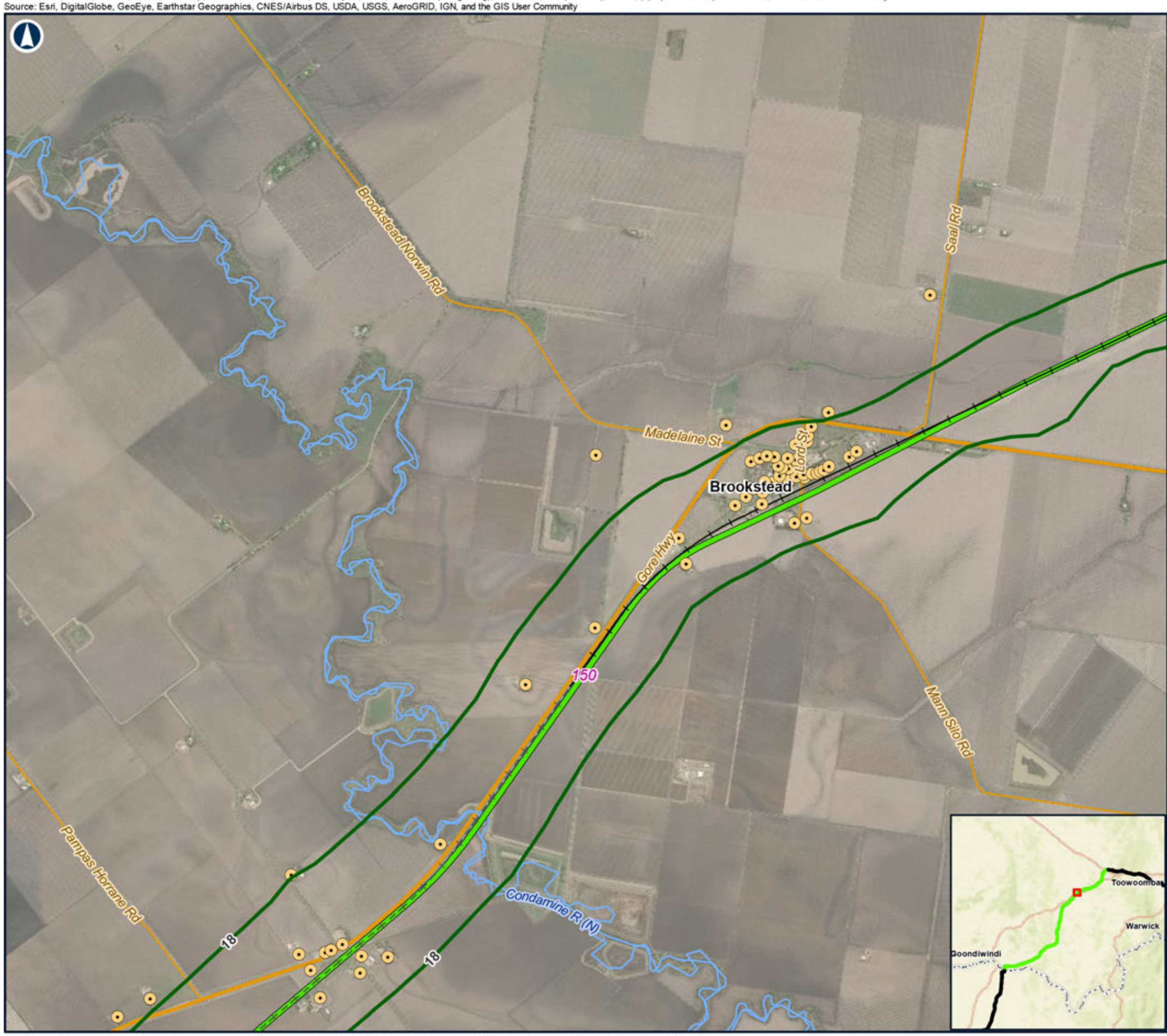


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**BORDER TO GOWRIE**

Figure 11.16u: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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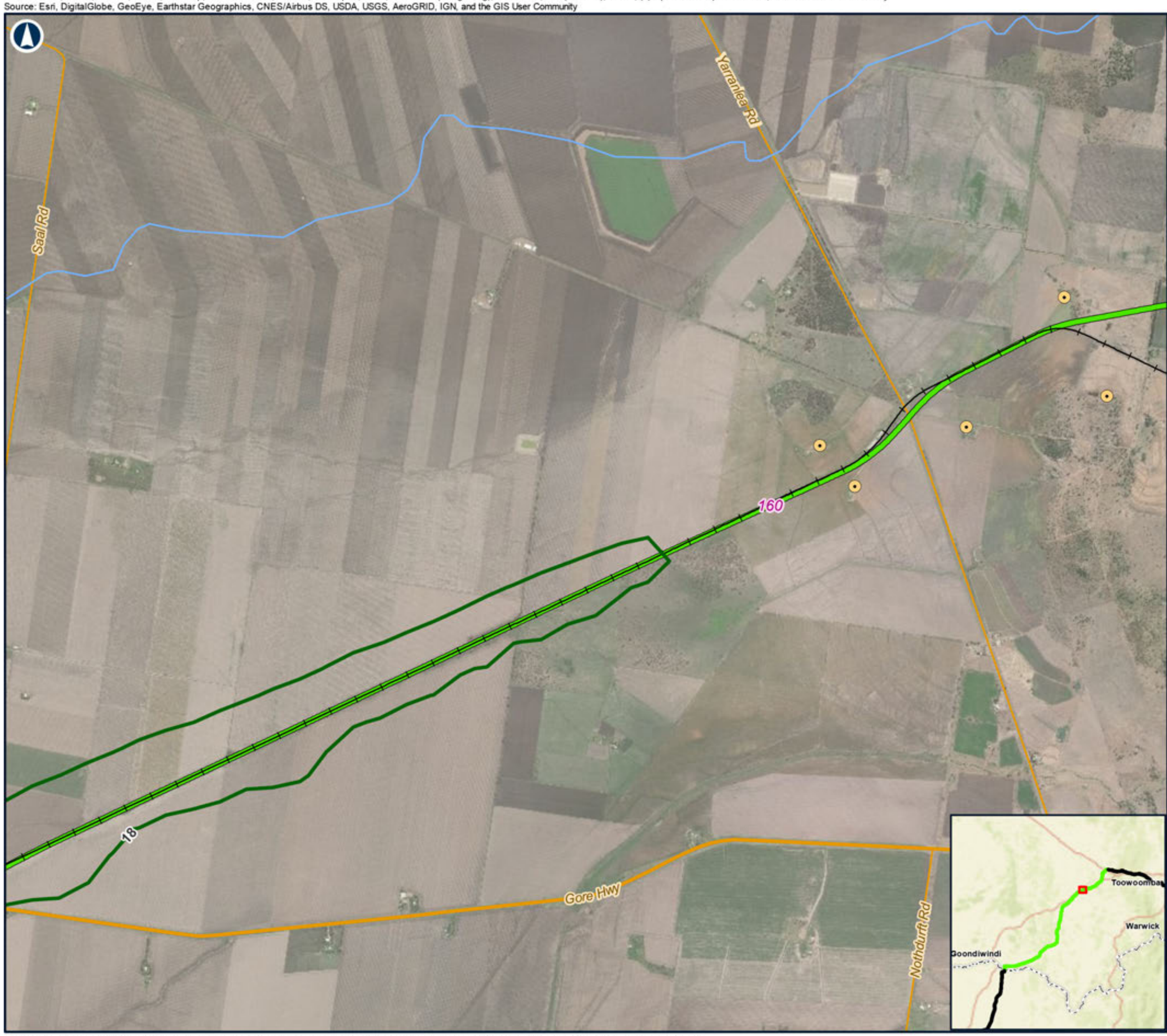


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## BORDER TO GOWRIE

Figure 11.16v: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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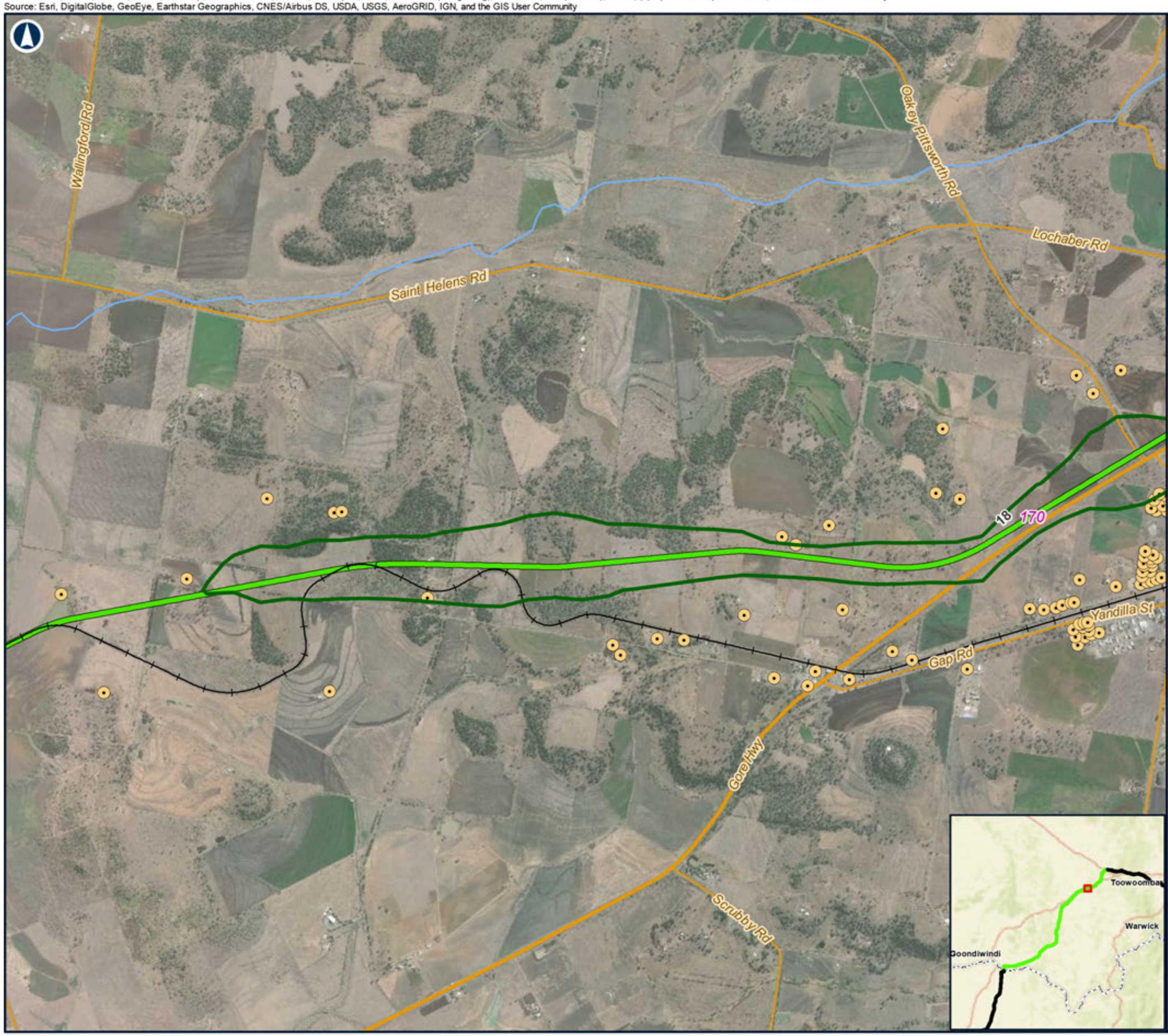


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**BORDER TO GOWRIE**

Figure 11.16w: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m³ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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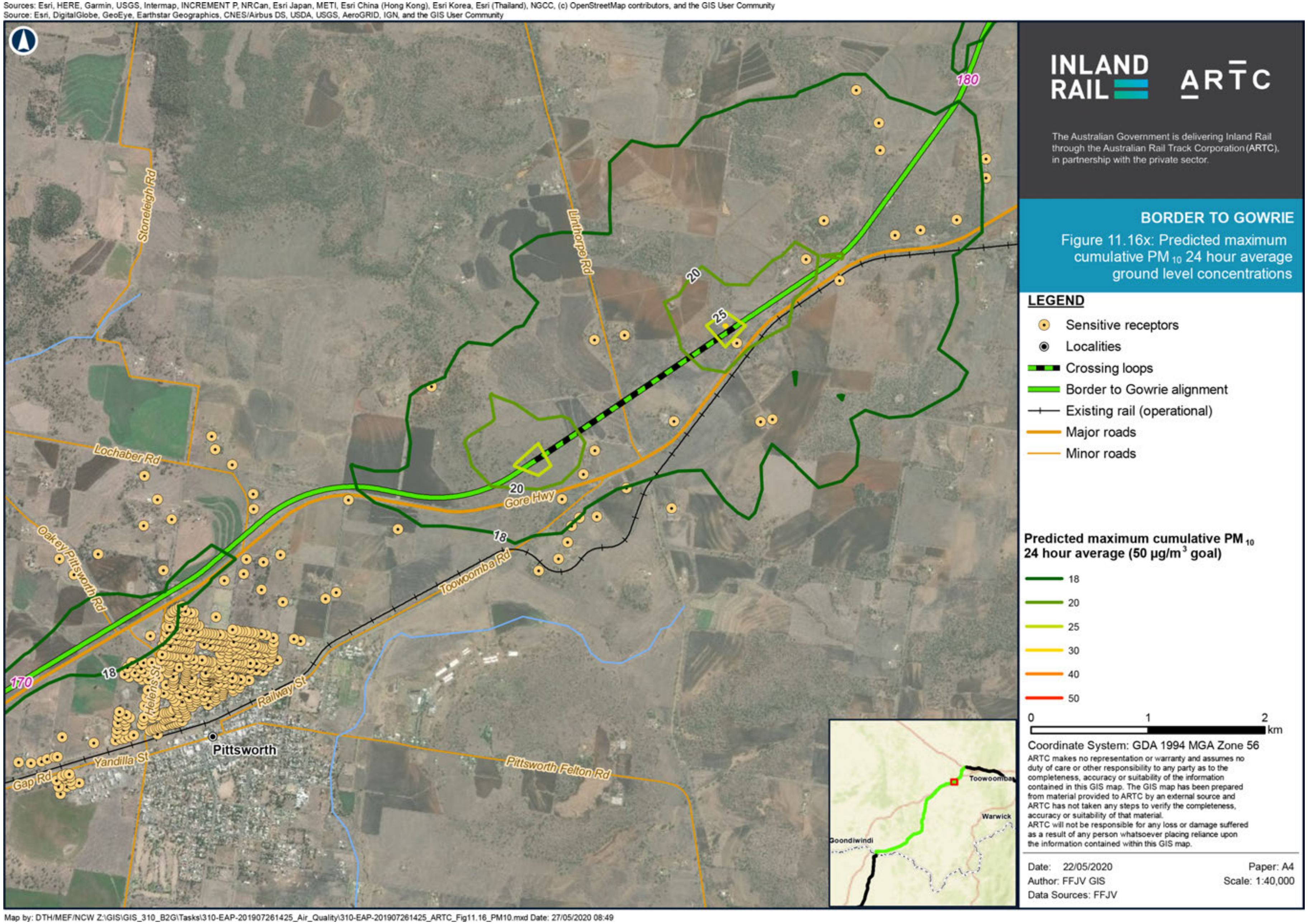

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BORDER TO GOWRIE
Figure 11.16x: Predicted maximum cumulative PM 10 24 hour average ground level concentrations
LEGEND
Sensitive receptors
Localities
Crossing loops
Border to Gowrie alignment
Existing rail (operational)
Major roads
Minor roads
Predicted maximum cumulative PM 10 24 hour average (50 µg/m3 goal)
18
20
25
30
40
50
0
1
2
km
Coordinate System: GDA 1994 MGA Zone 56
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Stoneleigh Rd
Linthorpe Rd
Lochaber Rd
Oakey Pittsworth Rd
Gore Hwy
Toowoomba Rd
Railway St
Helen St
Yandilla St
Gap Rd
Pittsworth
Pittsworth Felton Rd
170
180
Toowoomba
Warwick
Goondiwindi
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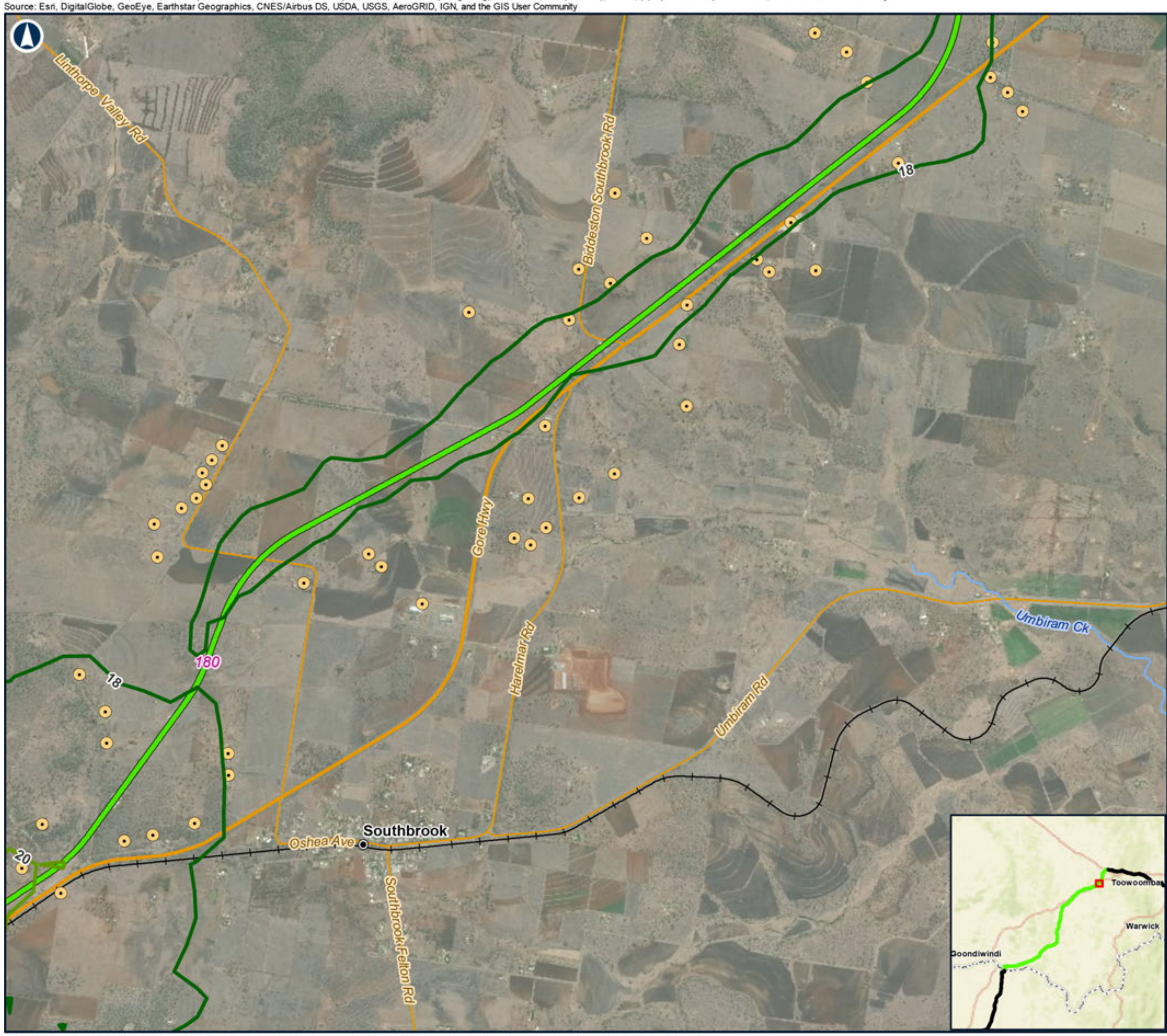


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**BORDER TO GOWRIE**

Figure 11.16y: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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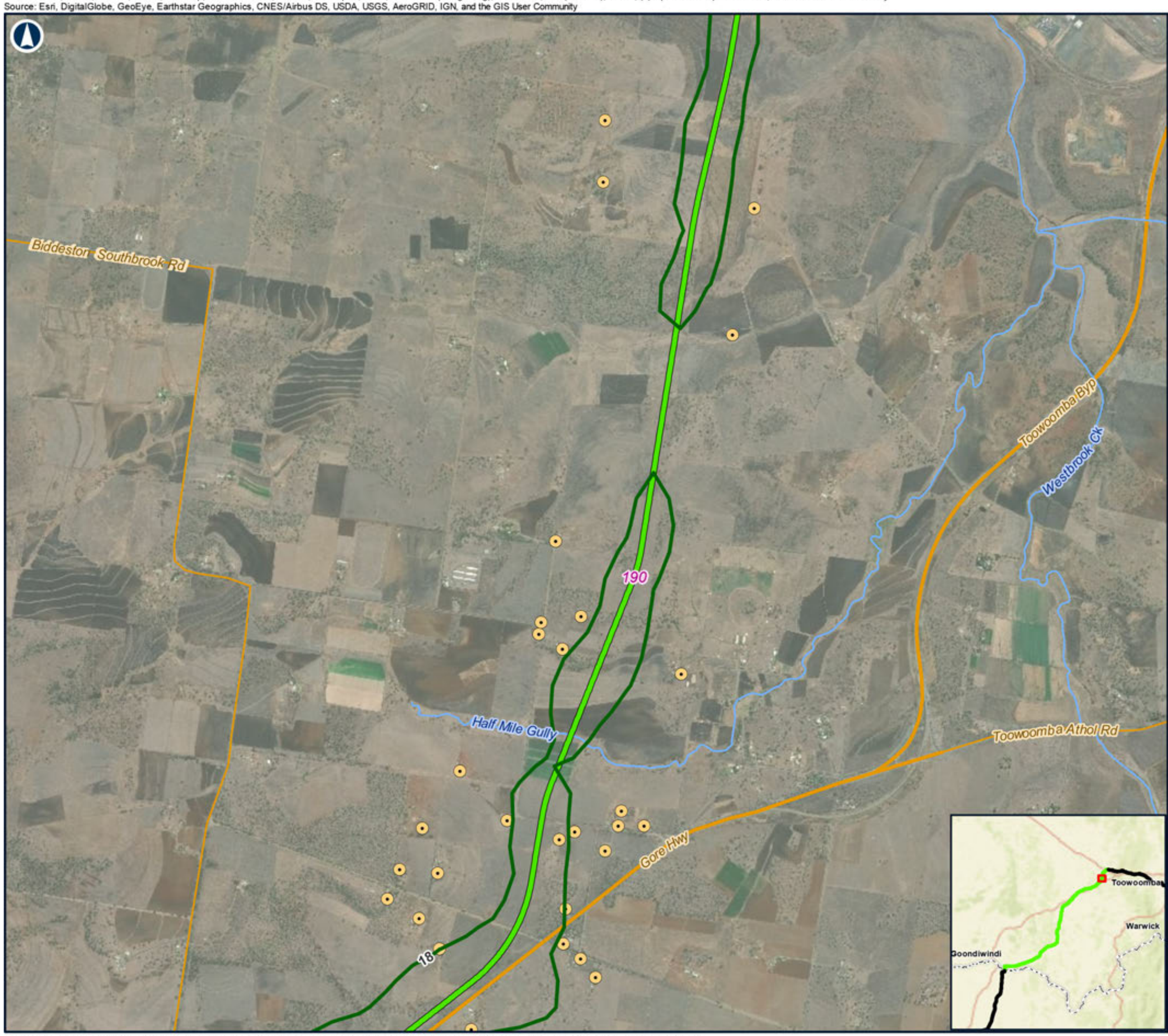


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## BORDER TO GOWRIE

Figure 11.16z: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

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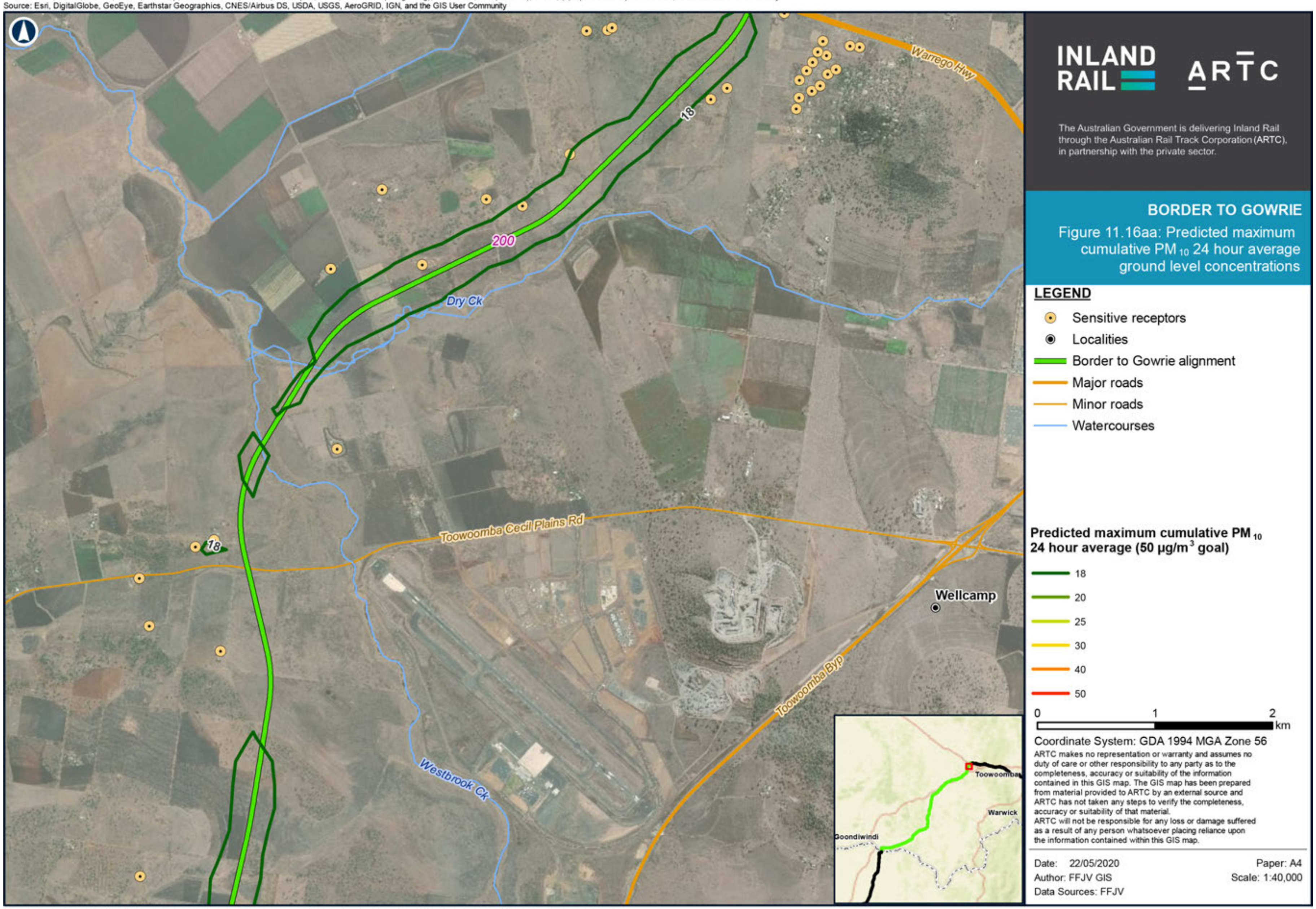


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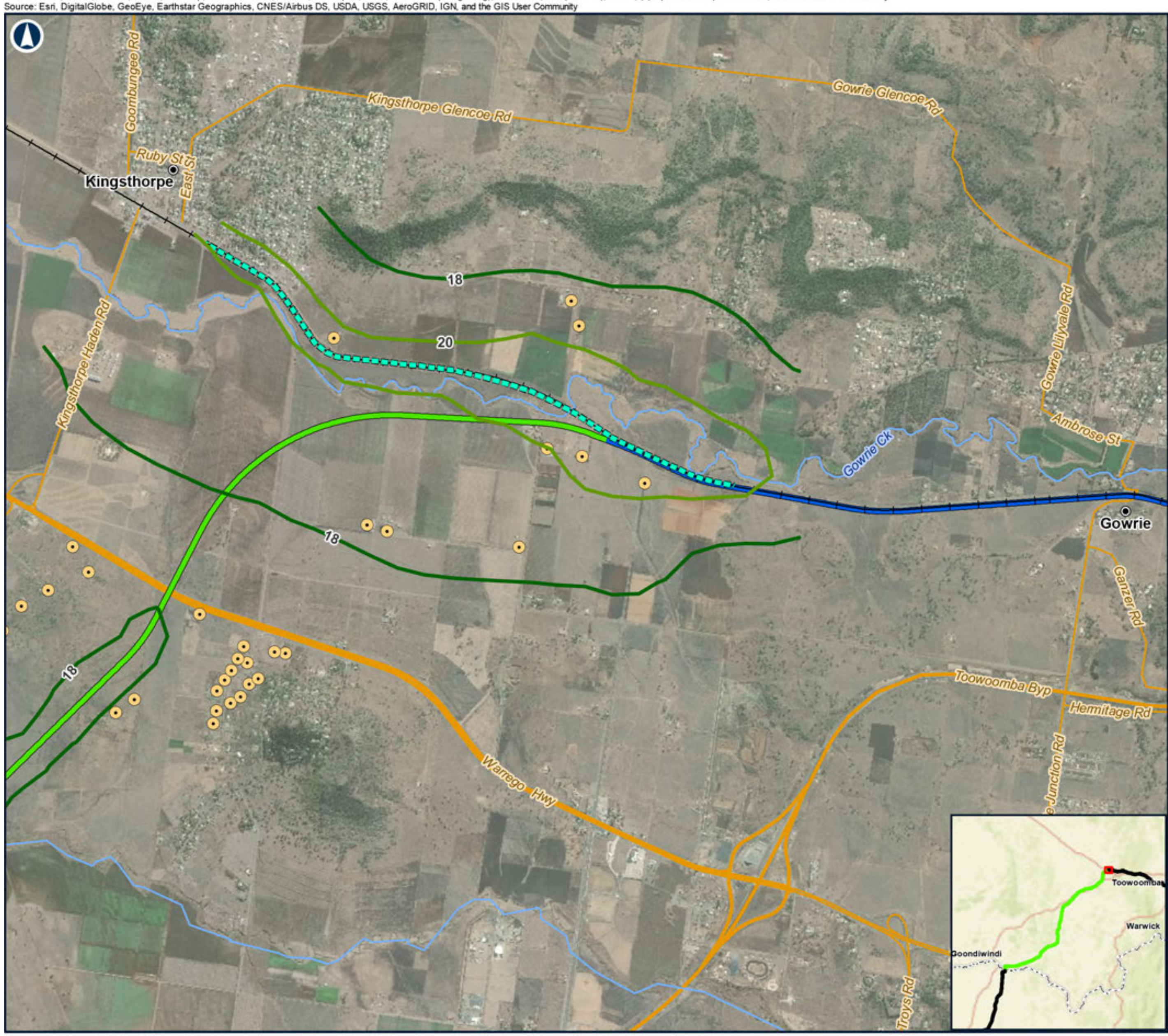


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The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

## BORDER TO GOWRIE

Figure 11.16ab: Predicted maximum cumulative $PM_{10}$ 24 hour average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Cumulative rail sources
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted maximum cumulative $PM_{10}$ 24 hour average (50 µg/m$^3$ goal)**

- 18
- 20
- 25
- 30
- 40
- 50

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Date: 22/05/2020 Paper: A4
Author: FFJV GIS Scale: 1:40,000
Data Sources: FFJV

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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
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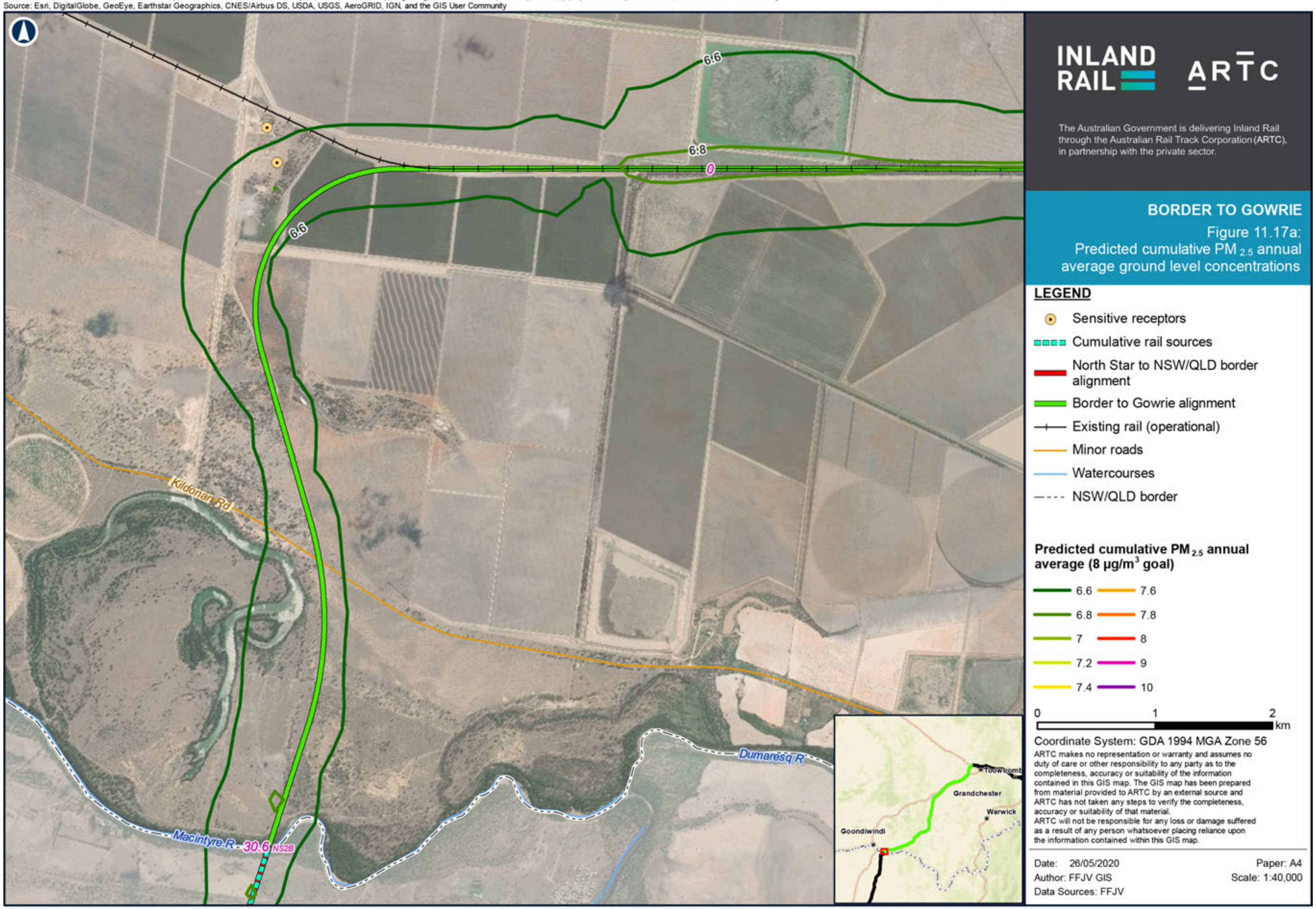


Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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
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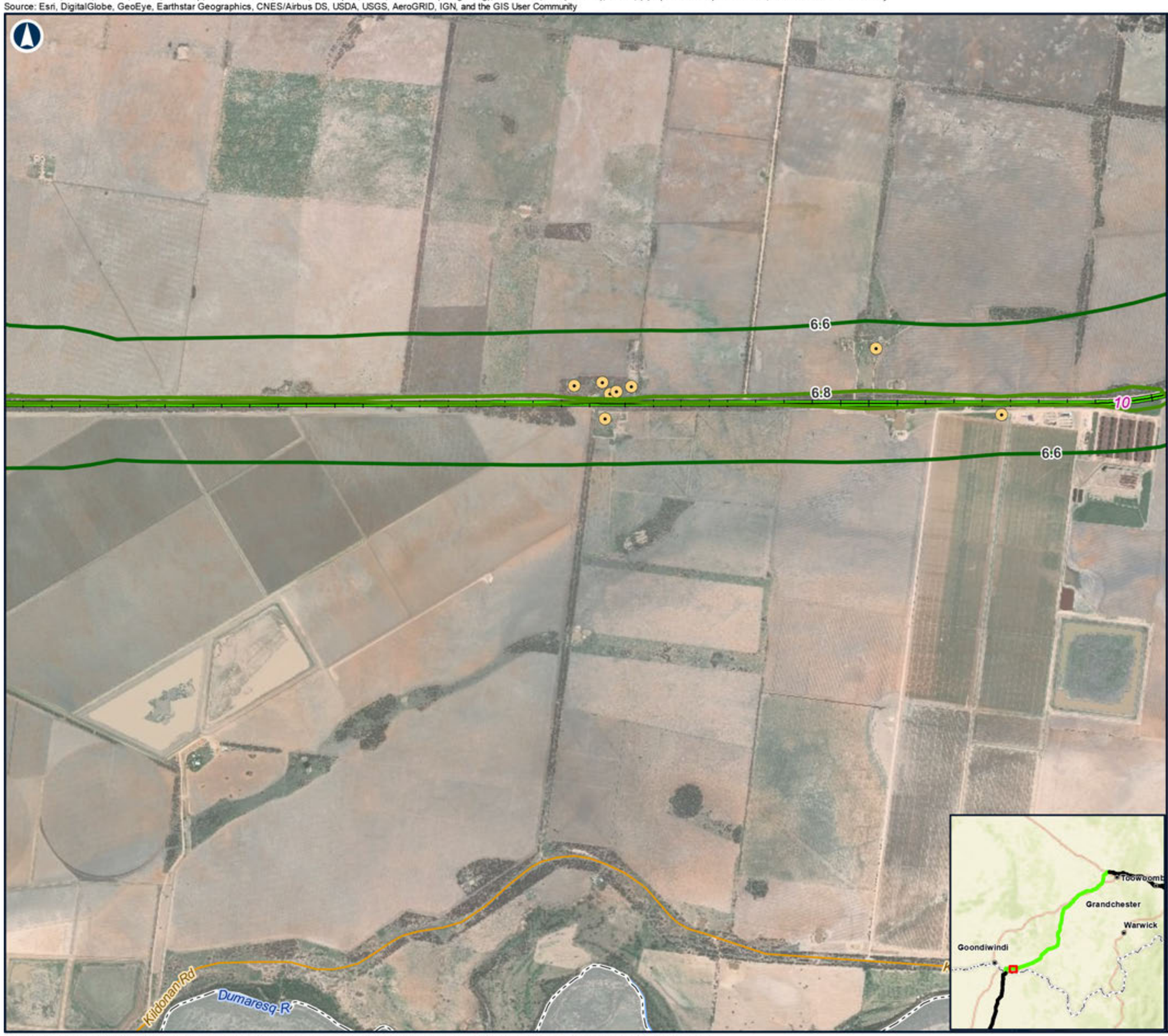


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## BORDER TO GOWRIE

Figure 11.17b:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- Watercourses
- NSW/QLD border

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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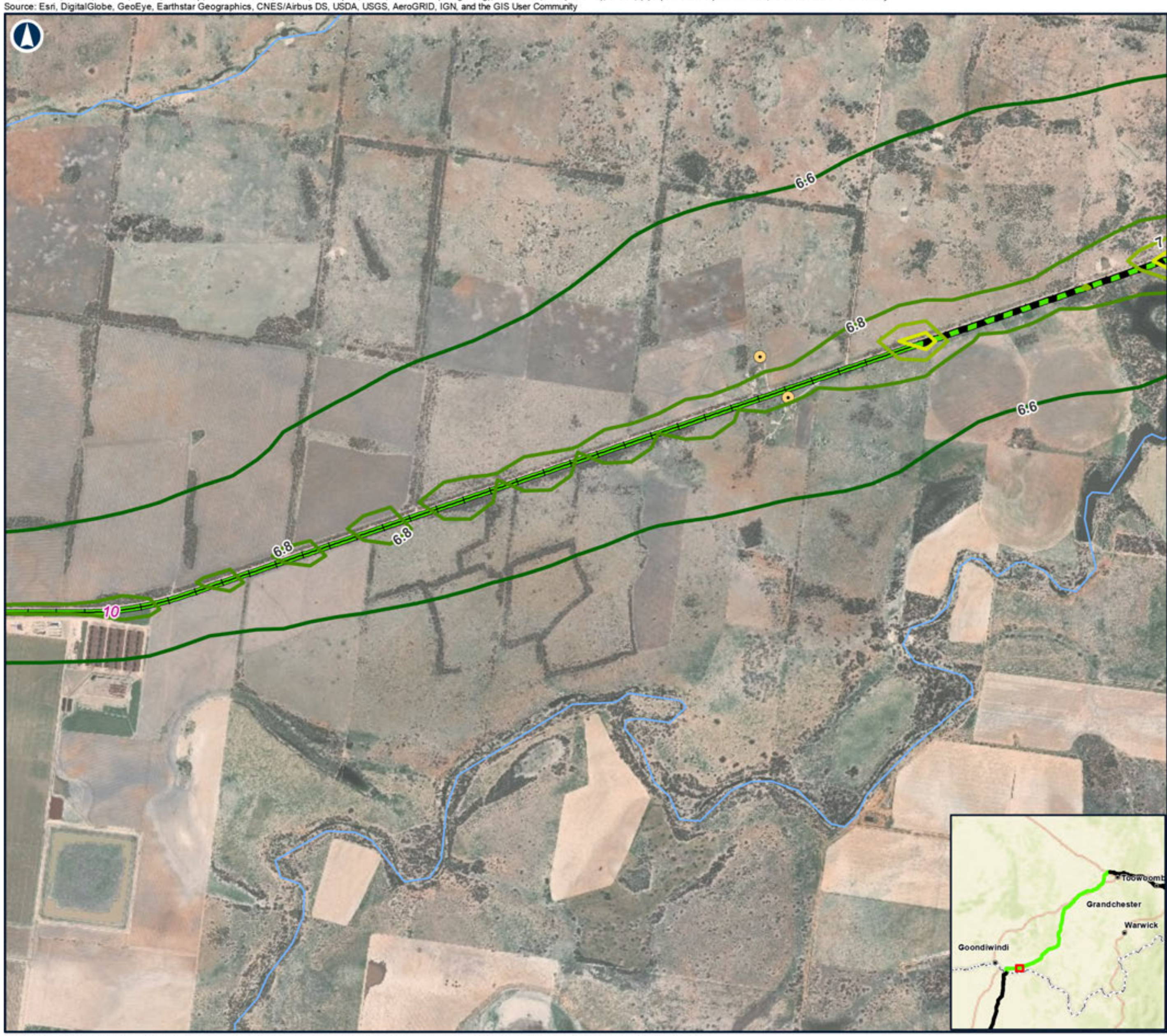
Date: 26/05/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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

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**BORDER TO GOWRIE**

Figure 11.17c:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Rail loops
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Date: 26/05/2020
Author: FFJV GIS
Data Sources: FFJV

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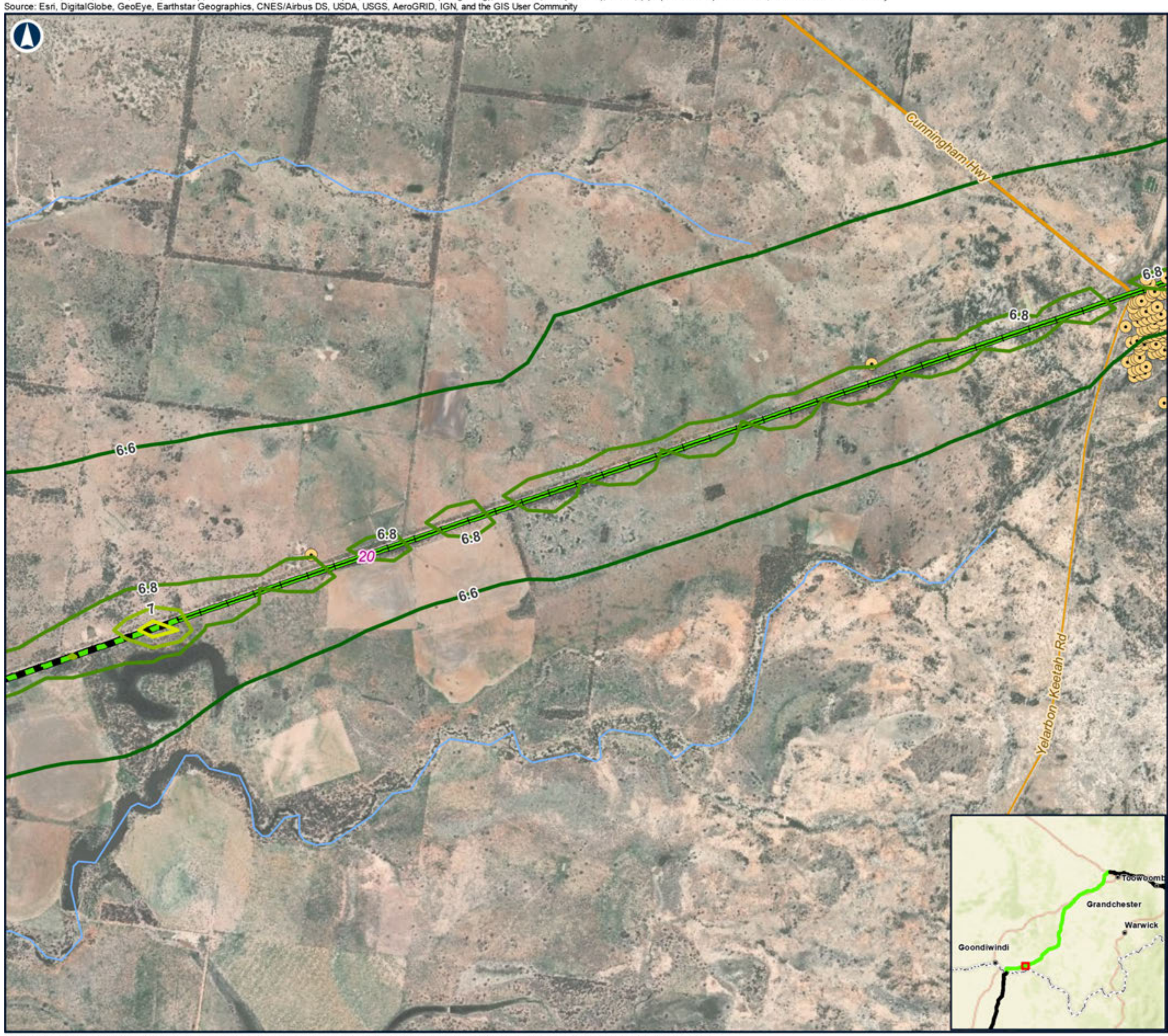
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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

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**BORDER TO GOWRIE**

Figure 11.17d: Predicted cumulative PM 2.5 annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Rail loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted cumulative PM 2.5 annual average (8 µg/m³ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

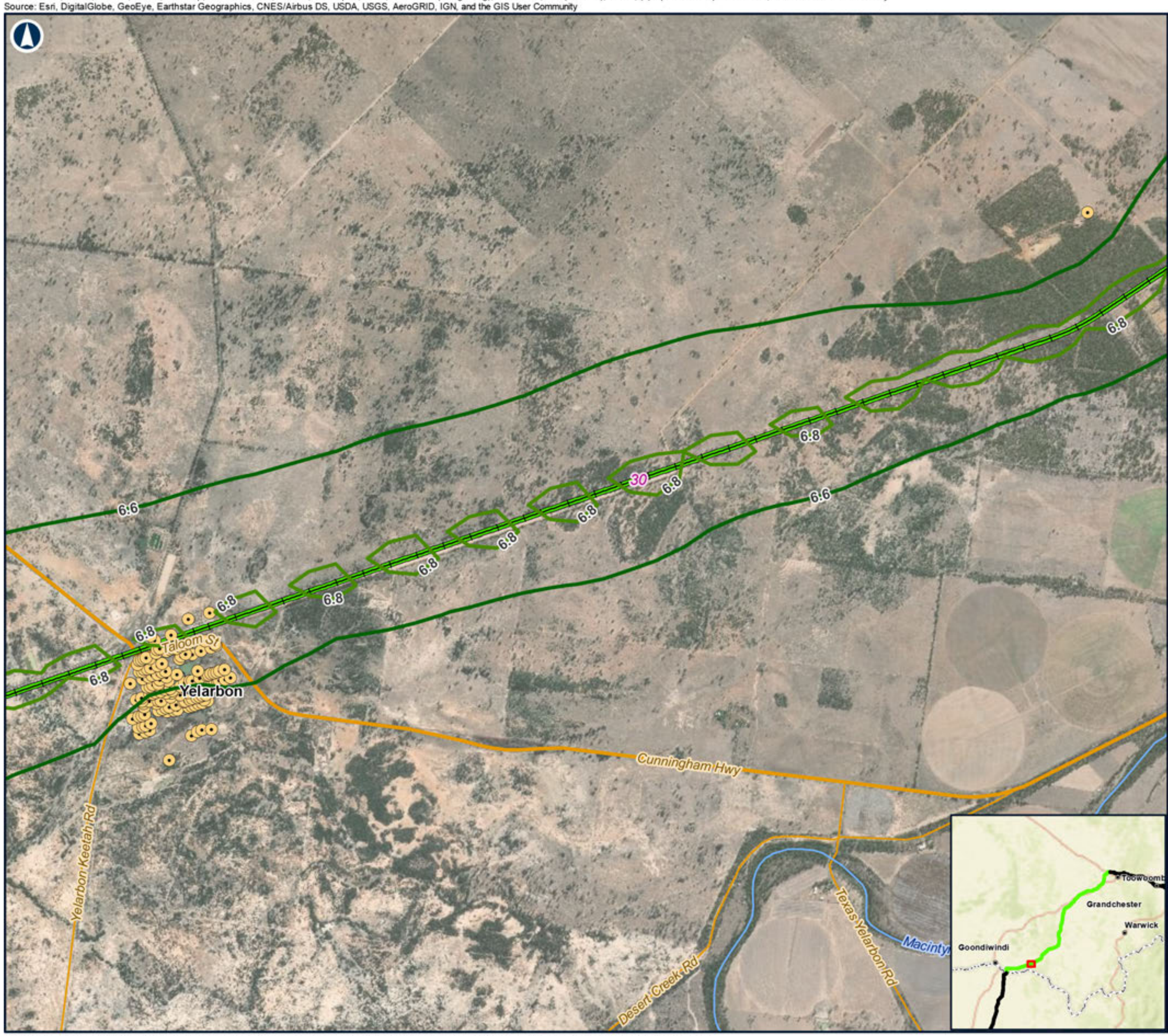
Coordinate System: GDA 1994 MGA Zone 56



Date: 26/05/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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

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**BORDER TO GOWRIE**

Figure 11.17e: Predicted cumulative $PM_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative $PM_{2.5}$ annual average (8 µg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

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Author: FFJV GIS Scale: 1:40,000
Data Sources: FFJV

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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
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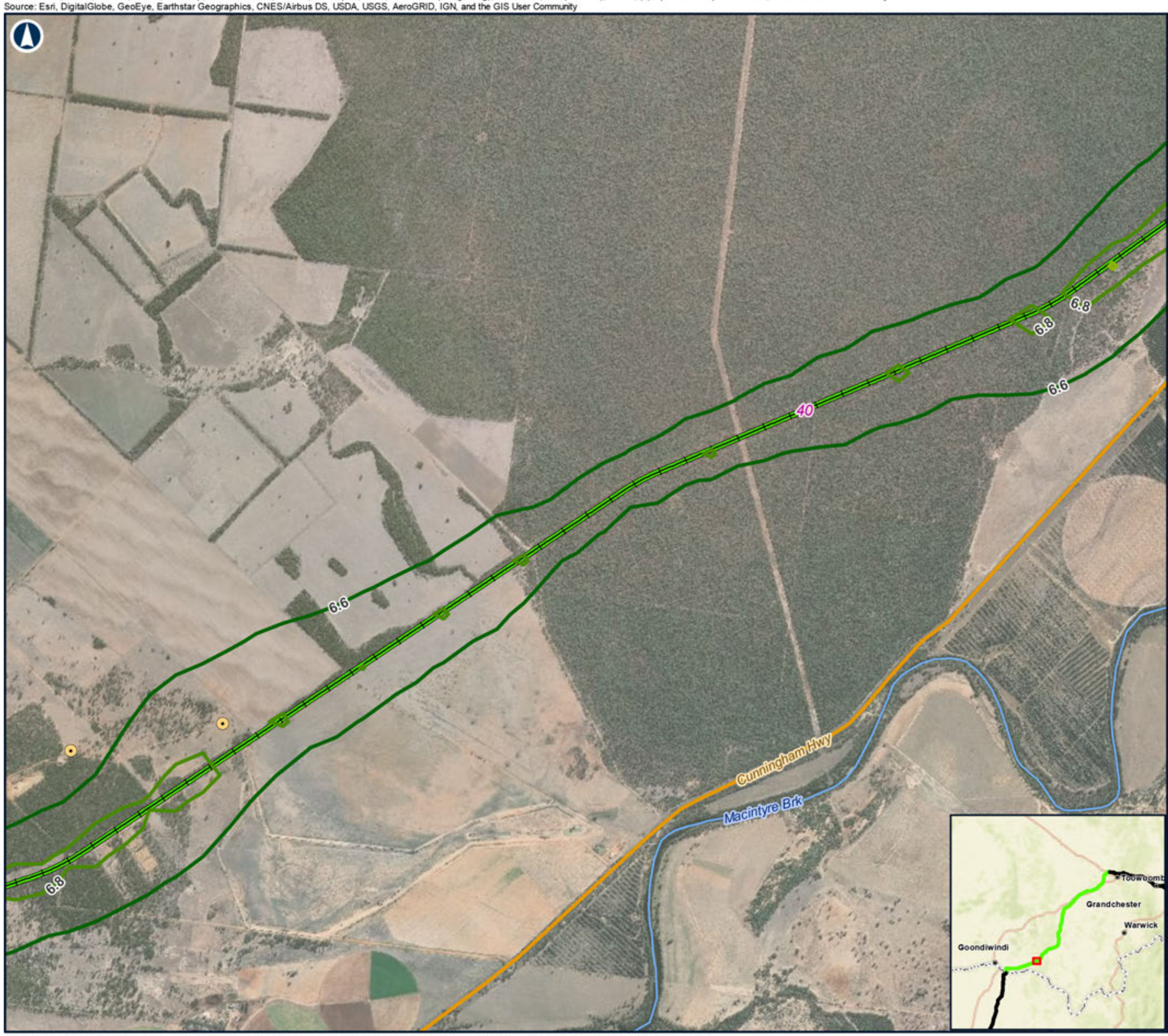


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**BORDER TO GOWRIE**

Figure 11.17f: Predicted cumulative $PM_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Watercourses

**Predicted cumulative $PM_{2.5}$ annual average (8 μg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Author: FFJV GIS
Data Sources: FFJV

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Scale: 1:40,000

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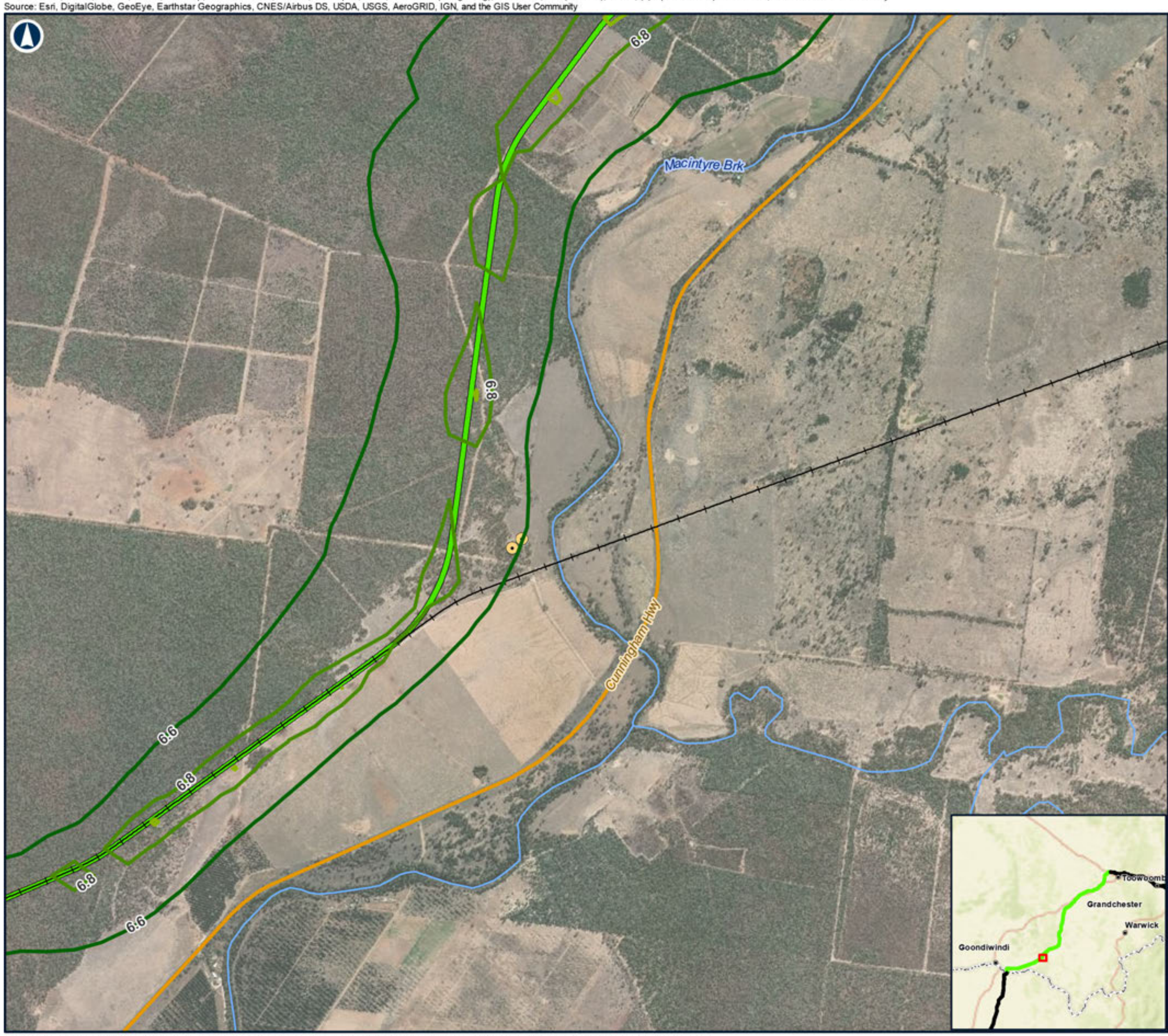
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN,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

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**BORDER TO GOWRIE**

Figure 11.17g: Predicted cumulative $PM_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Watercourses

**Predicted cumulative $PM_{2.5}$ annual average (8 μg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

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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
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**BORDER TO GOWRIE**

Figure 11.15h:
Identified sensitive receptor locations

**LEGEND**

- Localities
- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

0 1 2 km

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Data Sources: FFJV

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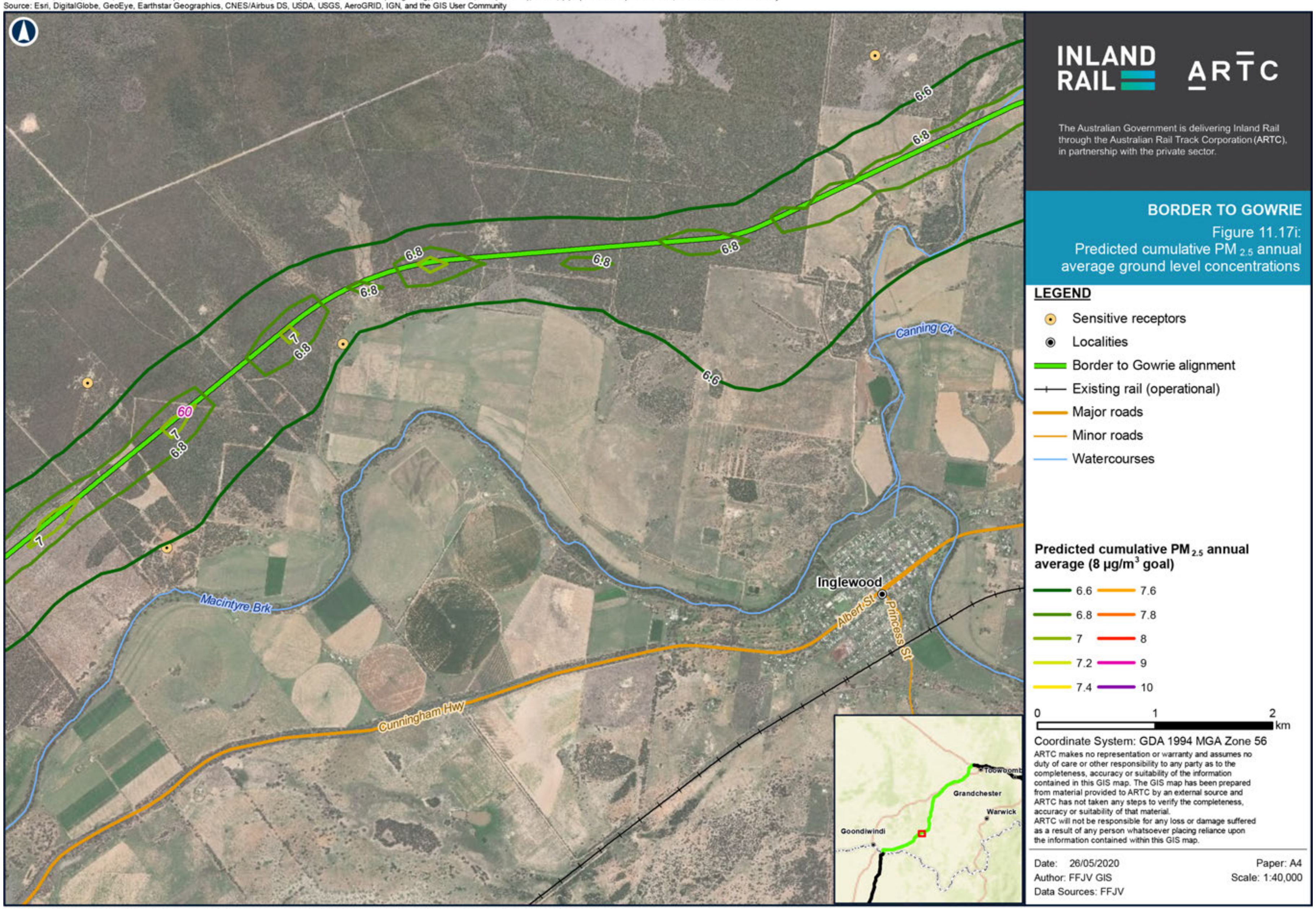
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN,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

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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
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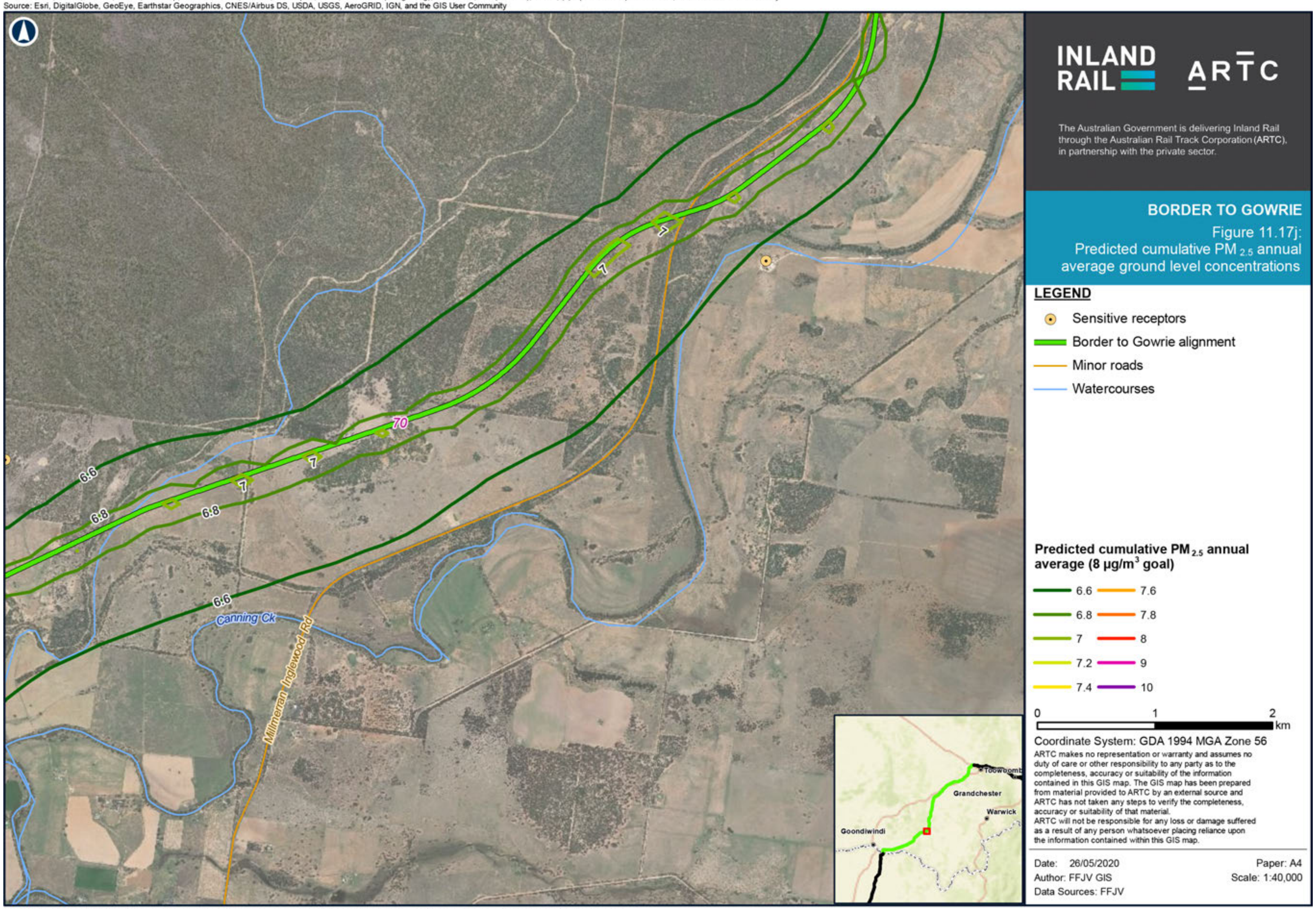


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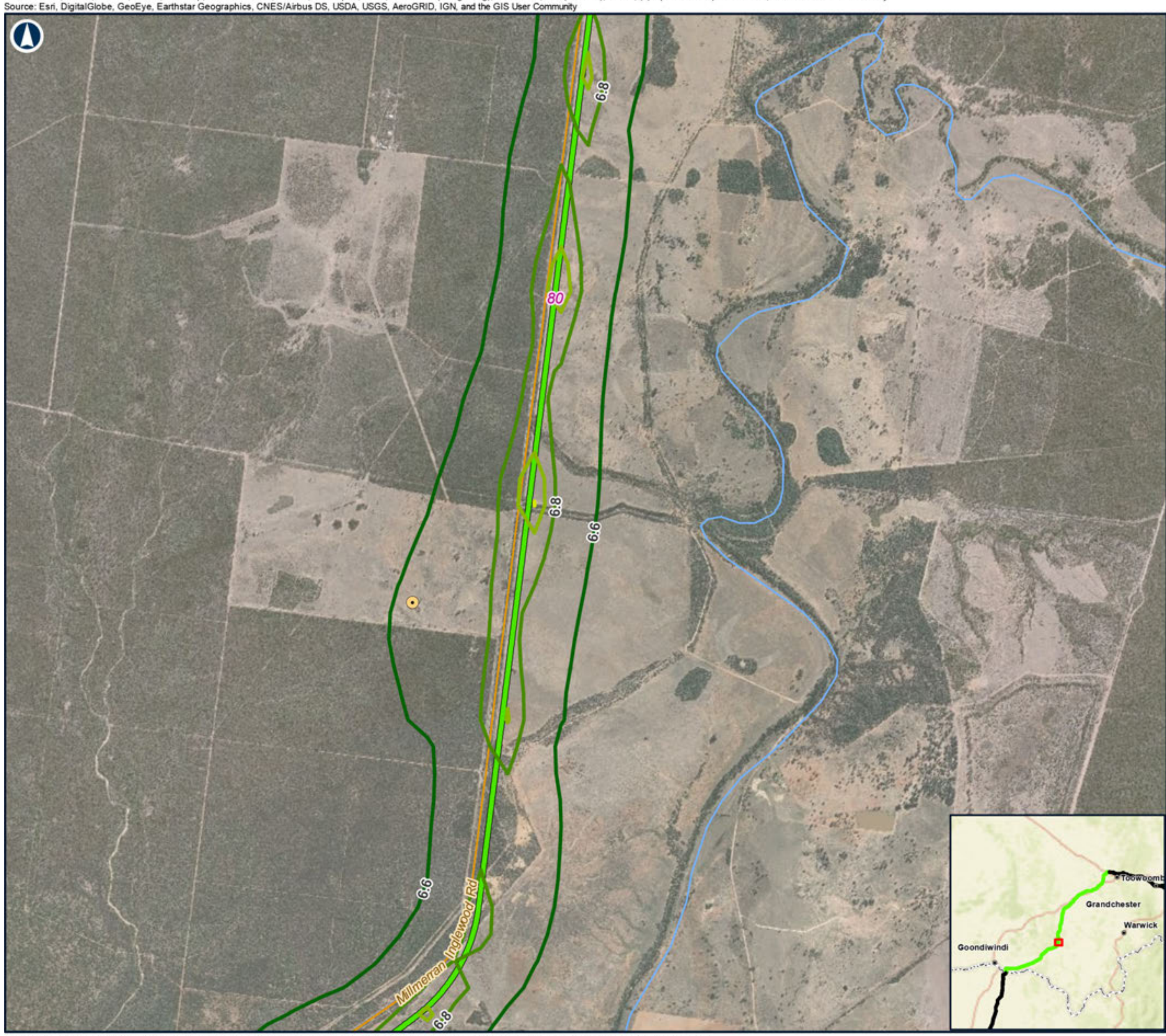


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**BORDER TO GOWRIE**

Figure 11.17k:
Predicted cumulative PM 2.5 annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m³ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:40,000

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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
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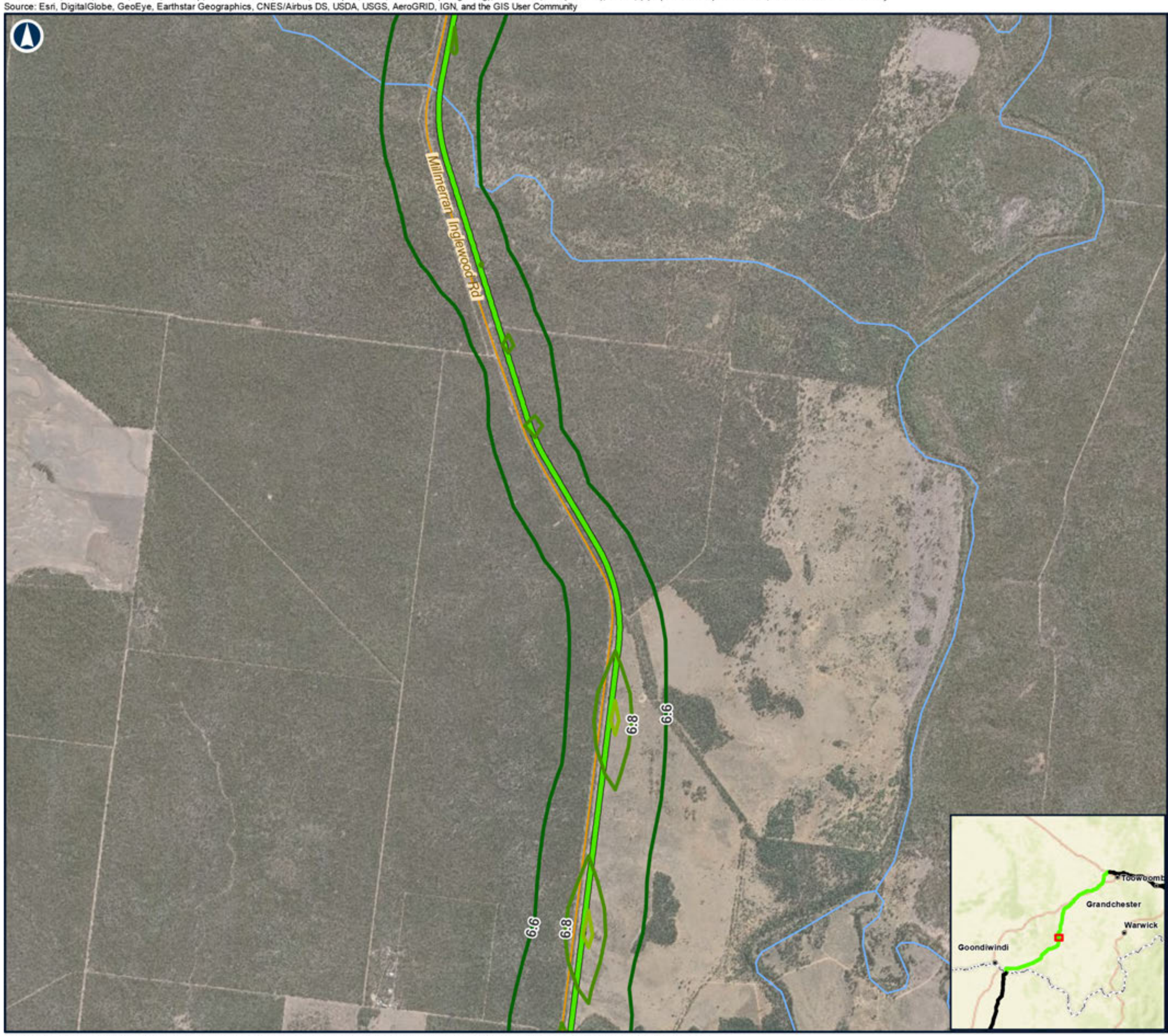


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**BORDER TO GOWRIE**

Figure 11.17l: Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Border to Gowrie alignment
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Author: FFJV GIS
Data Sources: FFJV
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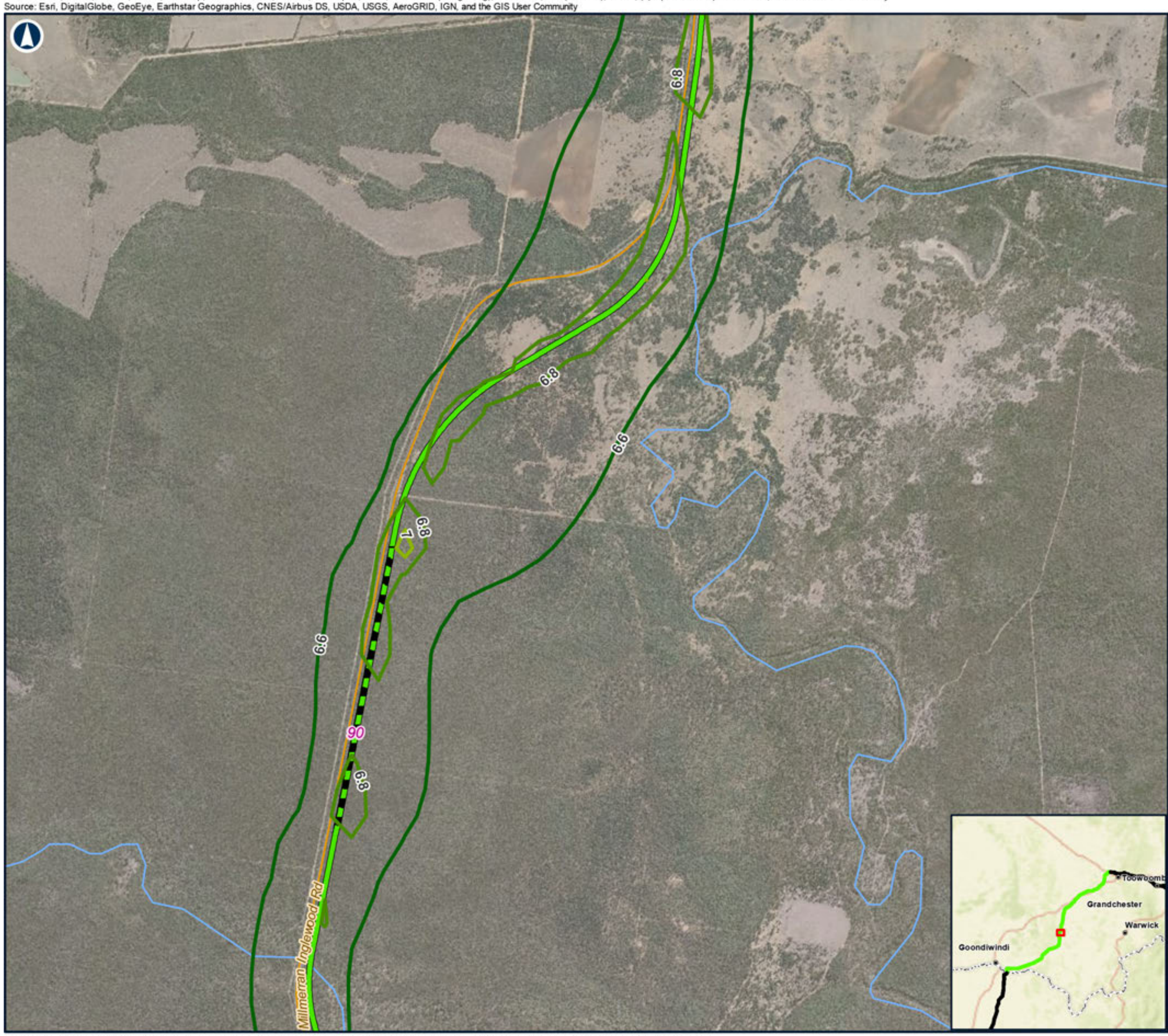
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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

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**BORDER TO GOWRIE**

Figure 11.17m:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Rail loops
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Date: 26/05/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.17_PM2_5.mxd Date: 27/05/2020 09:20

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
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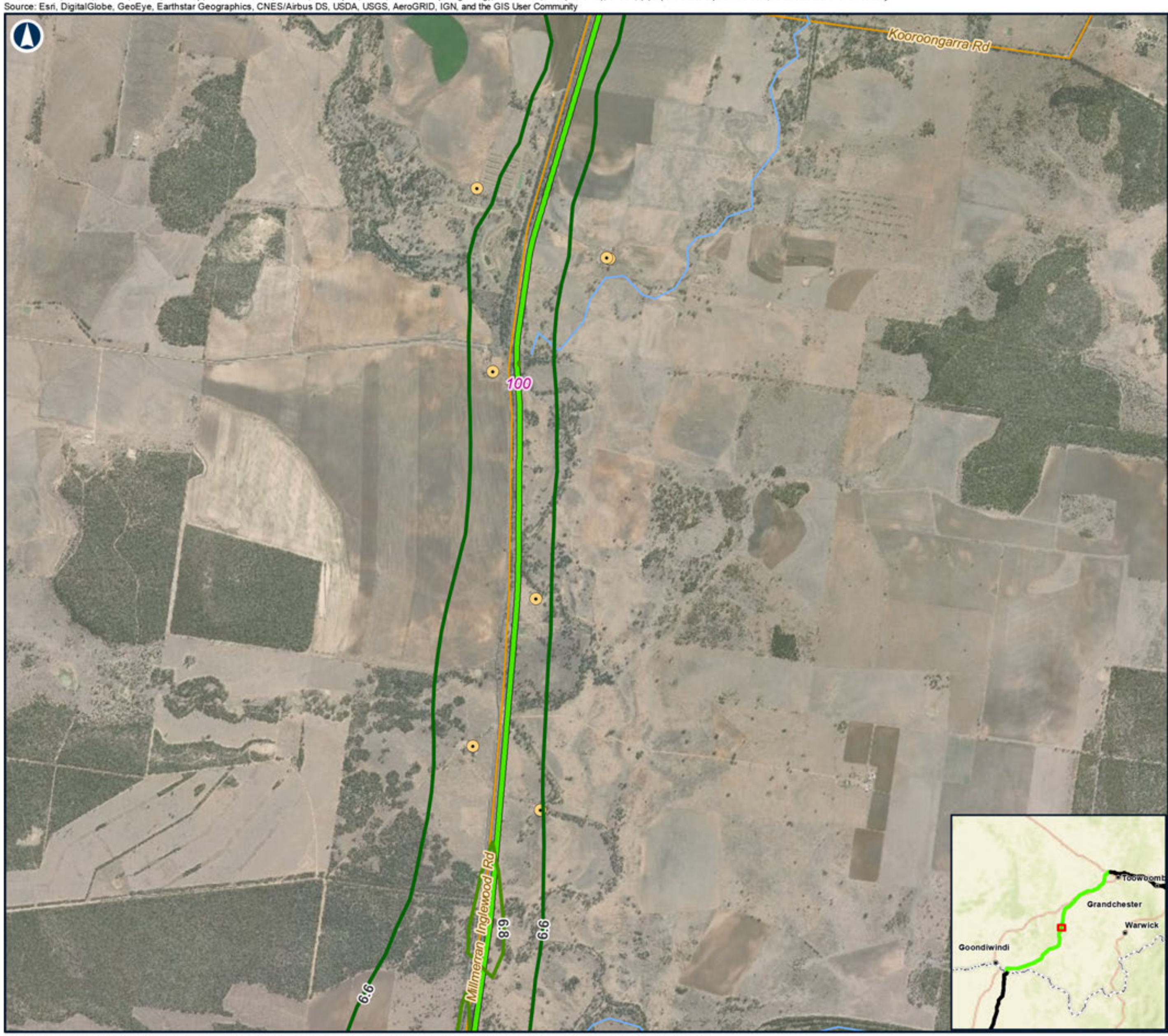


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**BORDER TO GOWRIE**

Figure 11.17n: Predicted cumulative $PM_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $PM_{2.5}$ annual average (8 µg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

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Author: FFJV GIS
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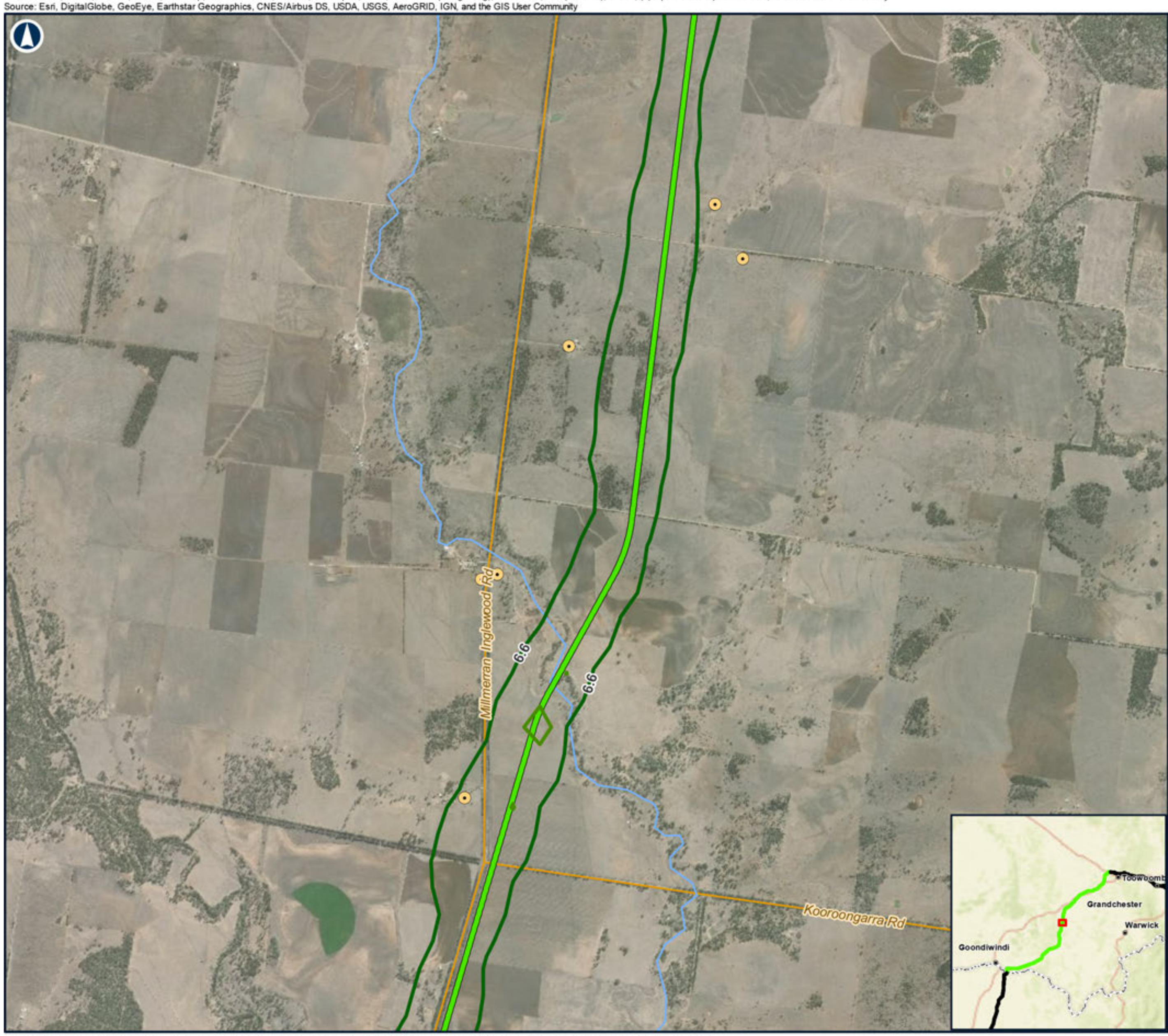


INLAND RAIL

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## BORDER TO GOWRIE

Figure 11.17o:
Predicted cumulative PM 2.5 annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative PM 2.5 annual average (8 µg/m³ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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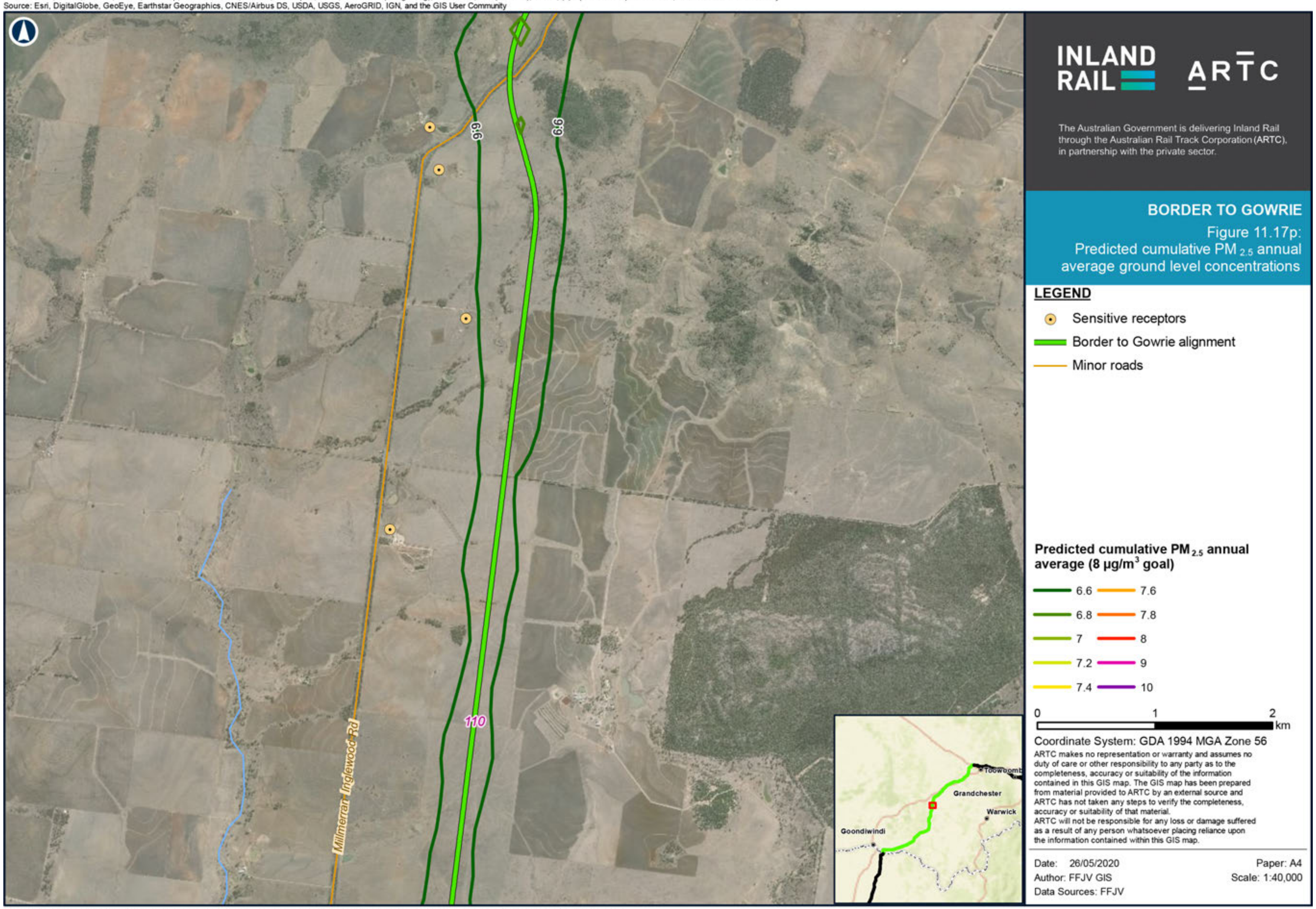


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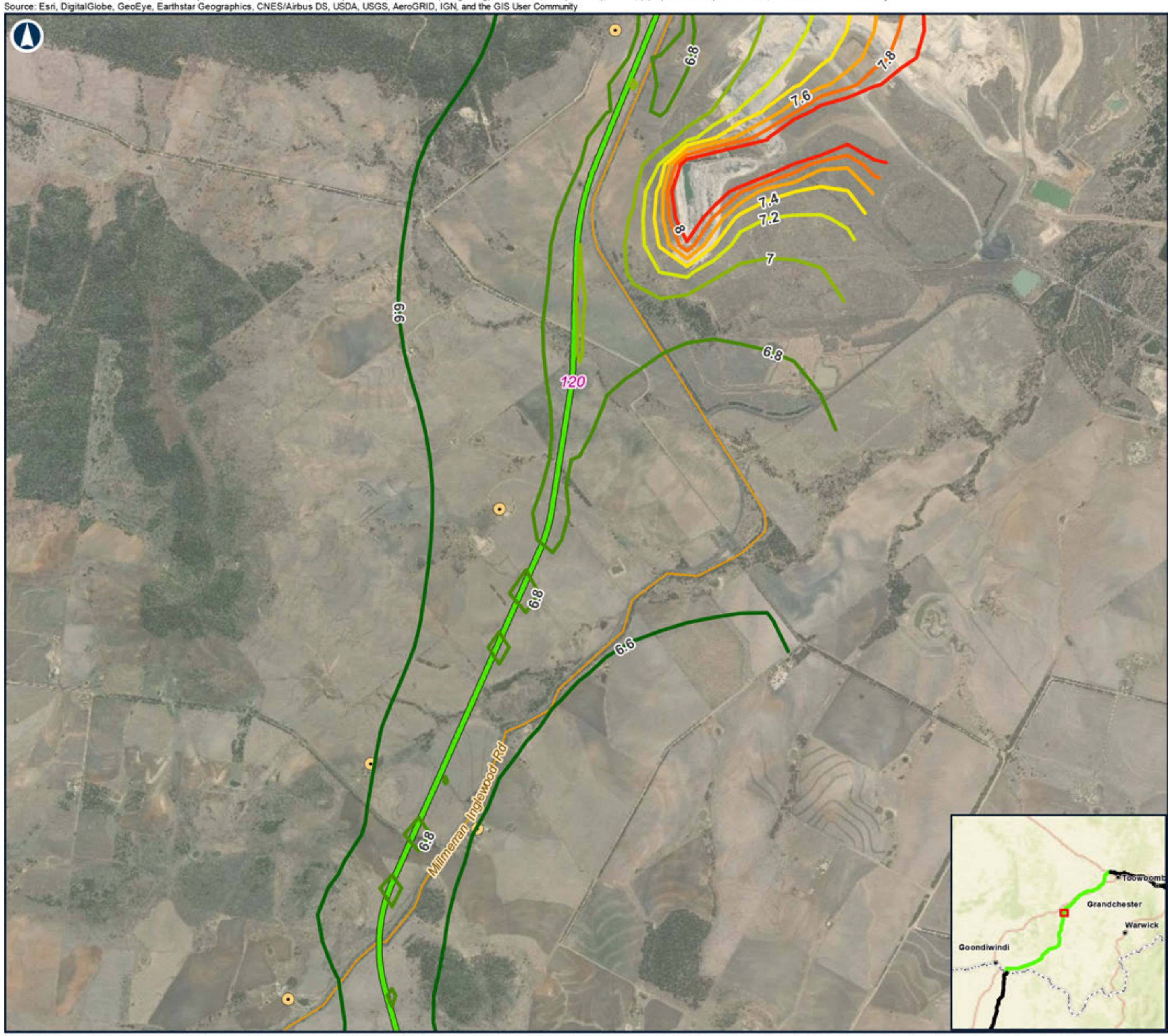


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## BORDER TO GOWRIE

Figure 11.17q: Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 μg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

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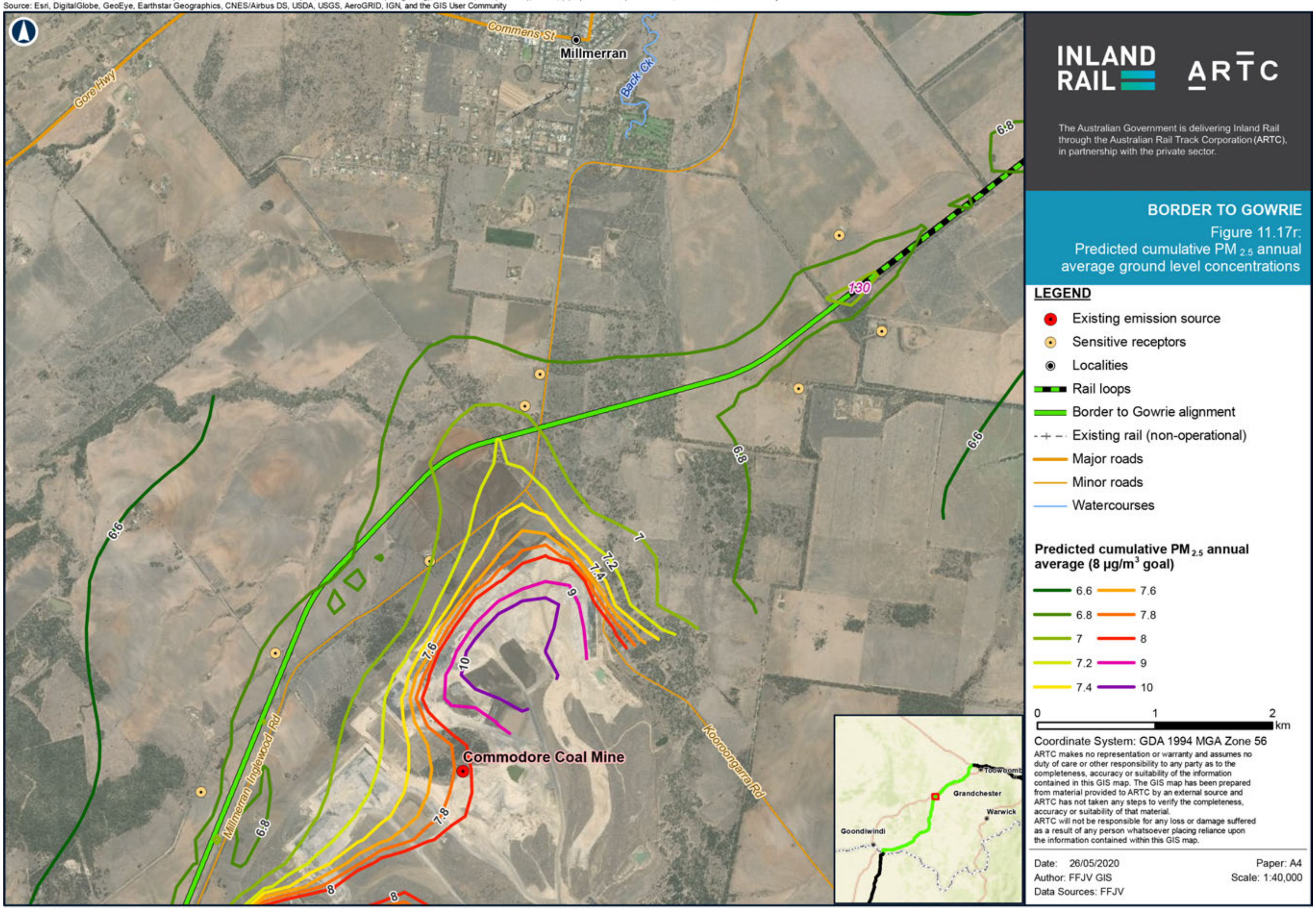


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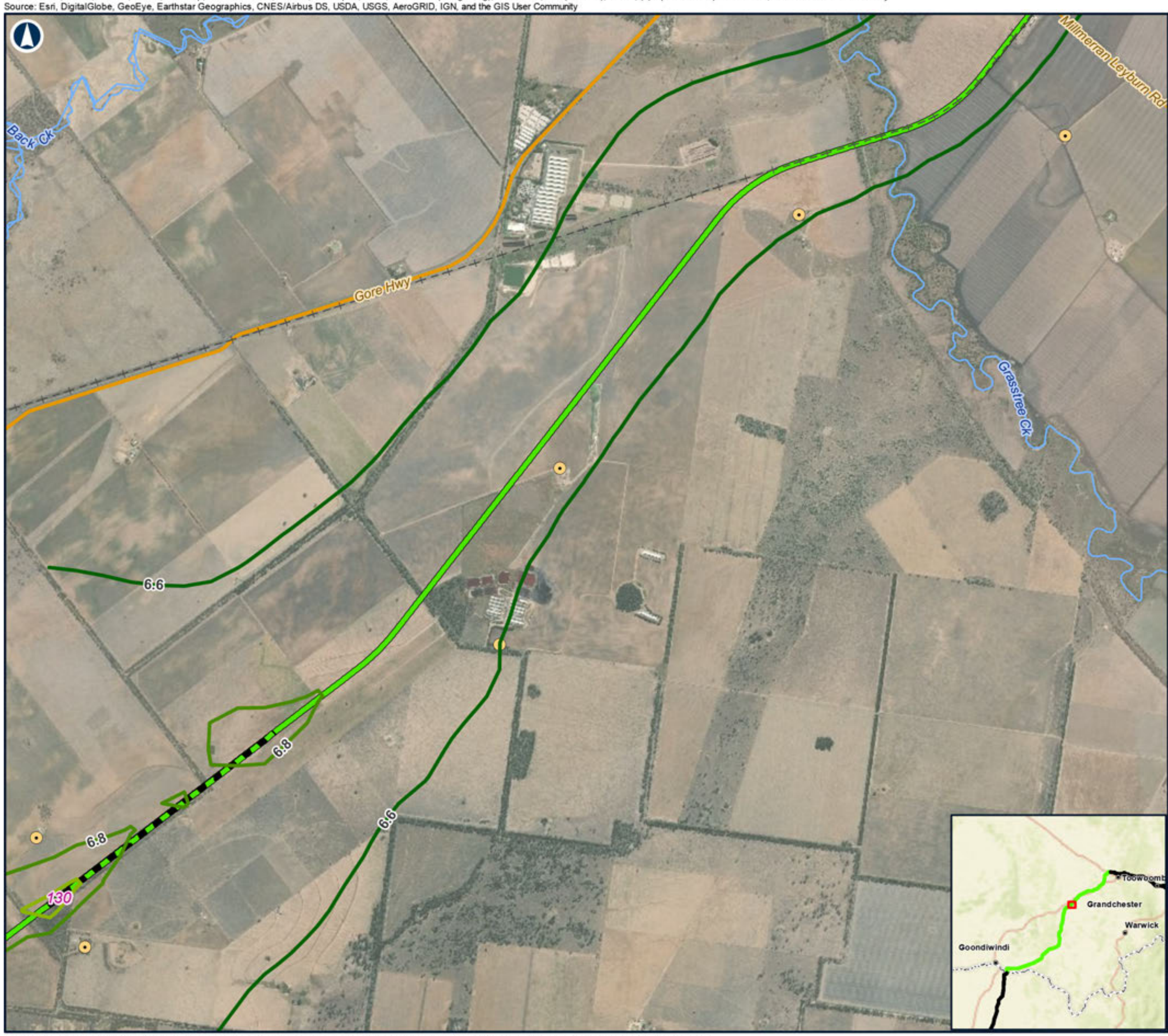


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**BORDER TO GOWRIE**

Figure 11.17s:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Rail loops
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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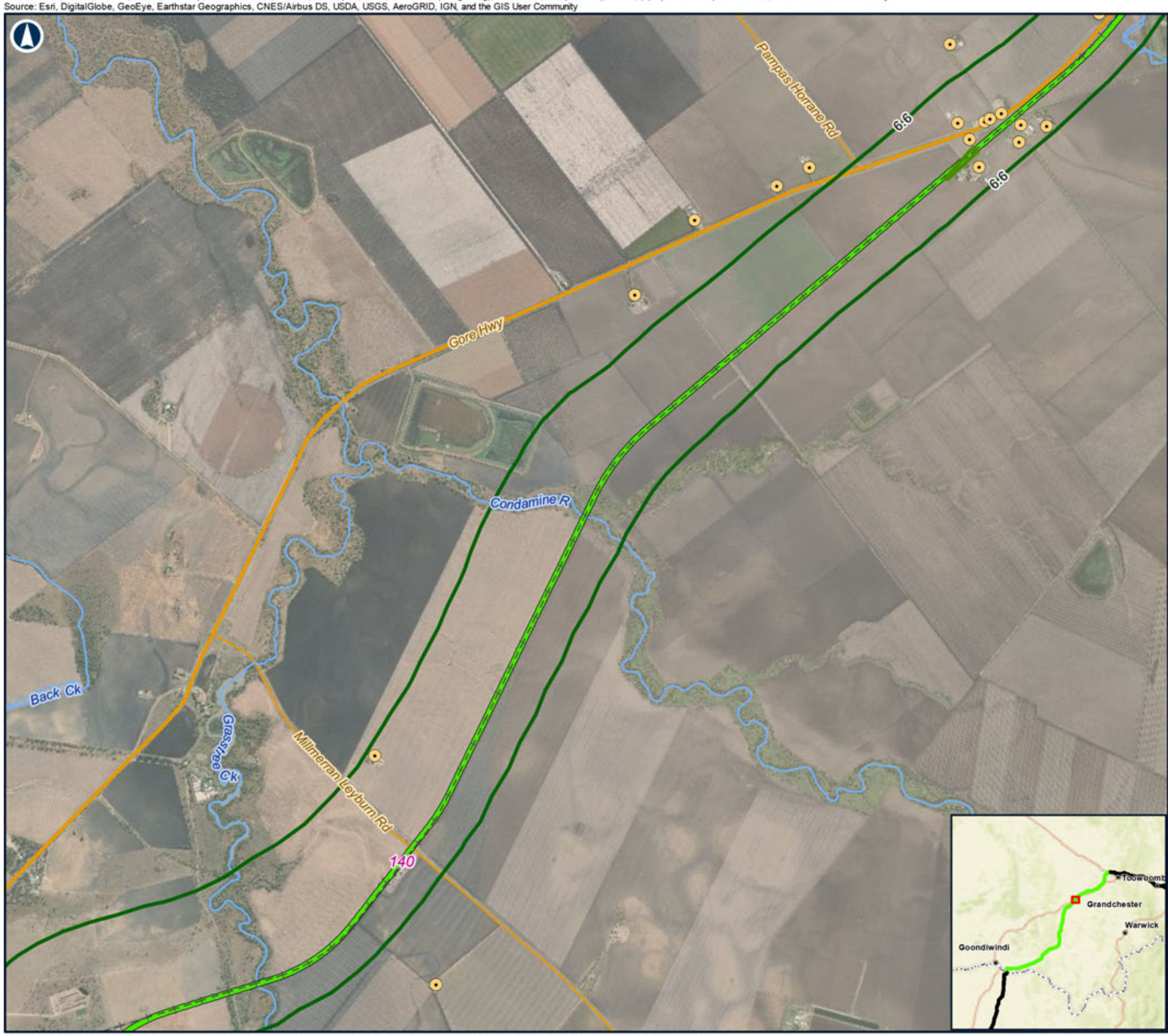


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**BORDER TO GOWRIE**

Figure 11.17t: Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

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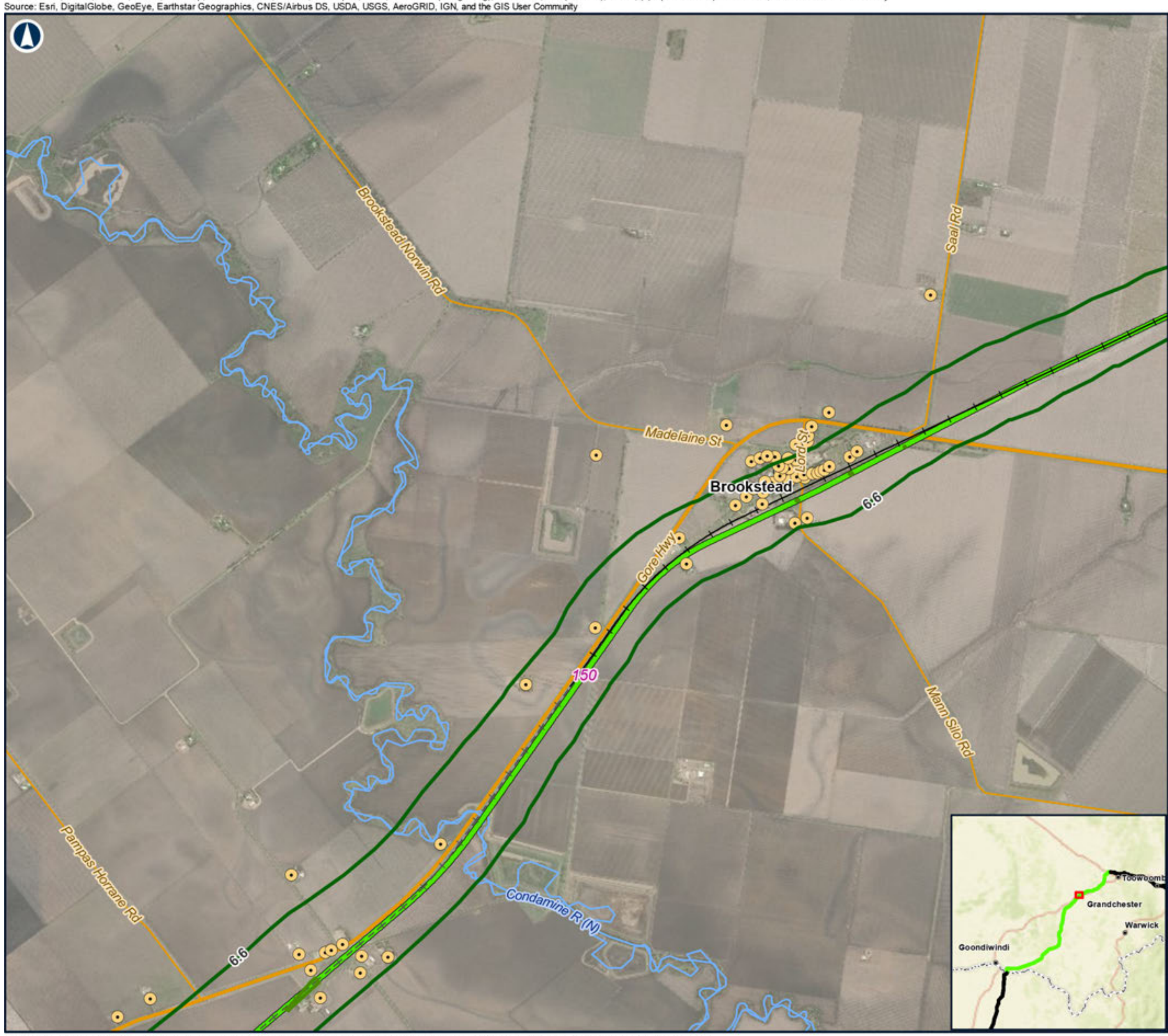


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**BORDER TO GOWRIE**

Figure 11.17u: Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 μg/m$^3$ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

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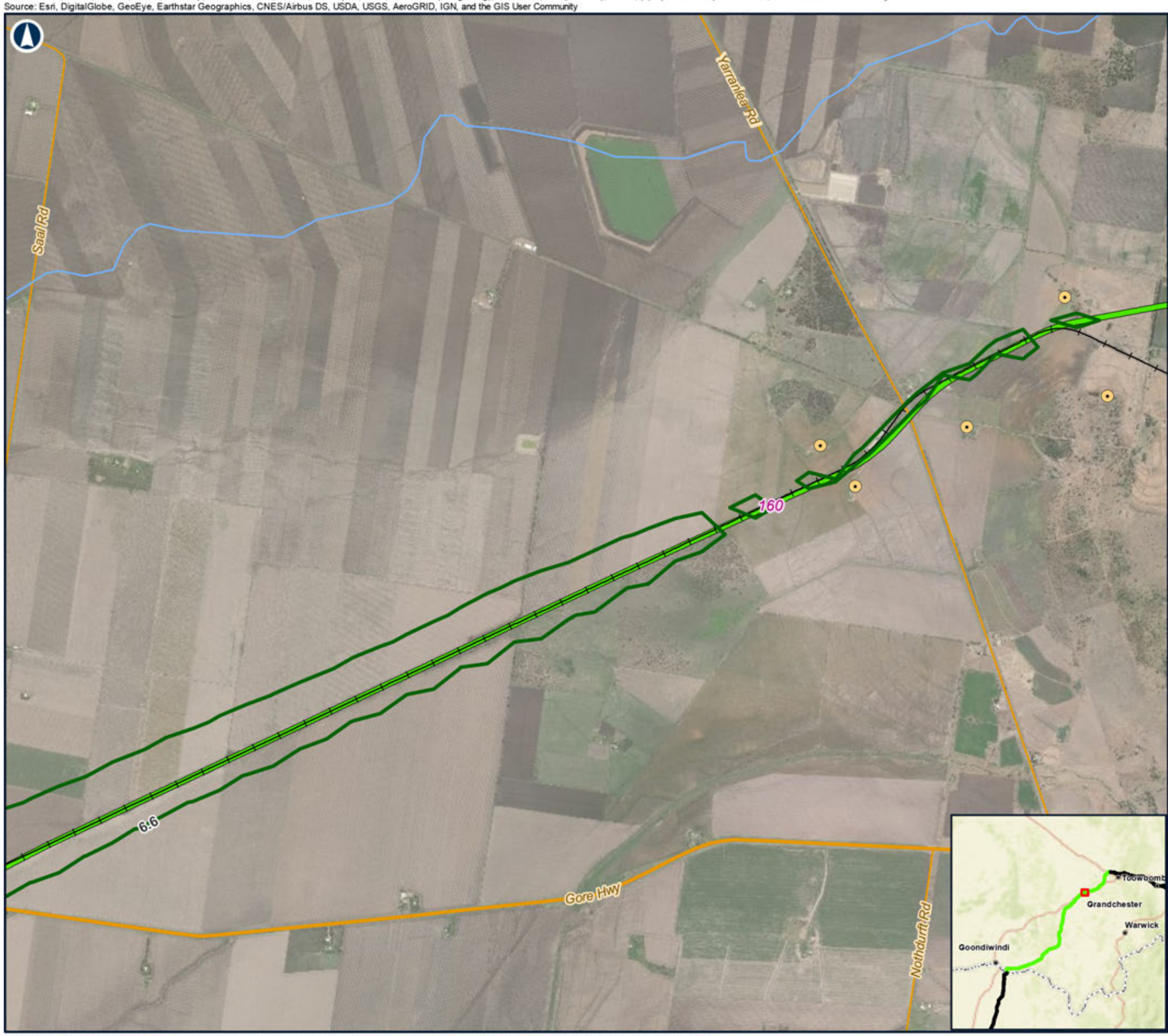


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**BORDER TO GOWRIE**

Figure 11.17v:
Predicted cumulative PM 2.5 annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted cumulative PM 2.5 annual average (8 μg/m$^3$ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

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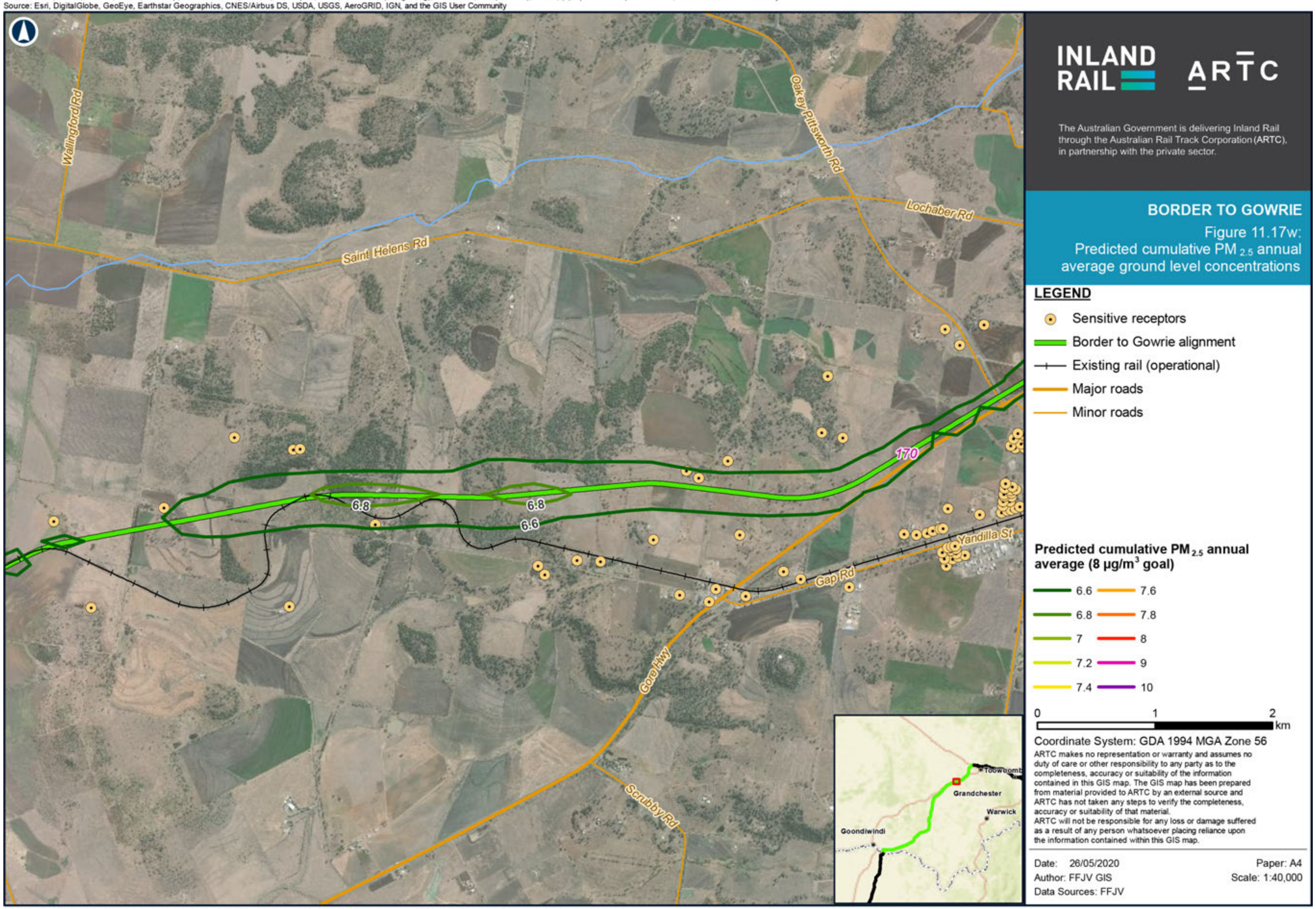


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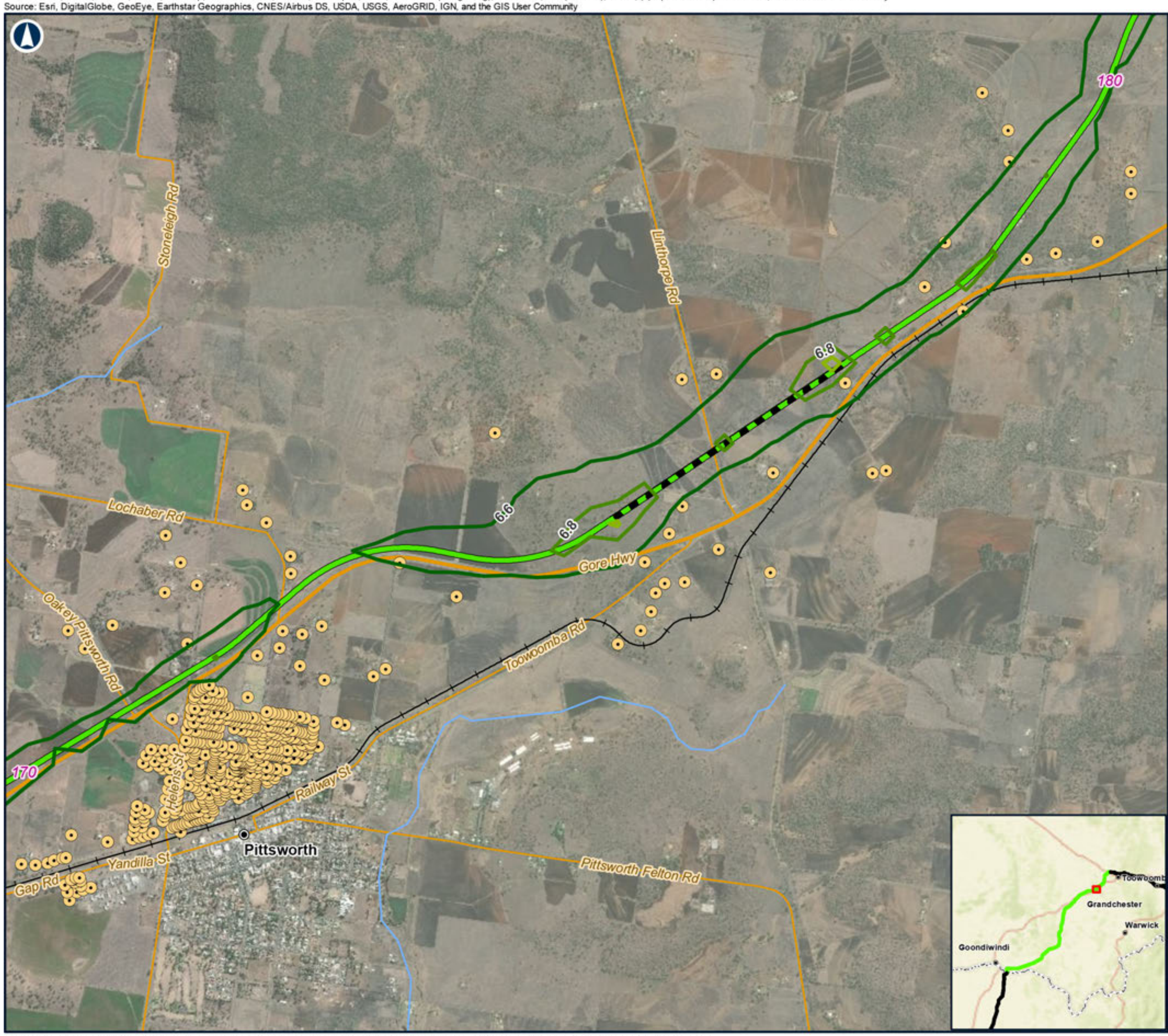


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**BORDER TO GOWRIE**

Figure 11.17x:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Rail loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted cumulative PM $_{2.5}$ annual average (8 μg/m$^3$ goal)**

6.6, 6.8, 7, 7.2, 7.4, 7.6, 7.8, 8, 9, 10

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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**BORDER TO GOWRIE**

Figure 11.17y:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 μg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

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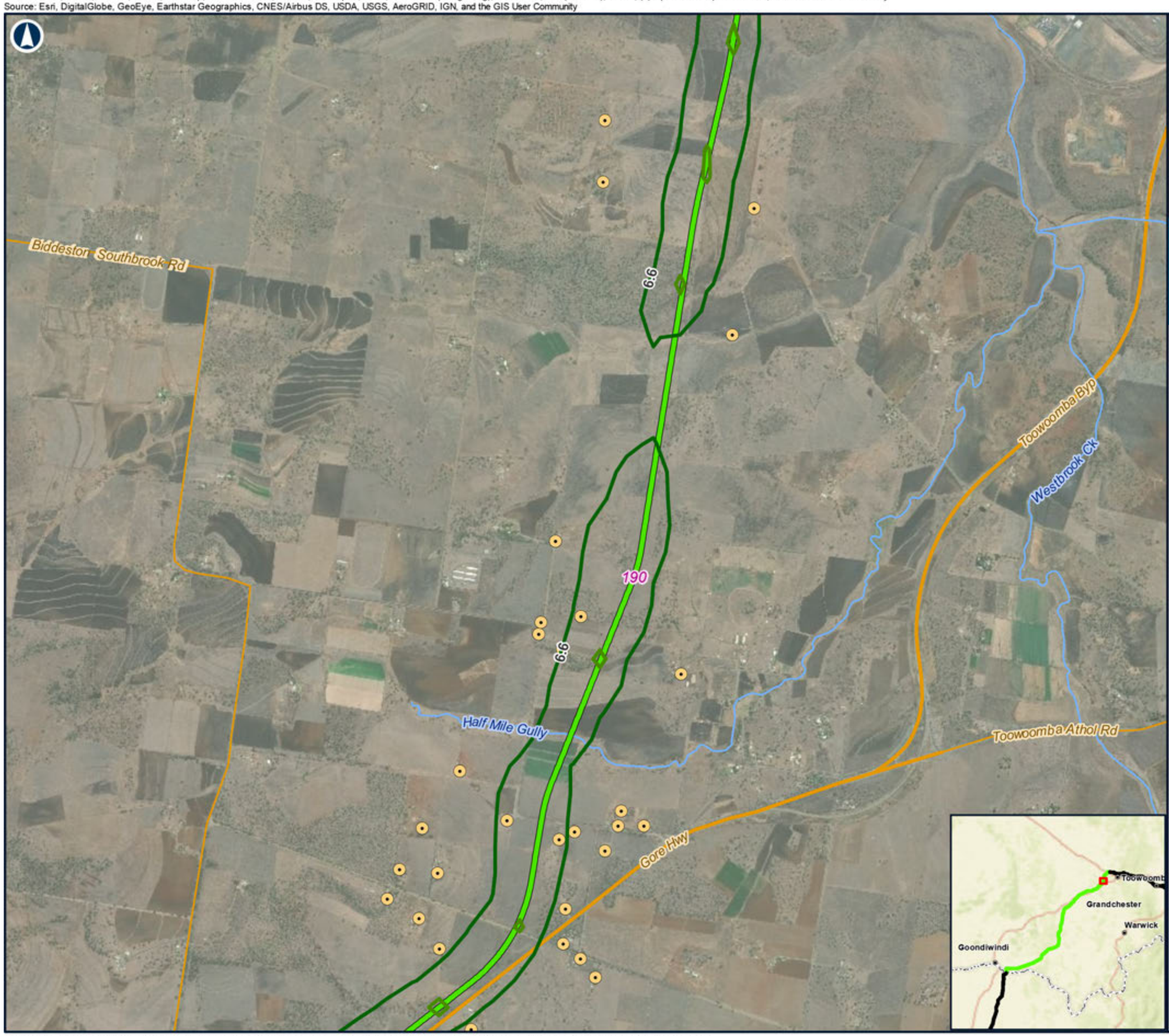


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**BORDER TO GOWRIE**

Figure 11.17z: Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Border to Gowrie alignment
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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**BORDER TO GOWRIE**

Figure 11.17aa:
Predicted cumulative PM $_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative PM $_{2.5}$ annual average (8 µg/m$^3$ goal)**

- 6.6
- 6.8
- 7
- 7.2
- 7.4
- 7.6
- 7.8
- 8
- 9
- 10

0 1 2 km

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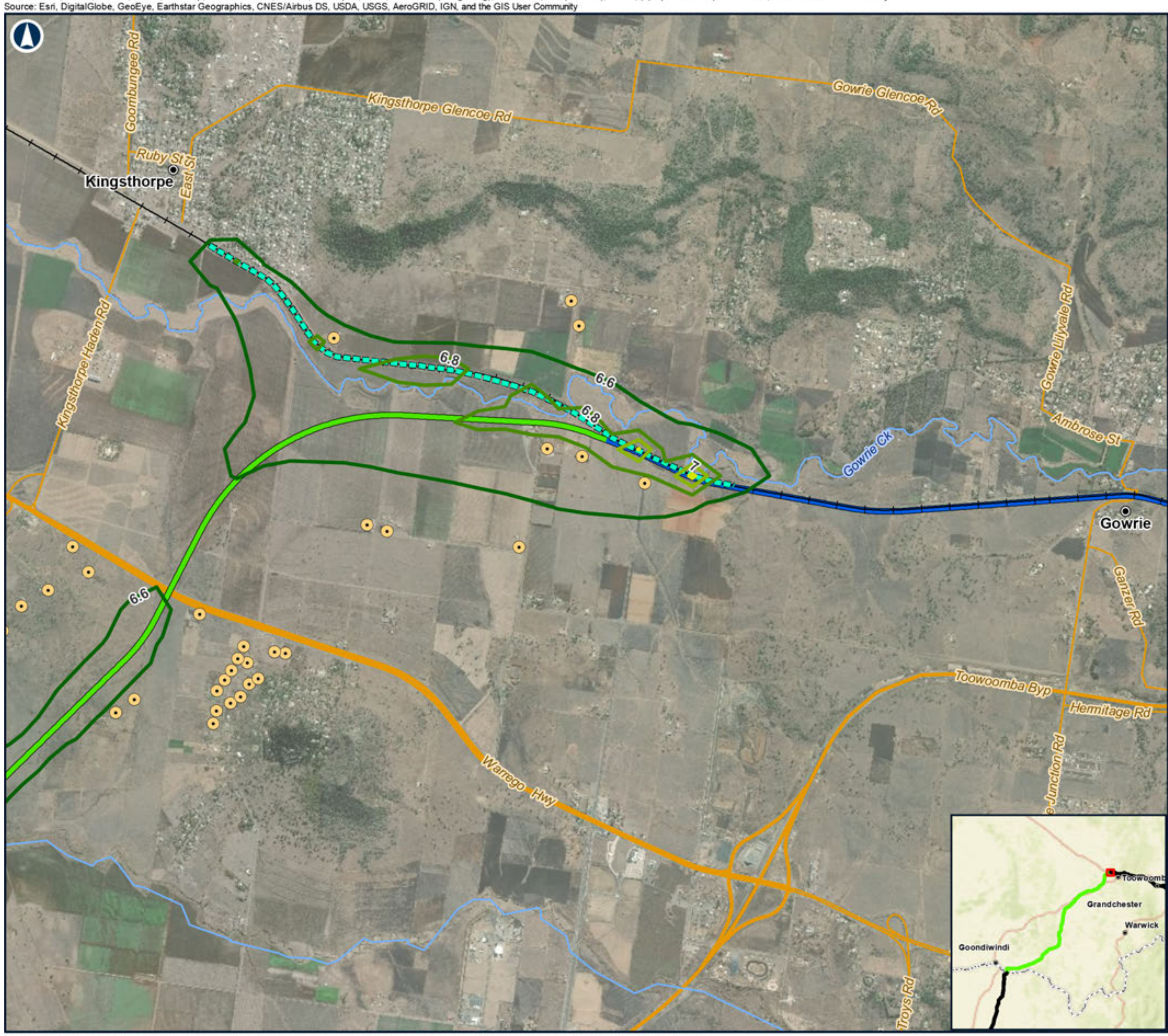


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## BORDER TO GOWRIE

Figure 11.17ab:
Predicted cumulative $PM_{2.5}$ annual average ground level concentrations

**LEGEND**

- Sensitive receptors
- Localities
- Cumulative rail sources
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative $PM_{2.5}$ annual average (8 μg/m³ goal)**

| | |
|---|---|
| 6.6 | 7.6 |
| 6.8 | 7.8 |
| 7 | 8 |
| 7.2 | 9 |
| 7.4 | 10 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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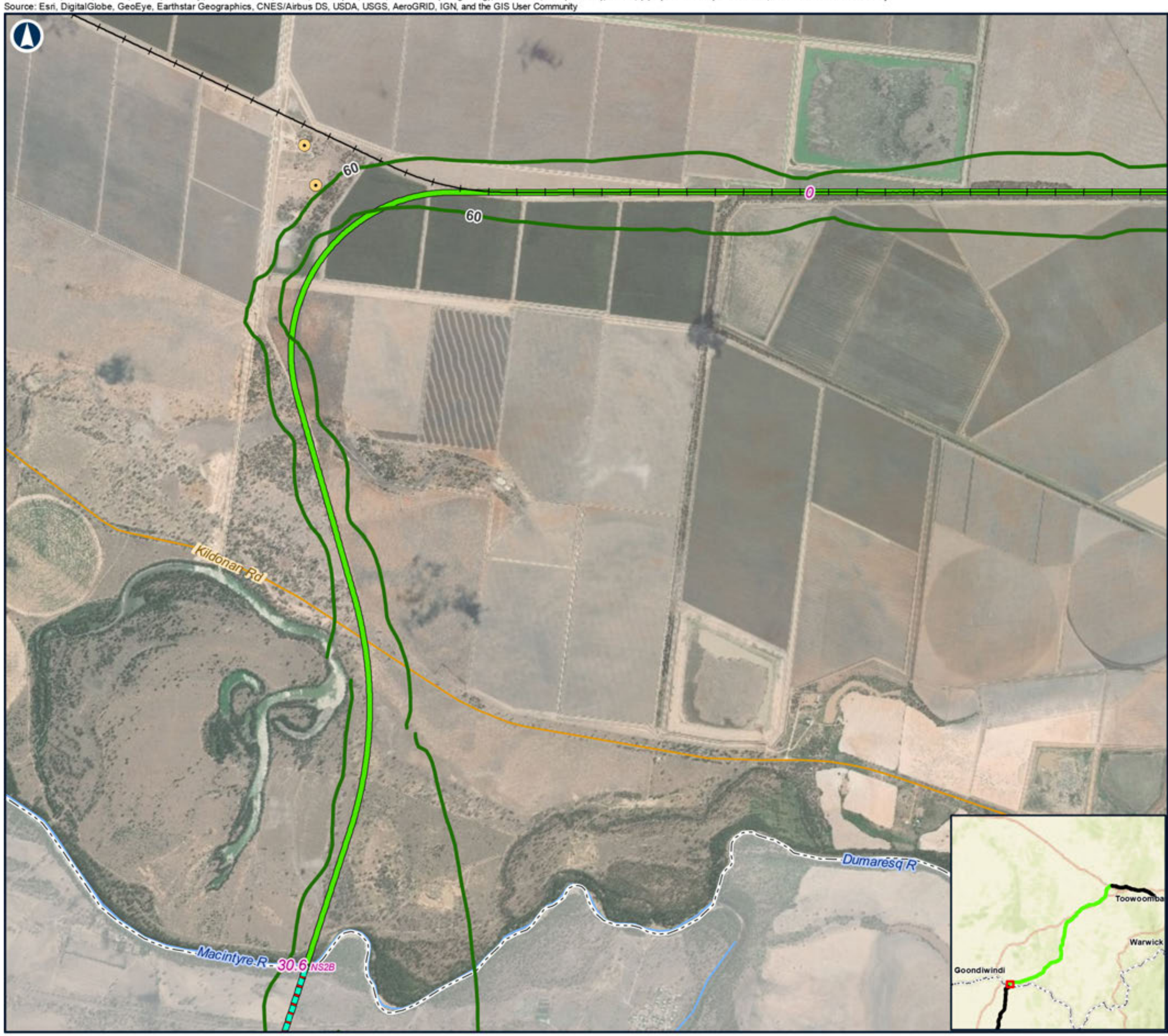


INLAND RAIL ARTC

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**BORDER TO GOWRIE**

Figure 11.18a: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Cumulative rail sources
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- Watercourses
- NSW/QLD border

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



Date: 28/05/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:40,000

Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.18_NO2.mxd Date: 28/05/2020 13:49

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
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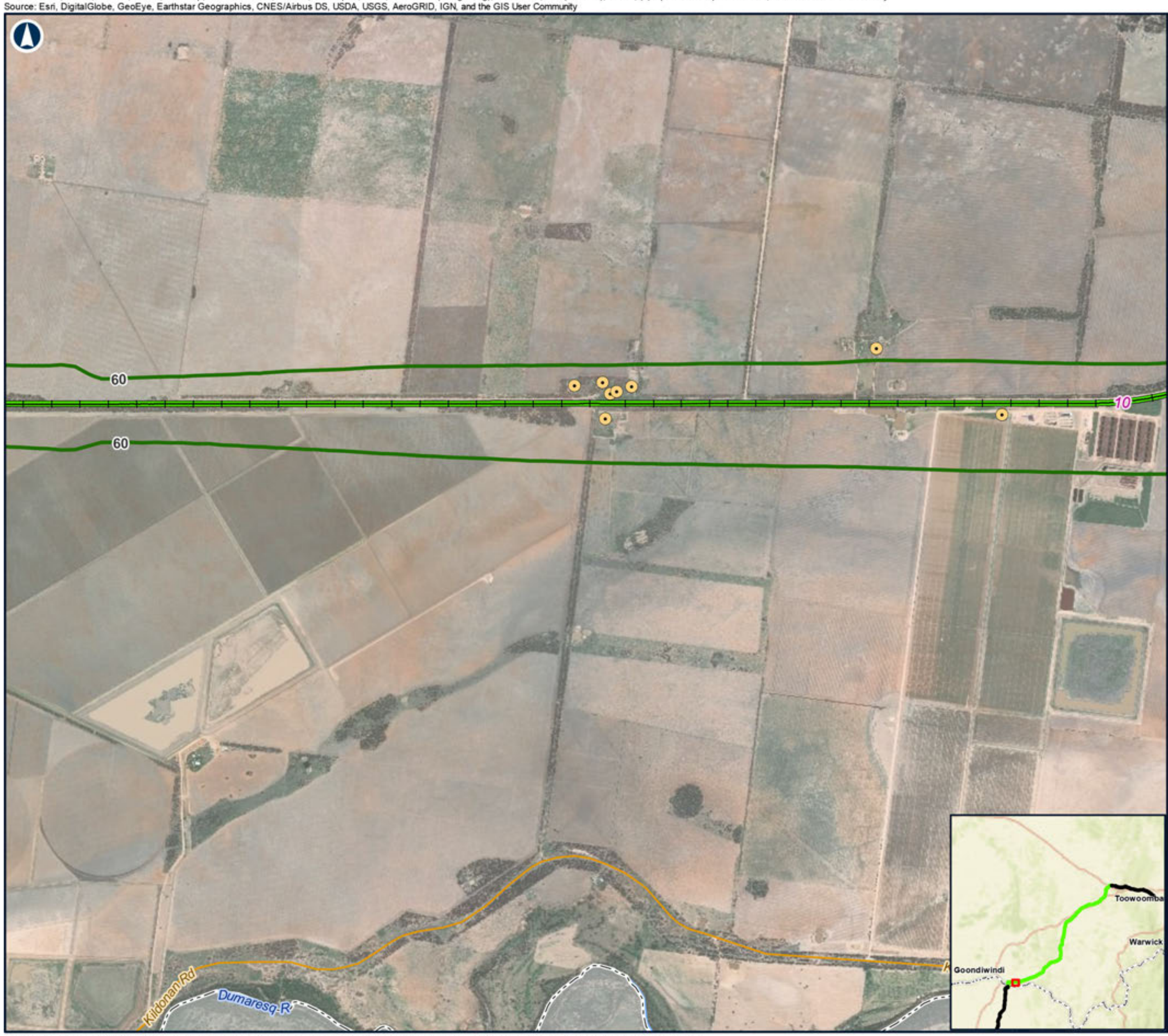


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## BORDER TO GOWRIE

Figure 11.18b: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- Watercourses
- NSW/QLD border

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



Date: 28/05/2020
Author: FFJV GIS
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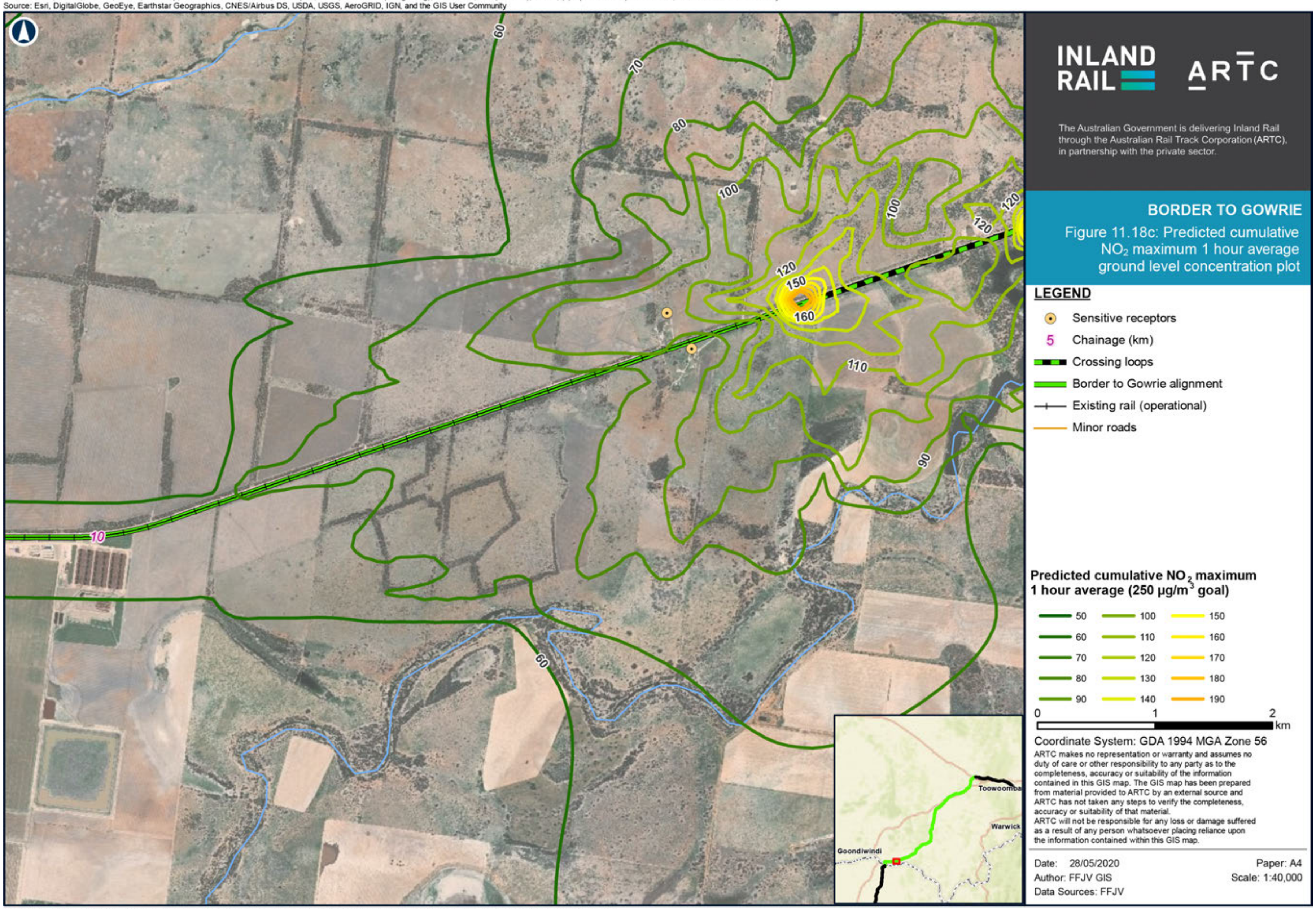


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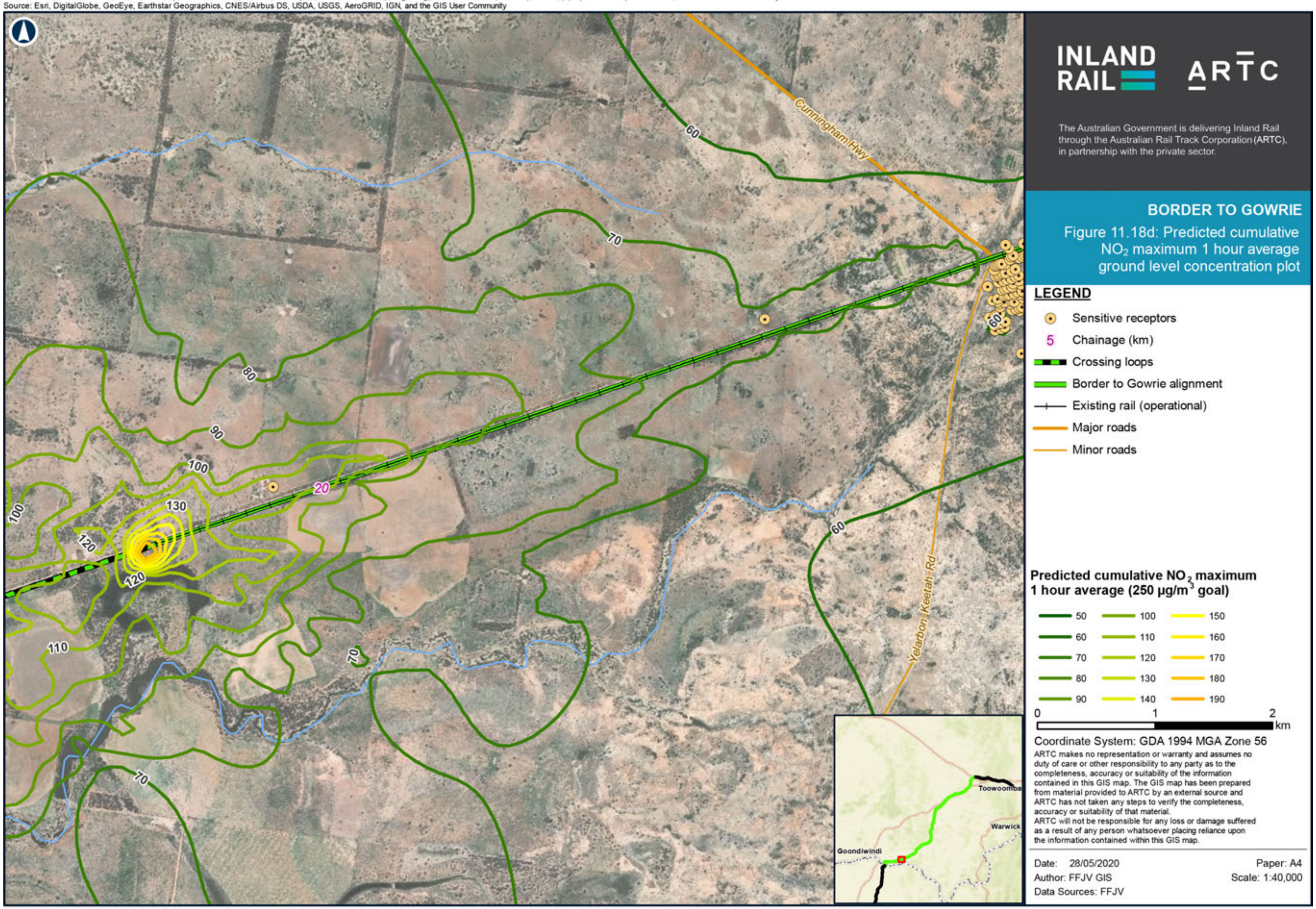


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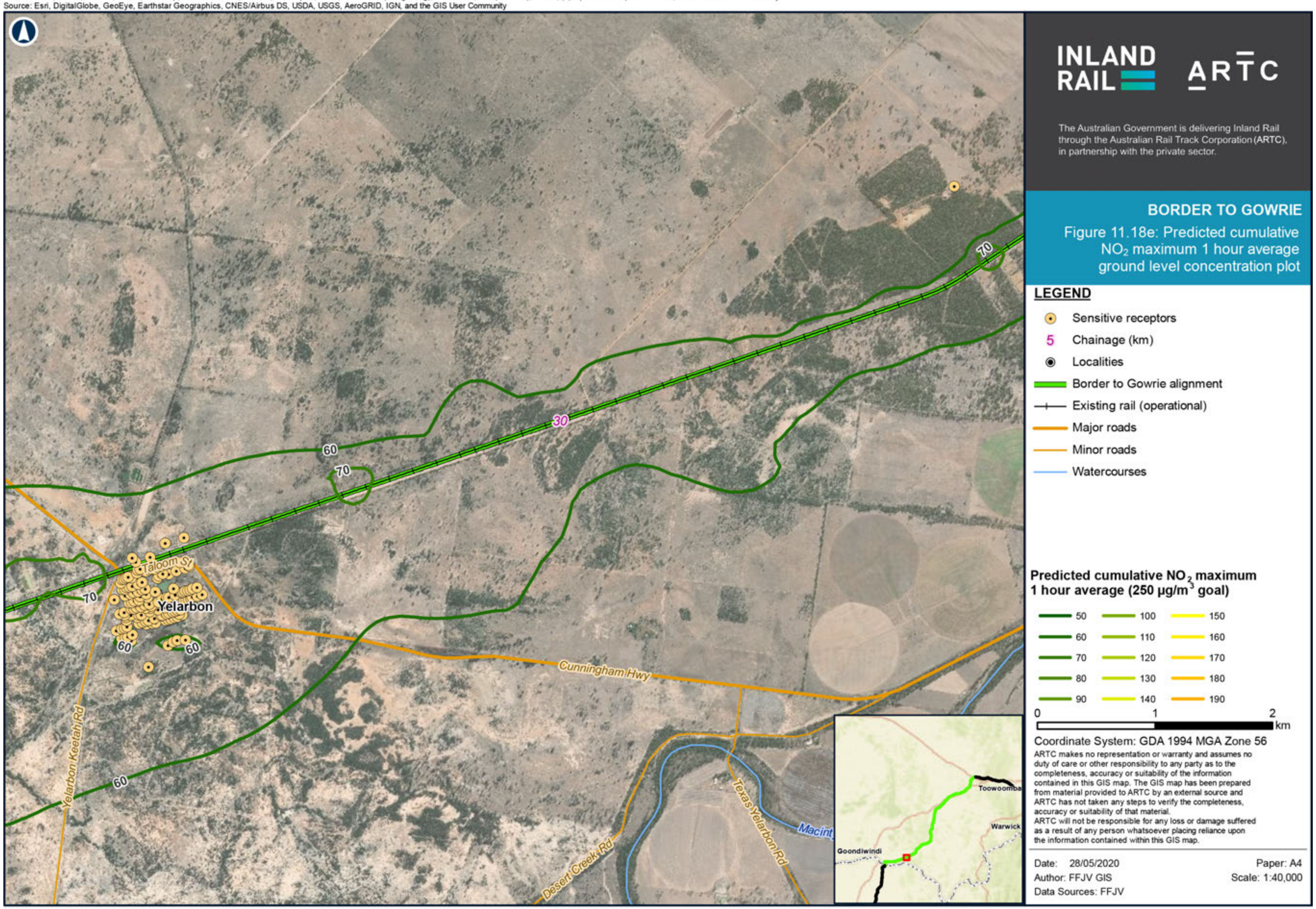


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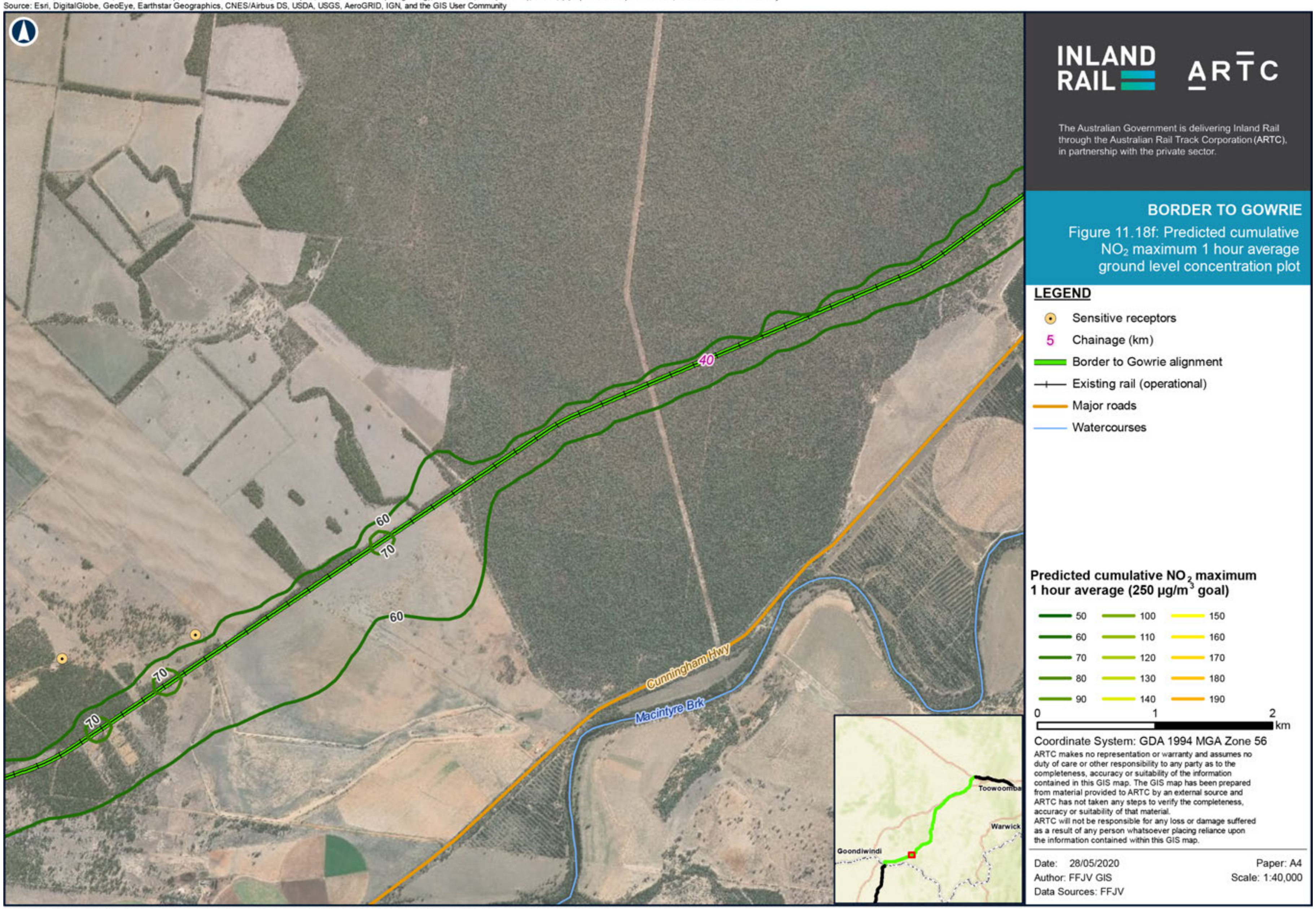


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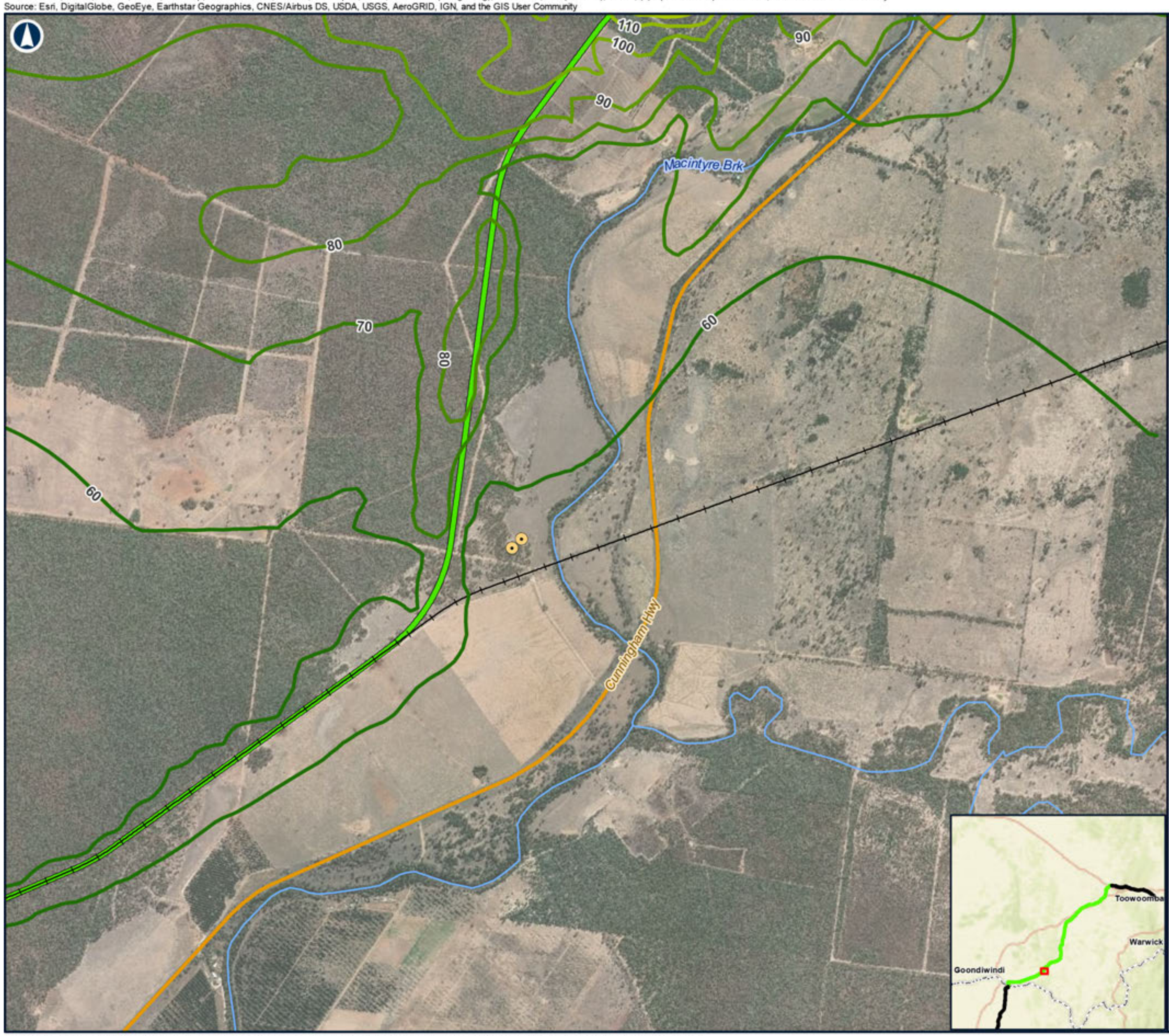


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## BORDER TO GOWRIE

Figure 11.18g: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Watercourses

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



Date: 28/05/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:40,000

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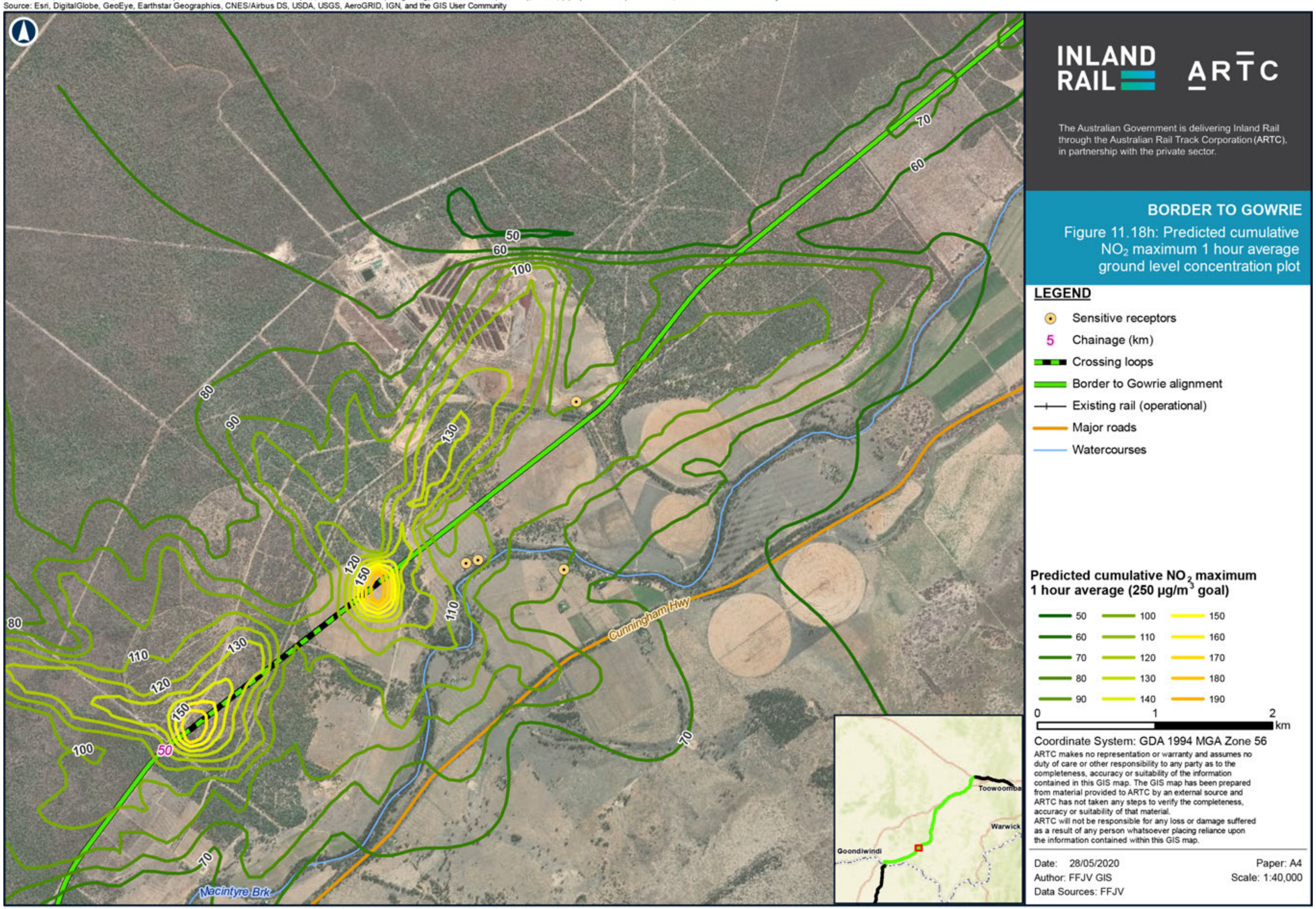


Figure 11.18h: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

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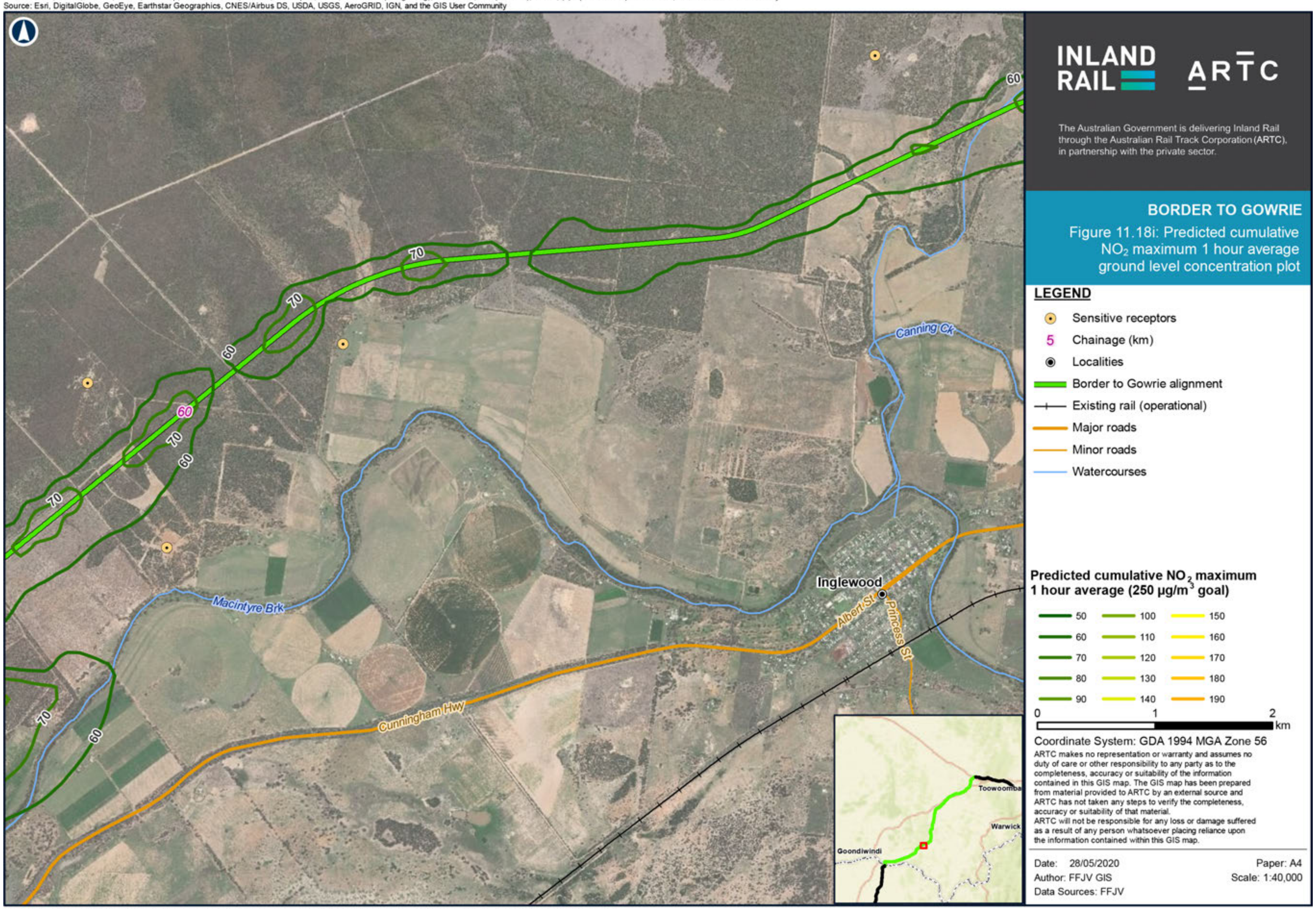


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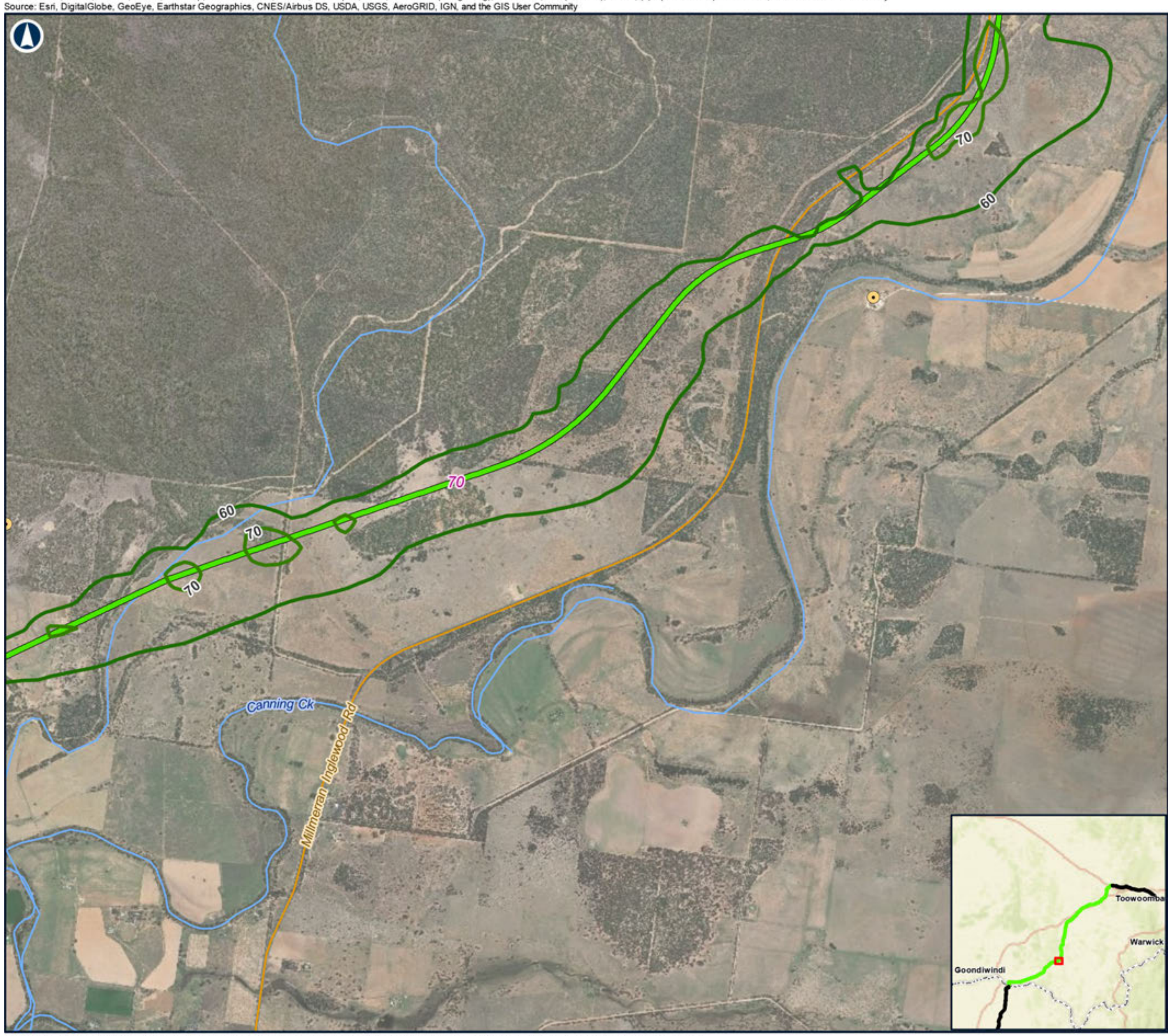


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## BORDER TO GOWRIE

Figure 11.18j: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads
- Watercourses

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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## BORDER TO GOWRIE

Figure 11.18k: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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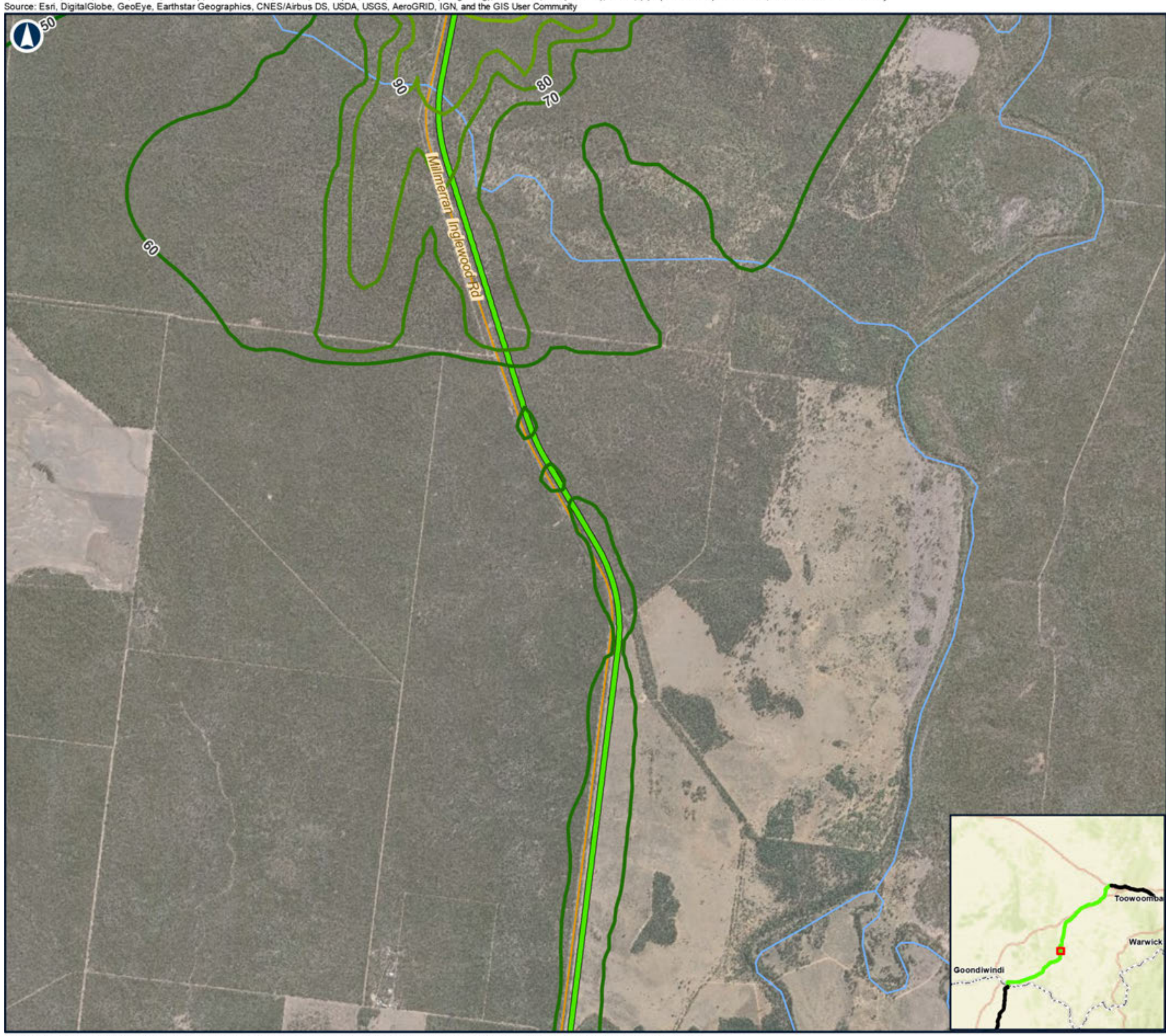


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**BORDER TO GOWRIE**

Figure 11.18l: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

5 Chainage (km)

Border to Gowrie alignment

Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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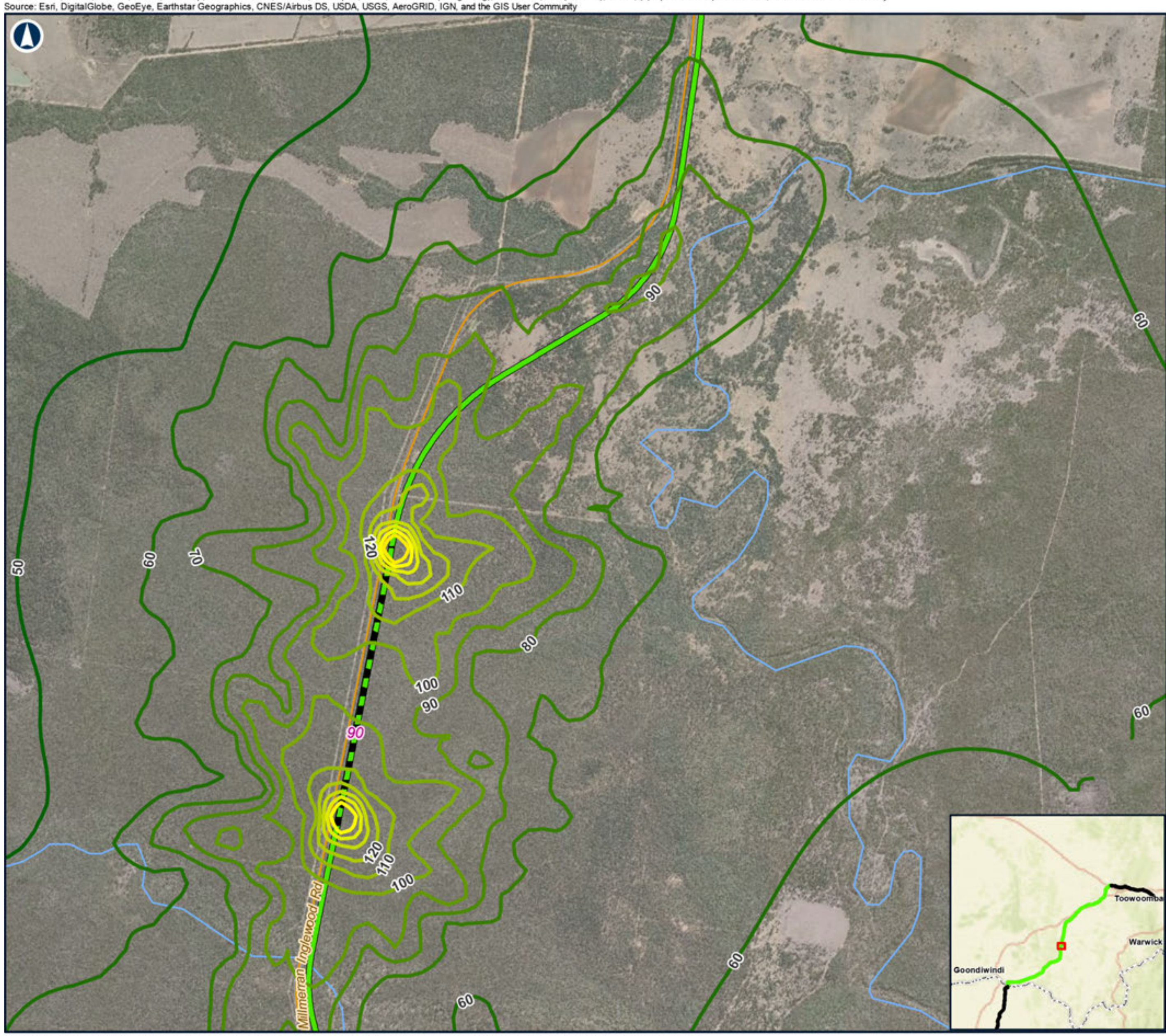


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## BORDER TO GOWRIE

Figure 11.18m: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- 5 Chainage (km)
- Crossing loops
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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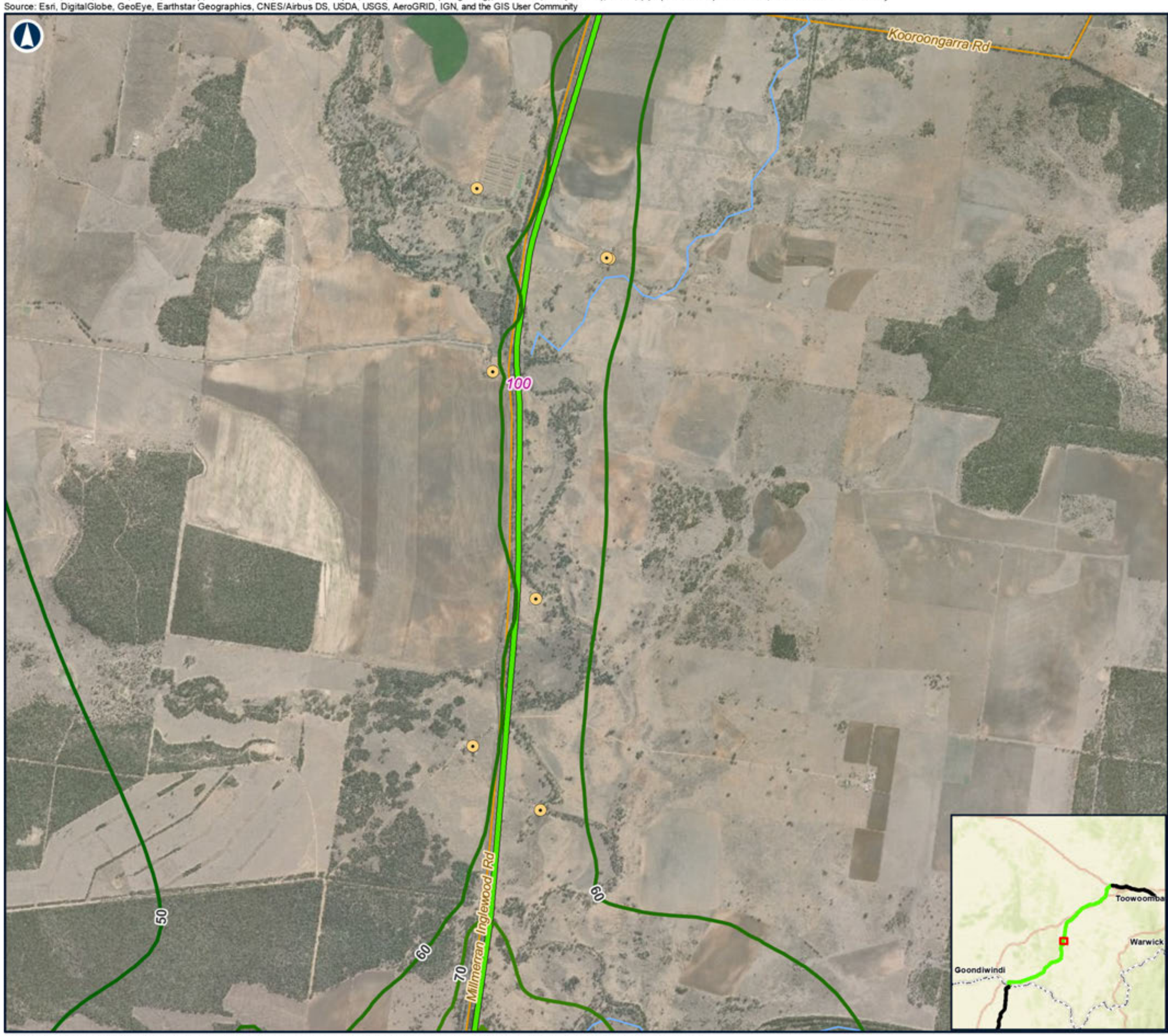


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## BORDER TO GOWRIE

Figure 11.18n: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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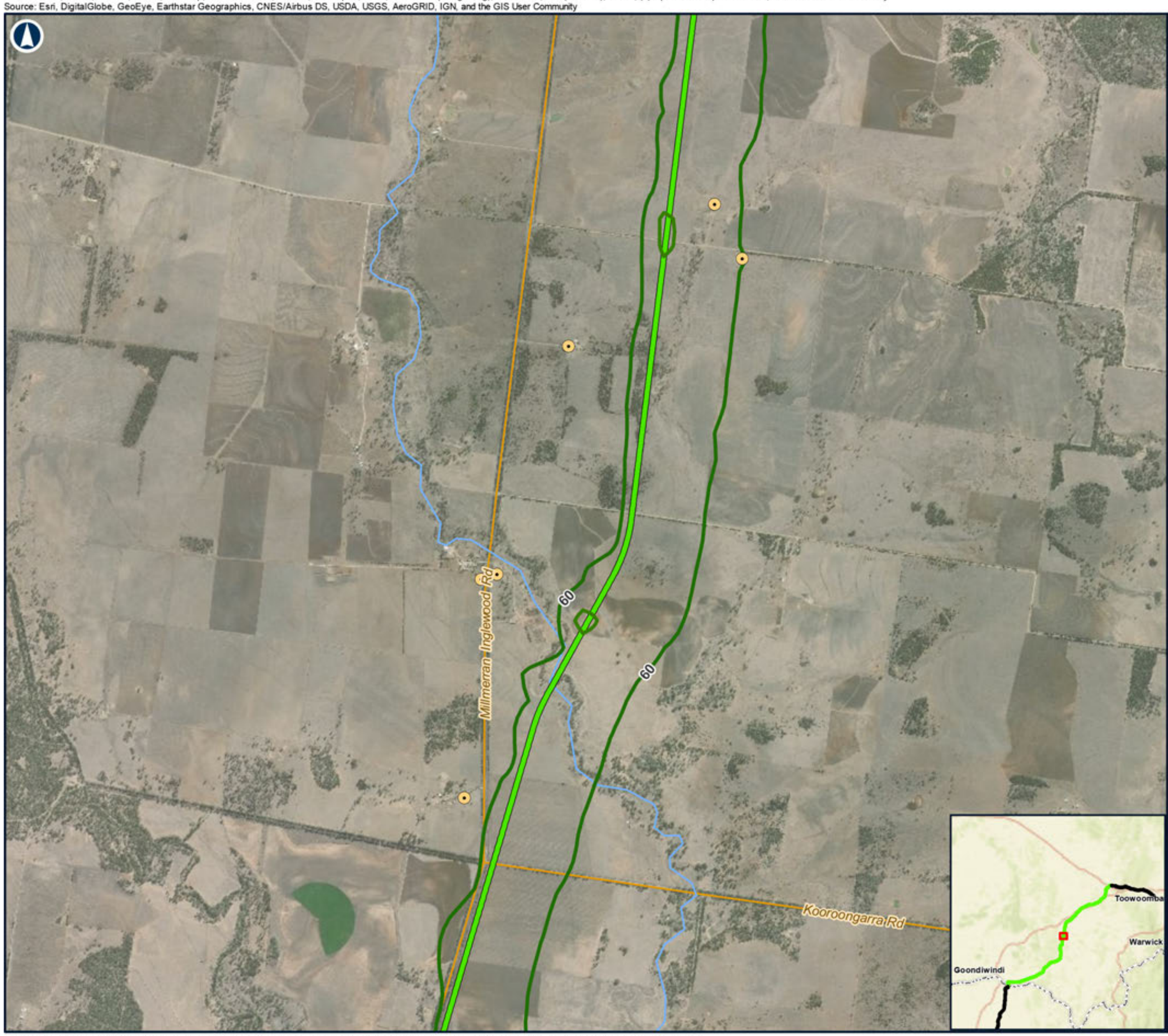


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## BORDER TO GOWRIE

Figure 11.18o: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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**BORDER TO GOWRIE**

Figure 11.18p: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km


Coordinate System: GDA 1994 MGA Zone 56

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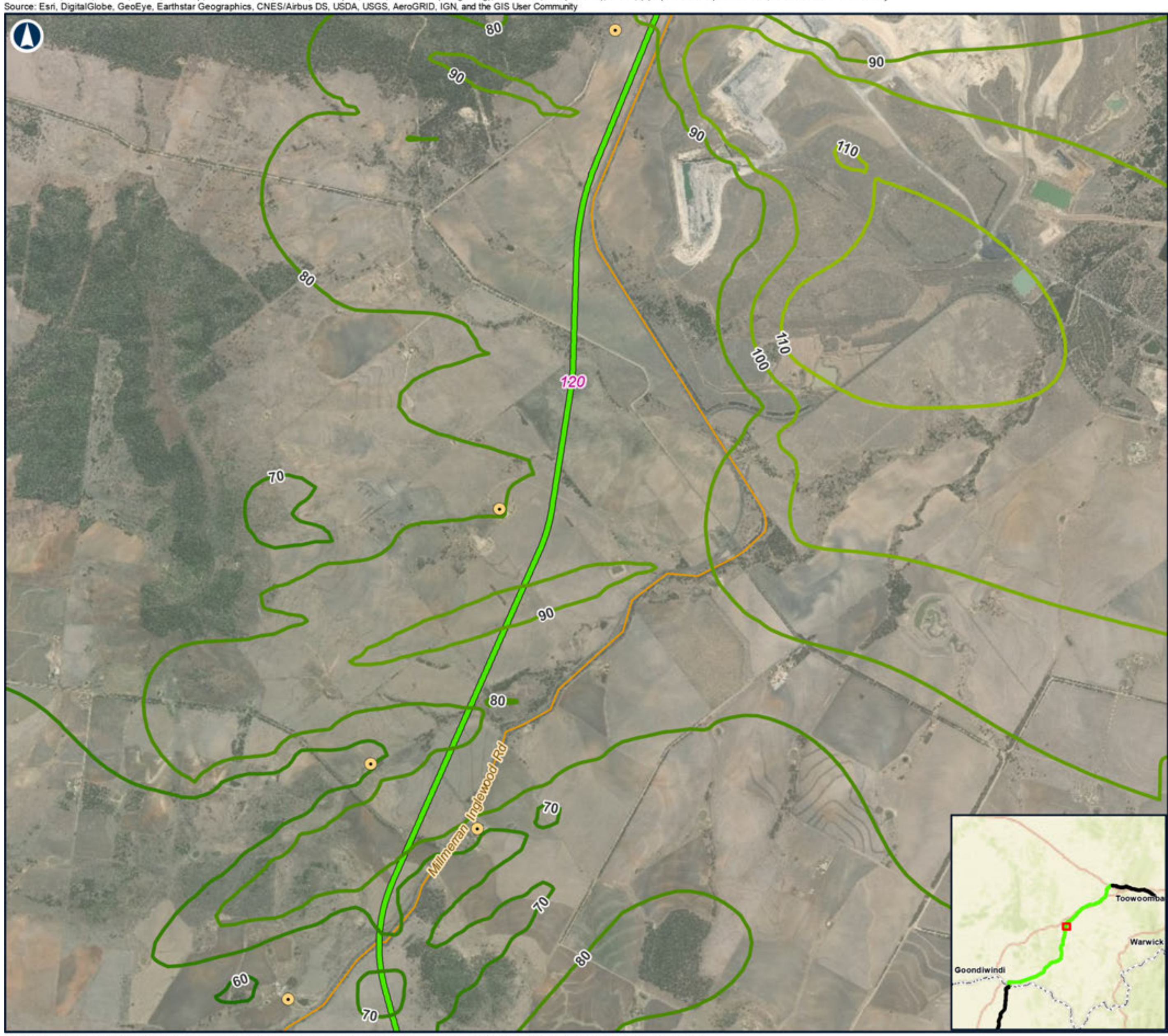


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## BORDER TO GOWRIE

Figure 11.18q: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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Data Sources: FFJV

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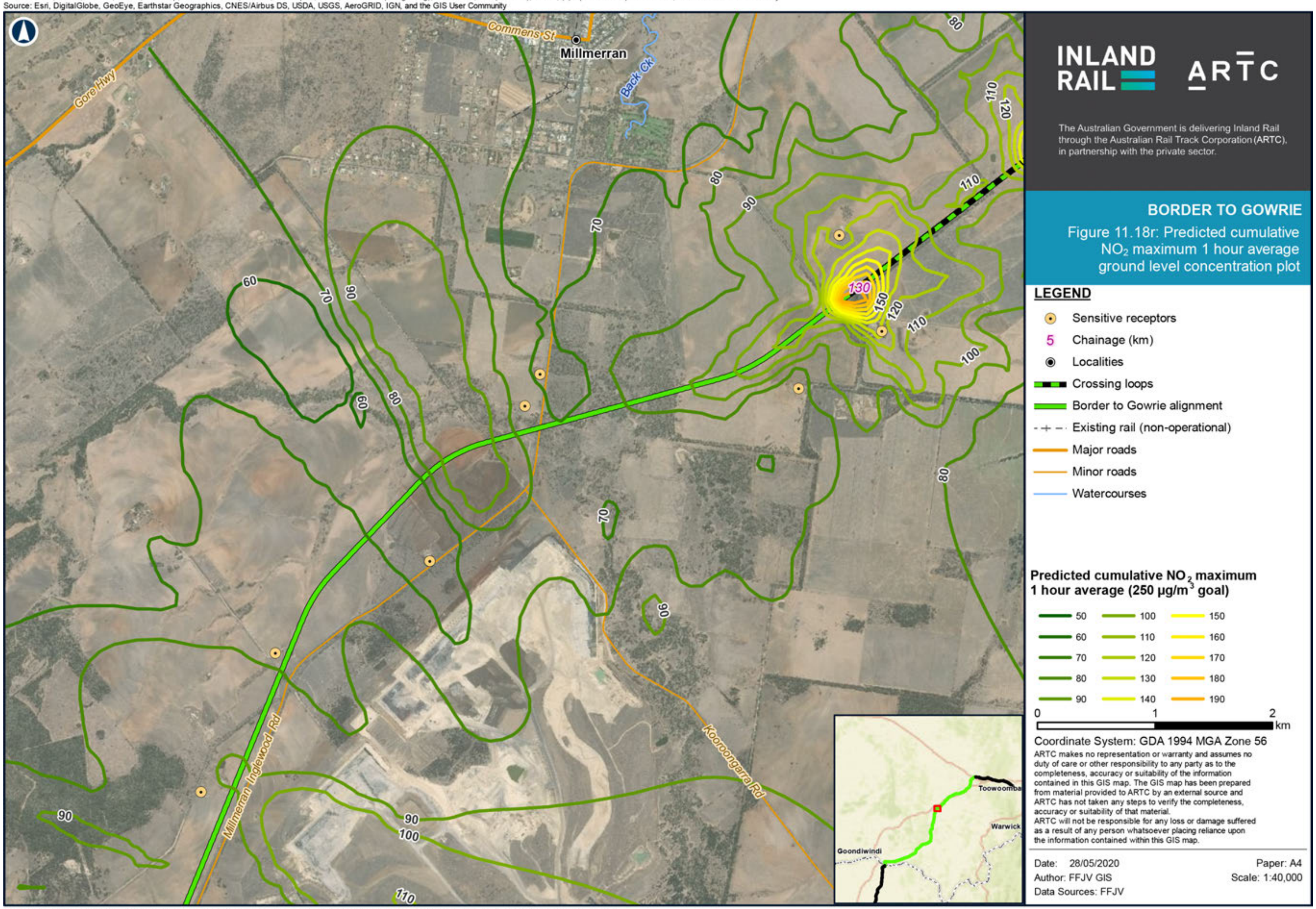


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## BORDER TO GOWRIE

Figure 11.18s: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Crossing loops
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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## BORDER TO GOWRIE

Figure 11.18t: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



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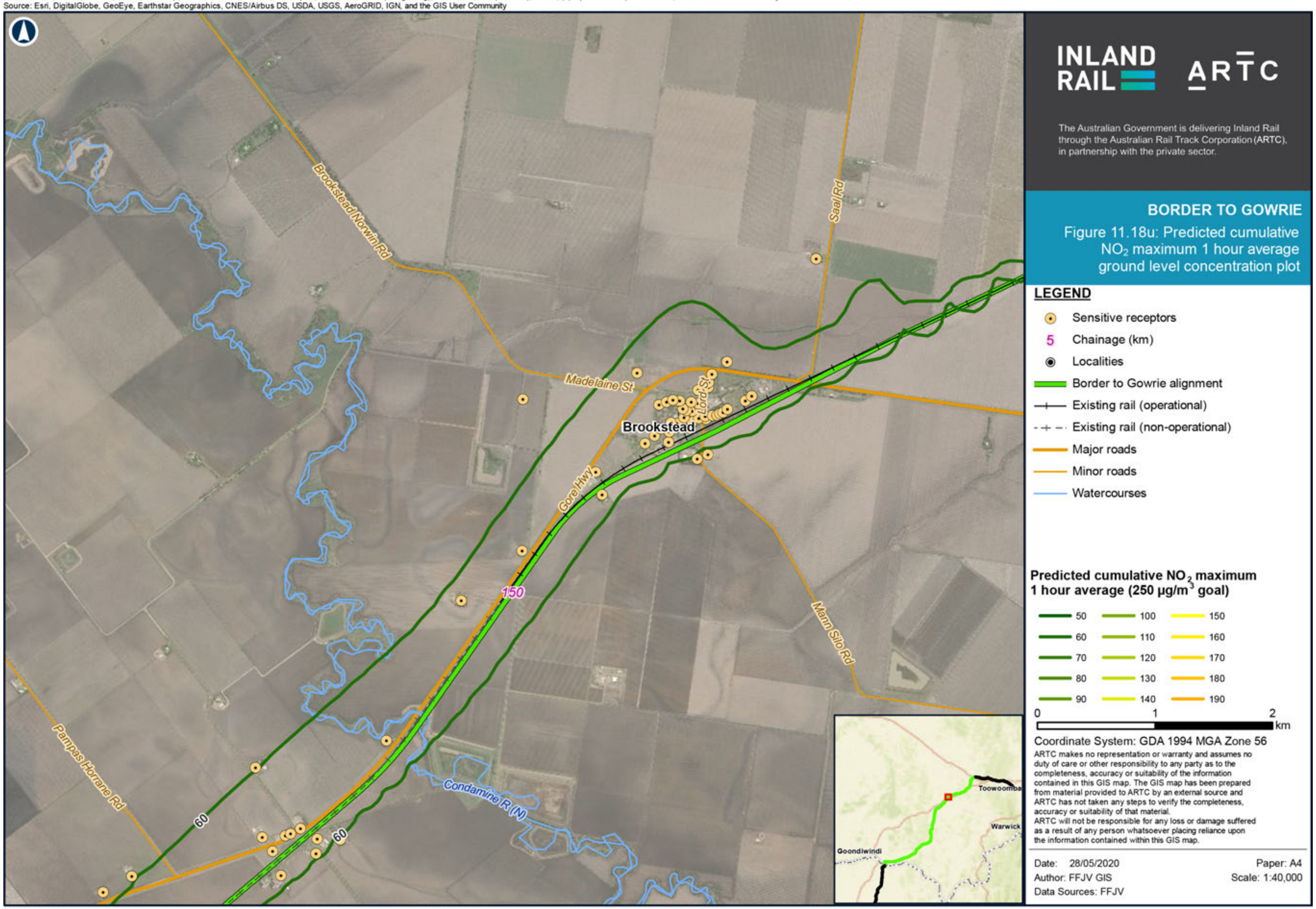


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**BORDER TO GOWRIE**

Figure 11.18v: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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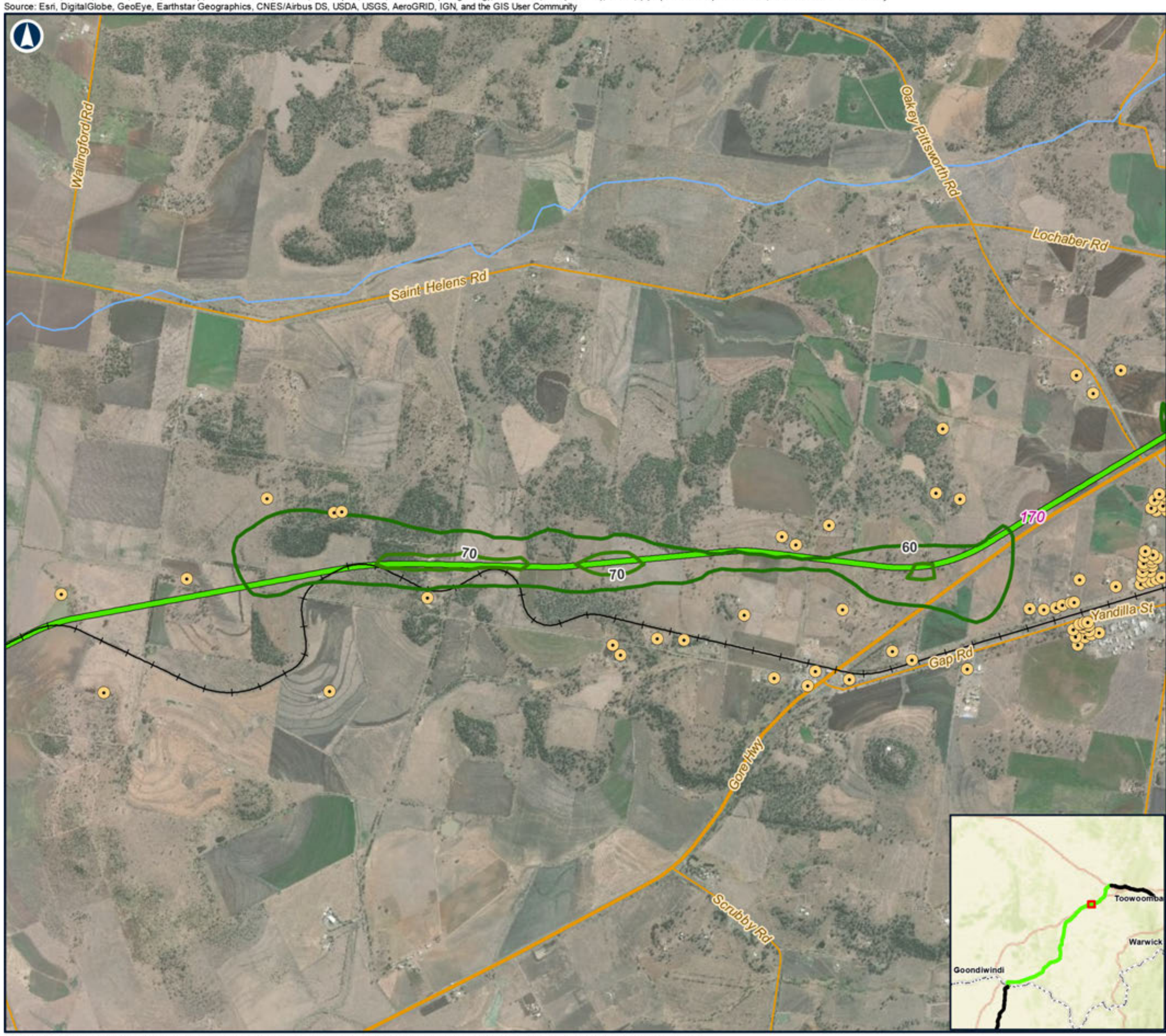


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**BORDER TO GOWRIE**

Figure 11.18w: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/m$^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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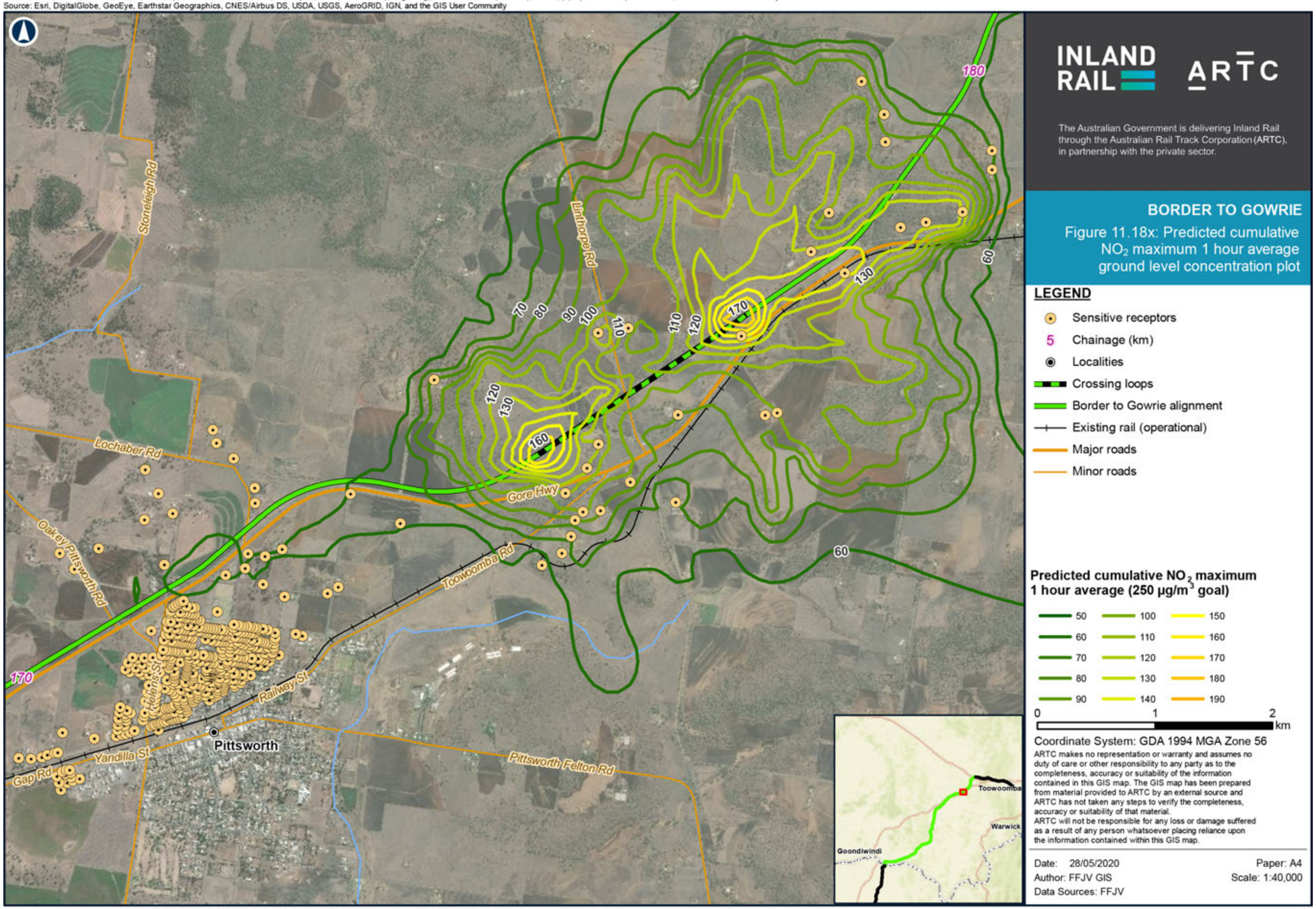


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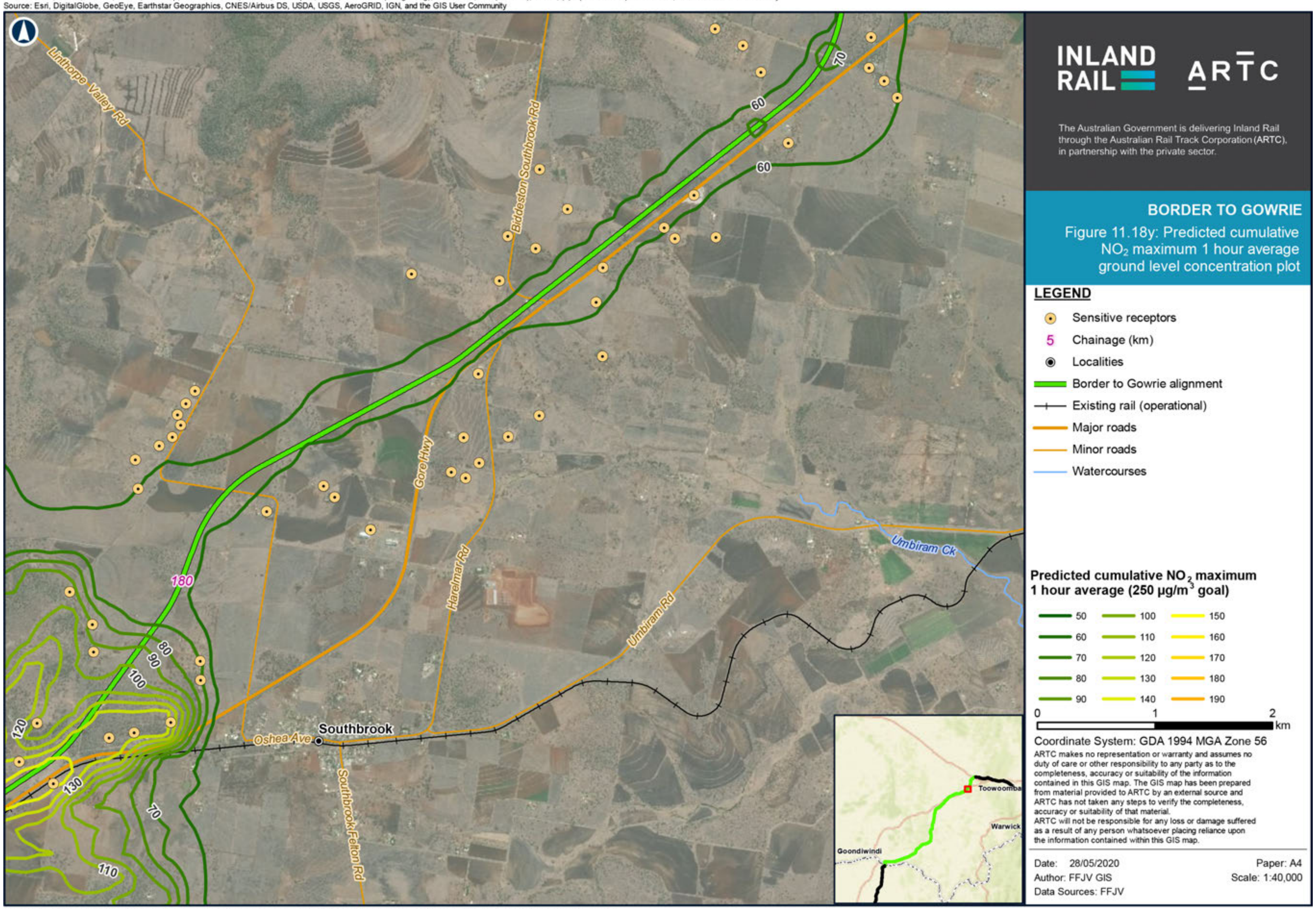


BORDER TO GOWRIE

Figure 11.18y: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

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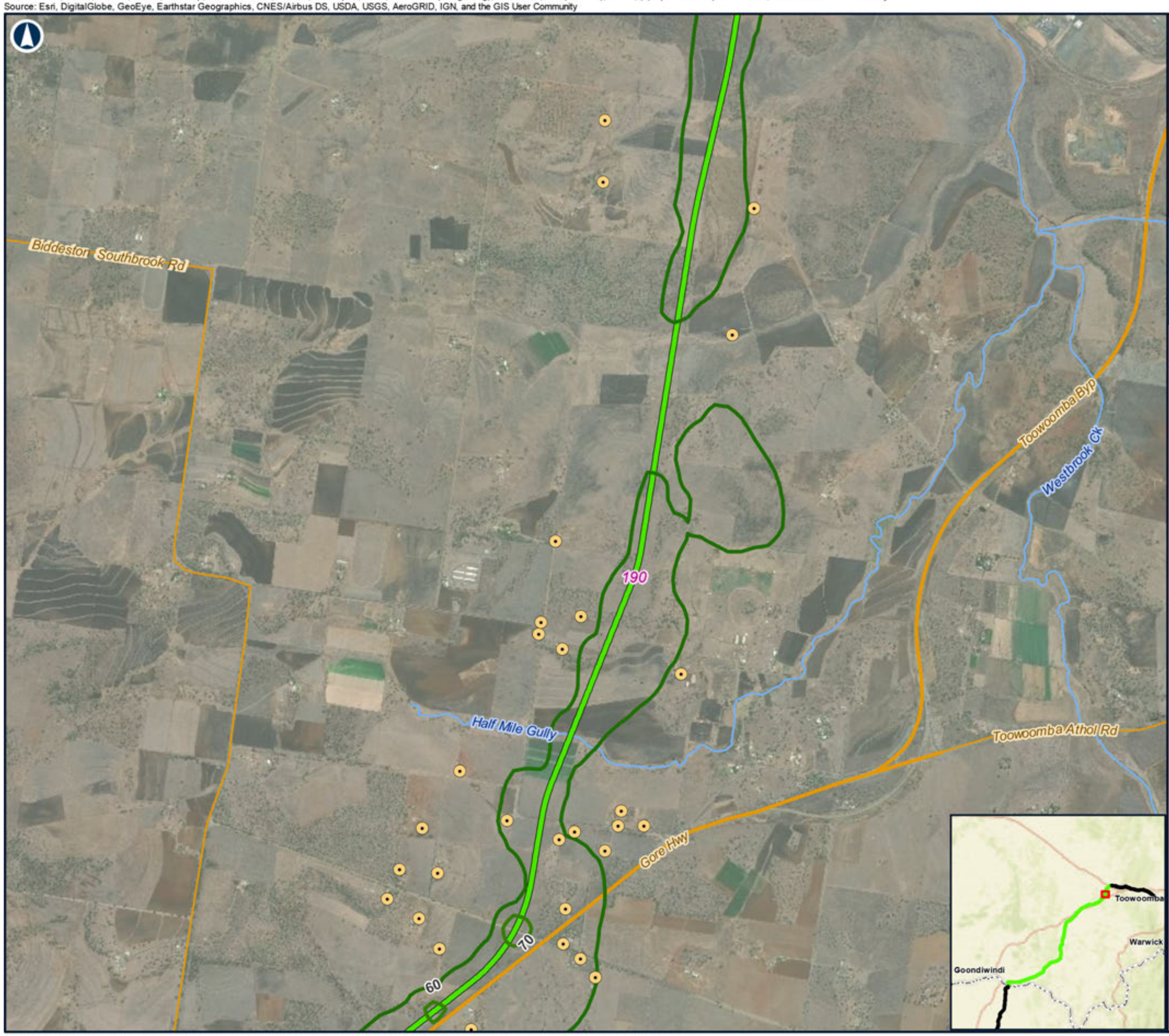


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**BORDER TO GOWRIE**

Figure 11.18z: Predicted cumulative $NO_2$ maximum 1 hour average ground level concentration plot

**LEGEND**

- Sensitive receptors
- 5 Chainage (km)
- Border to Gowrie alignment
- Major roads
- Minor roads
- Watercourses

**Predicted cumulative $NO_2$ maximum 1 hour average (250 µg/$m^3$ goal)**

| | | |
|---|---|---|
| 50 | 100 | 150 |
| 60 | 110 | 160 |
| 70 | 120 | 170 |
| 80 | 130 | 180 |
| 90 | 140 | 190 |

0 1 2 km

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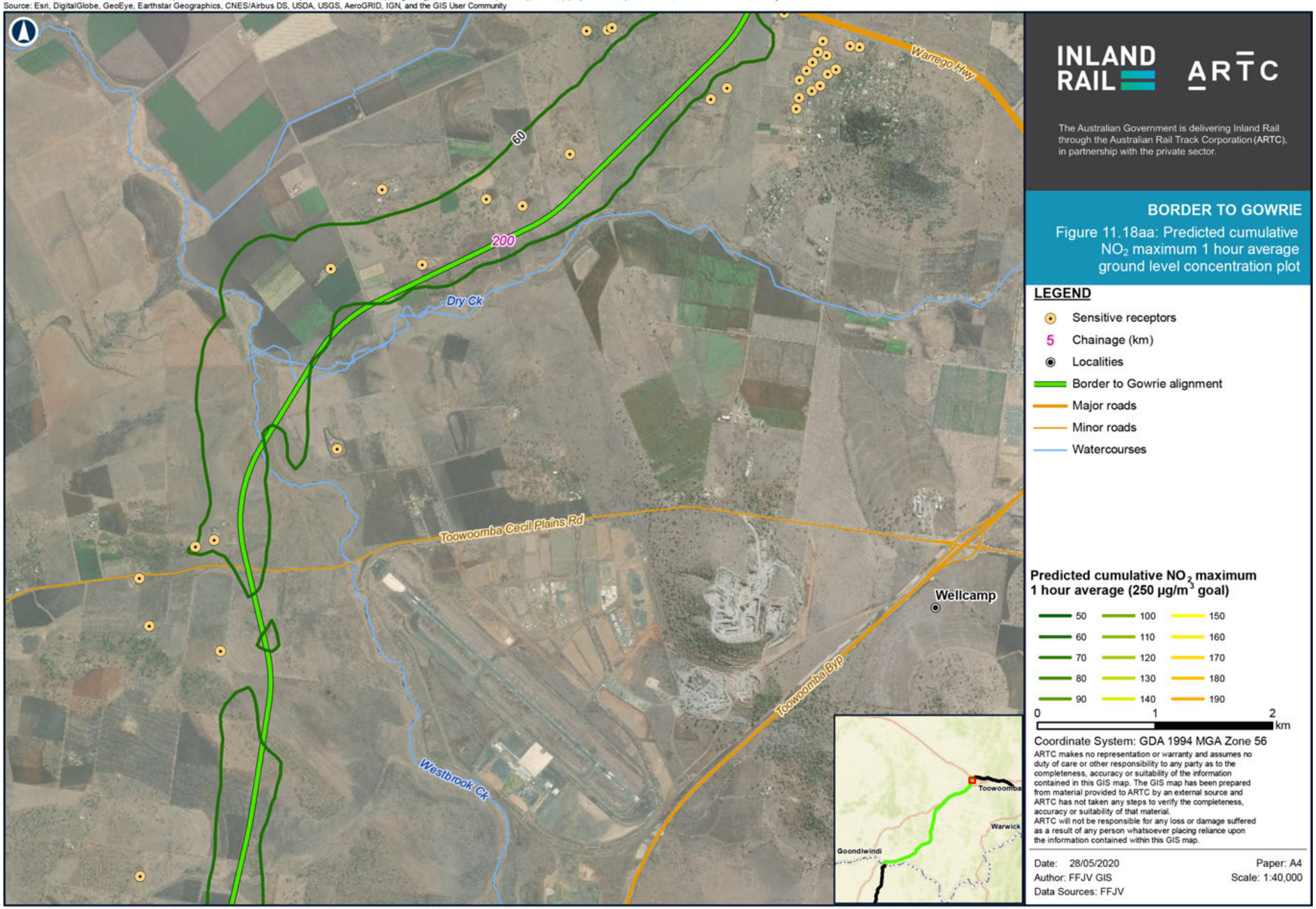


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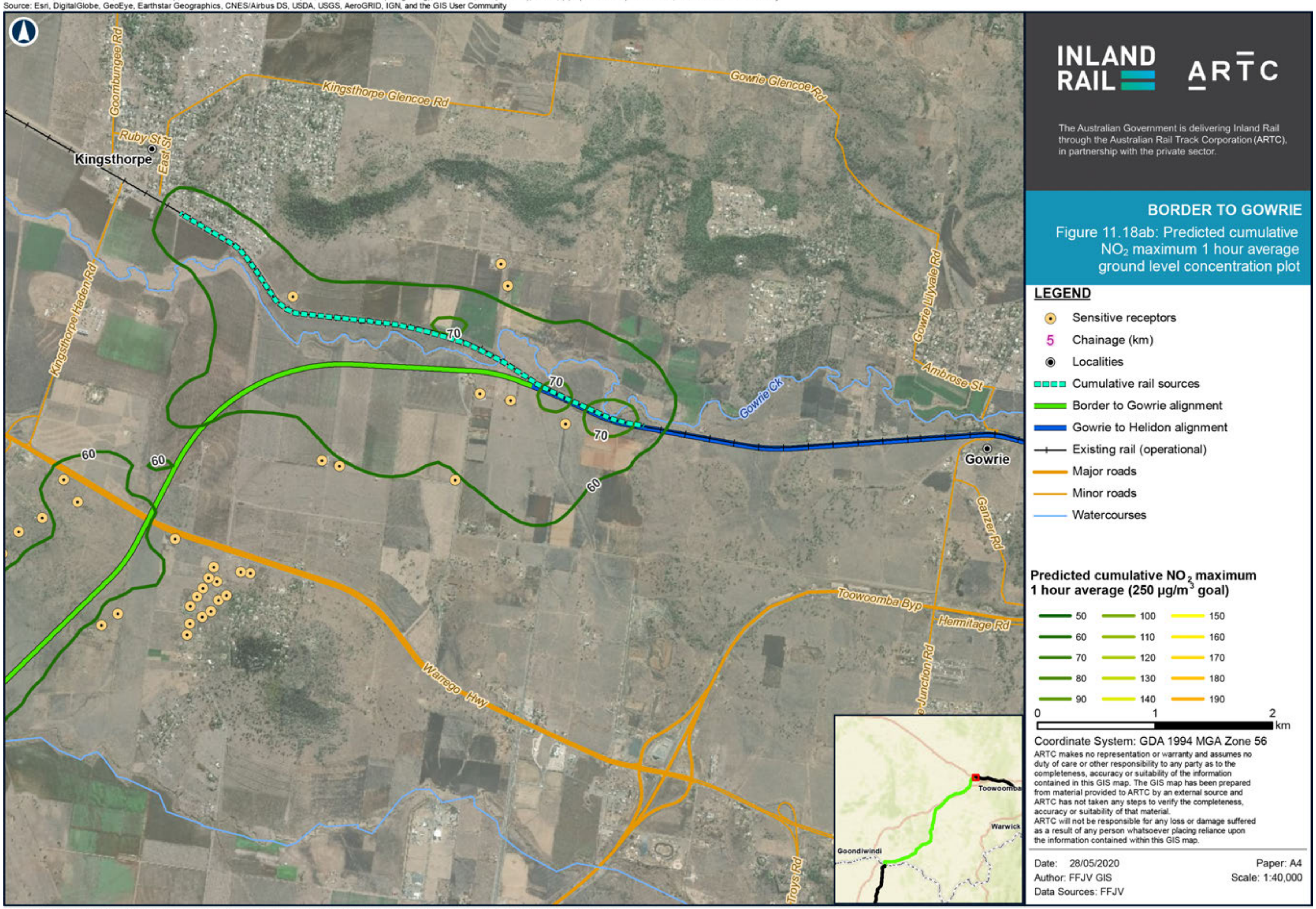


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## 11.9 Mitigation measures and monitoring

This section outlines the air quality mitigation measures that have been identified and incorporated into the reference design for the Project (Section 11.9.1), in addition to those that will need to be implemented through future phases of the Project (Section 11.9.2). It also discusses the air quality monitoring that will be undertaken to support the Project.

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 are provided within the *Guideline for the Assessment of dust from demolition and construction* (UK IAQM, 2014); however, many of these measures are tailored to the UK and are not necessarily applicable for Australia. Where similar conditions do exist, the proposed mitigation measures do align with the suggested mitigation measures from the IAQM guideline document. Mitigation measures prescribed in the *NPI Emission Estimation Technique Manual for Mining* (DSEWPaC, 2012a) are also considered applicable for the construction phase, and selected mitigation measures from this document are proposed.

The mitigation measures that are identified are considered to represent best-practice environmental management of air emissions.

### 11.9.1 Mitigation through the reference design phase

Development of the reference design for the Project has progressed in parallel with the impact assessment process. As a result, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the reference design as appropriate and where possible.

Mitigation measures and controls that have been factored into the reference design, or otherwise implemented during the reference design phase of the Project, are summarised in Table 11.36.

**TABLE 11.36 INITIAL MITIGATION MEASURES OF RELEVANCE TO AIR QUALITY**

| Aspect | Initial mitigation measures |
|---|---|
| Emissions from refuelling activities during construction | ▸ The planning, siting and assessment of potential temporary fuel storage locations has taken into consideration the location of sensitive receptors, to avoid potentially impacting sensitive receptors as far as practical. |
| Emissions from construction vehicles | ▸ The horizontal and vertical alignment has been established to optimise the earthworks required and achieve as close to a net balance as is possible. By minimising the material deficit for construction of the Project, the volume of material required to be imported has been reduced. Less imported material equates to fewer construction truck movements and less vehicular emissions.<br>▸ Construction haulage routes that provide the shortest journey time between origin and destination have been identified. These routes restrict fuel consumption and vehicular emissions. These routes have been assessed as part of the traffic impact assessment in the draft EIS (refer Chapter 18: Traffic, Transport and Access). |
| Fugitive dust emissions (windborne erosion) during construction and operation | ▸ The Project footprint has been established to provide the minimum clearing extents required to safely and efficiently construct and operate the Project, thus minimising the total extent of exposed area where possible<br>▸ Laydown areas and other construction-phase facilities have been located to avoid impacts to environmental and social receptors<br>▸ Embankment batters and other exposed surfaces have been designed to enable stabilisation to reduce fugitive dust emissions<br>▸ An air-quality monitoring station has been installed at a residential dwelling on 524 Millmerran–Inglewood Road, Millmerran (sensitive receptor 188), which is located approximately 1.4 km to the north of Commodore Mine. Monitoring data ($PM_{10}$ and $PM_{2.5}$) from this location will improve understanding of ambient air quality and emissions from the mine and will be used to guide the detail design and finalisation of the construction approach for the Project. Further discussion of the monitoring at this location is provided in Section 11.9.4 |

| Aspect | Initial mitigation measures |
|---|---|
| Emissions from operational locomotives | ‣ The Project has been co-located within existing transport corridors as much as possible, including being positioned within the existing South Western Line and Millmerran Branch Line rail corridors, to avoid introducing a new linear infrastructure corridor in proximity to receptors potentially sensitive to air emissions.<br>‣ 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 | ‣ Crossing loops at Yelarbon, Inglewood, Kooroongarra, Yandilla and Broxburn have been positioned to avoid, where possible, the exposure of sensitive receptors to diesel emissions from idling trains. |

### 11.9.2 Operation considerations

During operation, ARTC will be responsible for management of access to the Inland Rail network by third-party freight train operators and maintenance of the railway and other infrastructure components within the rail corridor.

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

There is presently no foreseeable market-driven demand for coal to be transported on the Inland Rail network, between the NSW/QLD Border and Gowrie; however, the transportation of coal on this section of the network cannot be precluded in future operation years. If coal is to be transported in future operation years, the potential for coal dust generation would require management via a Coal Dust Management Plan (CDMP). The measures included in the CDMP will aim to minimise surface lift-off of materials in transit and establish protocols to minimise spillage onto external areas of wagons. To achieve this, the following measures would be included:

- A requirement for veneering on loaded coal at coal-loading facilities prior to its transportation along the rail network
- Coal washing and moisture management
- Load profiling and use of 'garden bed profile'
- Monitoring of performance.

If a CDMP was required to support future operation years, the plan would be prepared in consultation with the relevant regulatory agency at that time.

### 11.9.3 Proposed mitigation measures

In order to manage and mitigate the Project's risks, several mitigation measures have been proposed for implementation in future phases of Project delivery. These proposed mitigation measures have been identified to address Project-specific issues and opportunities.

Table 11.37 identifies the relevant Project phase, the aspect to be managed and the proposed mitigation measure. For this purpose, proposed mitigation measures of relevance to pre-construction and construction-phase activities have been combined. For several of the mitigation measures proposed, 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* (DSEWPaC, 2012a).

The mitigation measures presented in Table 11.37 have then been factored into the assessment of residual significance, as documented in Table 11.38.

Chapter 22: Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

**TABLE 11.37 AIR QUALITY MITIGATION AND MANAGEMENT MEASURES FOR FUTURE PHASES OF PROJECT DELIVERY**

| Delivery phase | Aspect | Mitigation and management measures |
|---|---|---|
| Detail design | Emissions from construction vehicles | ▶ Haulage routes and access roads will be confirmed for construction of the Project based on the shortest and safest trafficable route for each vehicle type, in consultation with relevant road managers, to minimise vehicular emissions.<br>▶ Planning of haulage routes will seek to maximise the use of sealed trafficable surfaces, where appropriate to do so.<br>▶ Additional geotechnical data will be used to refine the earthworks balance for the Project by providing further confirmation on the expected quantities of reusable, unusable and excess material. The objective of refinement will be to further minimise the material deficit for construction of the Project, thereby reducing the number of vehicular movements as part of the mass haul task.<br>▶ Opportunities to treat and re-use otherwise unusable materials will be identified and assessed for applicability with the objective of minimising vehicular movements and emissions for offsite disposal.<br>▶ Opportunities for the use of ethanol-blend fuels during construction will be investigated. These opportunities will be adopted if found through investigation to be beneficial and if it is practical to do so. |
| | Fugitive dust emissions (windborne erosion) during construction and operation | ▶ The extent of sensitive receptor impacts will be re-assessed through the detail design process once the Project footprint and construction methodology have been confirmed. The location and classification of sensitive receptors in proximity to the finalised Project footprint will be confirmed as part of the re-assessment process.<br>▶ Baseline particulate data ($PM_{10}$ and $PM_{2.5}$) will continue to be collected from the air quality monitoring station on Millmerran–Inglewood Road, Millmerran. Data collected from this station will be used to guide the detail design and finalisation of the construction approach for the Project to ensure that air quality impacts to sensitive receptors are avoided or minimised as much as possible. Data will also enable comparison with $PM_{10}$ and $PM_{2.5}$ data collected during construction of the Project (refer Section 11.9.4 for details).<br>▶ Establish baseline dust deposition data (TSP) prior to construction in proximity to Commodore Mine (e.g. from Ch 120.0 km to Ch 128.0 km). This baseline data will enable comparison with TSP data during construction of the Project. Dust deposition monitoring will be completed at a small number of locations (< 5) adjacent to the Commodore Mine and nearby sensitive receptor locations. Monitoring will occur for a period of three months and will aim to collect data representative of dust-generating activities that occur at the mine, such as blasting, to provide baseline data on the existing air environment. This data will provide an indication of the impact on the local air quality from the nearby Commodore Mine and Millmerran Power Station. Dust deposition monitoring will be conducted in accordance with *AS/NZ 3580.10.1:2003—Determination of Particulate Matter—Deposited matter—Gravimetric method* (Standards Australia, 2003).<br>▶ Development of a Dust Management Sub-plan prior to construction commencing. The sub-plan will include the following measures, tailored to be specific to the construction methodology, once confirmed:<br>  ▶ Minimise major dust-generating activities, e.g. blasting or material loading/unloading, during high wind speeds where practicable and unwatered<br>  ▶ Routing roads away from sensitive areas wherever practically possible, e.g.:<br>    – Residential dwellings and caravan parks<br>    – Motels/hotels<br>    – Schools and kindergartens<br>    – Medical centres<br>    – Public parks and recreation areas.<br>  ▶ Restricting vehicle speeds on unsealed haul roads to reduce dust generation, e.g. to sign-posted speeds on public roads or to construction-site speed limits on construction tracks (nominally 40 km/hr—to be determined through consultation with the relevant local government and documented in the Traffic Management Sub-plan within the CEMP) |

| Delivery phase | Aspect | Mitigation and management measures |
|---|---|---|
| Detail design (continued) | Fugitive dust emissions (windborne erosion) during construction and operation (continued) | ▸ Further speed restrictions on construction tracks (e.g. from 40 km/hr to 20 km/hr) where the trafficable surface is within 200 m of a sensitive receptor<br>▸ Long-term stockpiled material will be covered or seeded to prevent wind erosion from the prevailing wind<br>▸ Regular cleaning of machinery and vehicle tyres to prevent track-out of dust onto public roads<br>▸ Installation of rumble grids or similar at locations where construction traffic departs from the construction site and joins the public road network<br>▸ Internal construction roads will be appropriately surfaced as soon as possible after the commencement of site activities<br>▸ Revegetating disturbed areas as soon as practicable, in accordance with the Rehabilitation and Landscaping Management Sub-plan<br>▸ Vehicles and equipment will be appropriately maintained to maximise fuel efficiency<br>▸ Visual monitoring of the effectiveness of dust controls will occur on a daily basis.<br>▸ Define and design temporary access tracks to minimise dust generation, e.g. appropriate surface treatments for the predicted construction traffic movements, installation of rumble grids, concrete pads or other physical measures to reduce track-out.<br>▸ Establish designated stockpile locations within the Project corridor. |
| | Emissions from operational locomotives | ▸ The vertical alignment of the rail will be subject to refinement and confirmation through the detail design. Opportunities to further optimise the track geometry will be assessed to reduce operational fuel consumption. |
| | Emissions from idling locomotives | ▸ Detail design of the railway corridor will be developed to minimise impacts to sensitive receptors from emissions from idling locomotives, through consideration of topography, gradients, landscaping treatments and other surface treatments, where practical.<br>▸ The confirmation of the location of the five crossing loops for the Project will seek to minimise the number of receptors in proximity to each loop. |
| Pre-construction and construction[1] | Impacts to sensitive receptors | ▸ If on-site wastewater treatment systems are required for accommodation, these systems will be planned and positioned in accordance with separation distances consistent with the EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013) and operated and maintained in accordance with conditions of approval (sought separately to approval sought through the EIS). Based on the anticipated requirement for a treatment system with a capacity of 300 EP, and assuming that a mechanical or biological wastewater treatment system will be used, a minimum separation distance of 67 m to sensitive receptors will be provided.<br>▸ Laydown areas and other construction facilities (e.g. concrete batching plant, flash-butt welding facility) will be planned to ensure that sources of emissions, such as temporary fuel tanks and generator sets, are positioned as far as possible from neighbouring sensitive receptors, within the confines of the construction footprint. |

| Delivery phase | Aspect | Mitigation and management measures |
|---|---|---|
| Pre-construction and construction[1]<br><br>(continued) | Dust generation from earthworks, clearing and grubbing, construction activities and exposed areas within the construction footprint | - Limit clearing to the extent required to construct the works, in accordance with the Project footprint defined during detail design.<br>- Stage clearing and grubbing activities to limit the size and duration of exposed areas<br>- Implement controls to prevent or minimise dust generation during activities involving excavation or disturbance of soils or vegetation, or handling ballast, e.g.:<br>  - Use of water sprays or water carts for dust suppression, as required (anticipated emission reduction of 50 per cent for water sprays when loading to or from material stockpiles, anticipated emission reduction of 70 per cent when water sprays applied to trucks unloading material)<br>  - Installation of hoardings or barriers on worksite perimeters, where appropriate<br>  - Polymer sealing of access roads, or similar, where practicable within the construction worksites and ensuring sealed access roads into worksites are kept relatively dust free by regular sweeping and washing, wherever needed (emission reduction of up to 100 per cent is possible for polymer sealing subject to the sealing method adopted)<br>  - Conducting demolition activities using appropriate dust controls, such as water sprays<br>  - Installing truck wheel wash stations in designated laydown areas, to control the spread of unsuitable materials from worksites.<br>- Determination of which dust controls to apply in a given instance will be guided by the objective to minimise the use of water during construction to that absolutely necessary.<br>- Water used in dust suppression will be consistent with the quality requirements specified for irrigation and general water use in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2018). Investigate suitable additives to the water to improve dust-suppression effectiveness and minimise water usage. Adopt the use of additives where appropriate and compliant with relevant approvals and legislation (i.e. the addition of soil binders to water for dust suppression on roads or hard stand areas).<br>- Stabilise disturbed areas and exposed surfaces as soon as practical following the completion of works in each area, in accordance with the Rehabilitation and Landscaping Management Sub-plan (refer to Chapter 8: Land Resources). The following mitigation methods may be used subject to the final purpose of the exposed area:<br>  - Initial establishment of vegetation (anticipated emission reduction of 30 per cent)<br>  - Maintained revegetation (anticipated emission reduction of 90 per cent)<br>  - Establishment of self-sustaining rehabilitation vegetation (anticipated emission reduction of 100 per cent).<br>- Sealing of exposed surface (i.e. concrete, asphalt, etc.) (anticipated emission reduction of 100 per cent). Long-term stockpiles will be avoided wherever possible; however, where necessary (e.g. topsoil), long-term stockpiles will be established in designated locations. Stockpiles will be positioned to minimise erosion by the prevailing wind.<br>- Stabilise and protect long-term stockpiles from erosive processes while not in use, such as through impermeable cover or seeding.<br>- To reduce wind erosion from stockpiles, the following mitigation methods may be used subject to water availability and stockpile activity:<br>  - Water sprays (anticipated emission reduction of 50 per cent)<br>  - Wind breaks or earthworks profiling (anticipated emission reduction of 30 per cent)<br>  - Application of rock armour/covering (anticipation emission reduction of 30 per cent).<br>- Covering of the stockpile with an impermeable covering (i.e. tarpaulin) or binding agent (anticipated emission reduction of 100 per cent). If water sprays are implemented for stockpiles, the application rate of water will be increased for stockpiles, which will receive new material regularly. |

| Delivery phase | Aspect | Mitigation and management measures |
|---|---|---|
| Pre-construction and construction[1]<br>(continued) | Dust generation from earthworks, clearing and grubbing, construction activities and exposed areas within the construction footprint<br>(continued) | ▸ Direct exposure of construction workers to respirable silica and other airborne contaminants will be controlled through the use of appropriate personal protective equipment in line with ARTC's Work Instruction for Personal Protective Equipment (WHS-WI-315) (available on the ARTC extranet)<br>▸ Construction speed limits will apply to all unsealed routes used by construction vehicles. Applicable speed limits for local government roads will be determined through consultation with the relevant local government and documented in the Traffic Management Sub-plan within the CEMP (refer to Chapter 22: Outline Environmental Management Plan).<br>▸ Minimising the requirement for vehicle movement outside worked areas, where practically possible<br>▸ Landowners will be notified in advance of the commencement of construction activities in an area proximal to them. This notification will be in accordance with community notification procedures established for the Project and will provide information on the types of activities that will occur, indicative scheduling and the potential impacts that may be experienced (e.g. generation of dust).<br>▸ A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction.<br>▸ In the event of a dust complaint, ARTC will:<br>  ▸ In the first instance, investigate the cause of the complaint<br>  ▸ Determine appropriate remedial action<br>  ▸ Liaise with administering authority and/or complainant over remedial action<br>  ▸ Implement appropriate remedial action.<br>▸ Maintain a complaints register relating to air quality, including record of remedial actions. |
| | Dust generation and deposition as a result of adverse weather conditions | ▸ Avoid ground-disturbing activities during windy conditions (i.e. winds > 36 km/hr). When this is not practical, implement additional management measures, such as enhanced watering of access roads (anticipated emission reduction of 50 to 75 per cent) and works areas to minimise the potential increase in dust generation.<br>▸ Monitor meteorological conditions at worksites and designated stockpile locations, particularly wind speed and direction. Implement additional dust suppression controls prior to the onset of adverse weather, including covering of stockpiles (anticipated emission reduction of 100 per cent for impermeable cover) and additional watering of access roads (anticipated emission reduction of 50 to 75 per cent).<br>▸ Maintain and improve (if necessary) weather-monitoring protocols to enable dust-suppression activities to occur prior to the onset of adverse weather. |
| | Cumulative effects of dust emissions from construction and external land uses or activities | ▸ Undertake dust deposition (TSP) monitoring during the active period of construction in proximity to the Commodore Mine, at locations where baseline data was collected (refer above), to determine if construction results in significant dust impacts. Dust deposition monitoring to be in accordance with AS/NZ 3580.10.1:2003 *Determination of Particulate Matter—Deposited matter—Gravimetric method* (Standards Australia, 2003). The results of construction dust deposition monitoring will be included in construction environmental reporting.<br>▸ Advise the operators of the Commodore Mine of proposed construction activities scheduled to occur in proximity to the mine, to enable coordinated consultation with potentially impacted stakeholders. |

| Delivery phase | Aspect | Mitigation and management measures |
|---|---|---|
| Pre-construction and construction[1] (continued) | Emissions from combustion engines (construction vehicles and generators) | ▸ Avoid queuing of the construction traffic vehicle fleet on public roads, which in turn would minimise the amount of exhaust emissions generated during construction works<br>▸ Marshalling and queuing of trucks and worksite vehicles to occur away from residential areas and other sensitive receptors, where possible<br>▸ Direct exhaust emissions from mobile and stationary plant away from the ground and sensitive receptors, where possible<br>▸ When locating temporary fuel storage, provide a minimum separation distance of 50 m from sensitive receptors and compliance with Australian Standard AS 1940:2017 *The storage and handling of flammable and combustible liquids* (Standards Australia, 2017a). This is of particular relevance where laydown facilities are in proximity to sensitive receptors, e.g. B2G–LDN006.3 on Yelarbon–Kurumbul Road (refer to Table 11.31).<br>▸ Minimise the use and intensity of diesel engines, as much as practicable<br>▸ For stationary plant and equipment, ensure all diesel motors are fitted with emission control measures and are regularly maintained to manufacturer's specifications<br>▸ Turn off idling plant, equipment and vehicles when not in use.<br>▸ Minimise haul distances between construction sites and spoil sites<br>▸ Implement a regular maintenance program to ensure equipment and construction fleet are maintained to manufacturer's specifications<br>▸ Use appropriately sized equipment for construction activities<br>▸ Procure energy efficient construction equipment, when appropriate<br>▸ Minimise waste from construction by procuring pre-fabricated products, where possible<br>▸ Where possible, use low-energy intensity materials instead of high-energy intensity building materials<br>▸ Minimise haul distances between construction sites to spoil sites<br>▸ Implement a regular maintenance program to ensure equipment and construction fleet are maintained to manufacturer's specifications<br>▸ Use appropriately sized equipment for construction activities. |
| | Fugitive dust emissions from vehicles transporting materials to and from site | ▸ Vehicles transporting material to and from the maintenance works site on public roads will cover loads to prevent wind-blown dust emissions and spillages<br>▸ Visually inspect vehicles entering/exiting the site and implement additional controls if corrective actions are required<br>▸ Install rumble grids, or similar, at the entry and exit points of laydown areas<br>▸ Site-based construction traffic is limited to identified haul routes as per the Traffic Management Sub-plan. |
| | Potential greenhouse gas (GHG) emissions (other than combustion engine emissions) | ▸ Procure energy efficient construction equipment, when appropriate<br>▸ Minimise waste from construction by procuring pre-fabricated products, where possible<br>▸ Where possible, use low-energy intensity materials instead of high-energy intensity building materials. |
| Operation | Particulate matter and other emissions from freight on operation locomotives | ▸ Before a train travels on the Inland Rail network, operators will make sure that the classes of dangerous goods, and the identification numbers of vehicles carrying dangerous goods, are recorded in the train consist documentation. Dangerous goods will be loaded, labelled, and marshalled in accordance with the Australian Dangerous Goods Code.<br>▸ If coal is to be transported in future operation years, the potential for coal dust generation will require management via a CDMP. The measures included in the CDMP will aim to minimise surface lift-off of materials in transit and establish protocols to minimise spillage onto external areas of wagons. The plan will be prepared in consultation with the relevant regulatory agency at the time. |

| Delivery phase | Aspect | Mitigation and management measures |
| --- | --- | --- |
| Operation (continued) | Emissions from combustion engines (construction vehicles and generators) | ▸ Maintenance plant, vehicles and machinery will be maintained and operated in accordance with manufacturer's recommendations to maximise fuel efficiency<br>▸ Minimise unnecessary travel between maintenance locations<br>▸ Turn off idling plant, equipment and vehicles when not in use. |
| | Stakeholder communication | ▸ Landowners will be notified in advance of the commencement of maintenance activities in an area proximal to them. This notification will be in accordance with community notification procedures established for the Project and will provide information on the types of activities that will occur, indicative scheduling and the potential impacts that may be experienced (e.g. generation of dust).<br>▸ A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust during operation and maintenance<br>▸ In the event of a dust complaint, ARTC will:<br>  ▸ In the first instance, investigate the cause of the complaint<br>  ▸ Determine appropriate remedial action<br>  ▸ Liaise with administering authority and/or complainant over remedial action<br>  ▸ Implement appropriate remedial action.<br>▸ Maintain a complaints register relating to air quality, including remedial actions<br>▸ Monitor, record and audit complaints about dust and emissions in accordance with the relevant complaints management handling procedures. |
| | Fugitive dust emissions from vehicles transporting materials to and from site (e.g. for maintenance) | ▸ All operational personnel are aware of the sensitivities regarding elevated dust levels within and adjacent to the Project footprint<br>▸ Vehicles transporting material to and from the maintenance works site on public roads will cover loads to prevent wind-blown dust emissions and spillages<br>▸ Visually inspect vehicles entering/exiting the site and implement additional controls if corrective actions are required<br>▸ During adverse wind conditions, visual inspection of stockpiles will be conducted and mitigation procedures implemented if required. |

**Table notes:**

1. Combined, as there is no distinction between mitigation measures applicable for pre-construction and construction phases of the Project.

### 11.9.4 Monitoring

#### 11.9.4.1 Particulate matter

Based on assumed background concentrations and estimates of pollutant emissions from the Commodore Mine and Millmerran Power Station, an exceedance of the $PM_{10}$ 24-hour air quality goal of 50 µg/m$^3$ is predicted at sensitive receptor 186, located approximately 1.1 km to the north of Commodore Mine (see Section 11.8.3.1). Due to uncertainties with respect to emissions from the mine and an absence of monitoring data in the area local to the mine and power station, there is uncertainty with respect to the accuracy of predicted cumulative concentrations at sensitive receptors in the area near the mine and power station, including at receptor 186.

To improve the understanding of background air quality in this area, an air quality monitoring station has been installed at a location representative of receptors near the mine and power station.

The monitoring station is located at 524 Millmerran–Inglewood Road, Millmerran, and is referred to as the Millmerran AQMS. The location of the Millmerran AQMS is shown in Figure 11.19. The monitoring location is approximately 1.4 km north of the Commodore Mine, and approximately 300 m north of sensitive receptor 186.

Consistent with the pollutants of concern for the assessment, the Millmerran AQMS monitors concentrations of $PM_{10}$ and $PM_{2.5}$ and measures meteorological conditions. Consistent with the methodology for the Inland Rail AQMS, monitoring is undertaken using Beta Attenuation Monitoring in accordance with AS/NZS 3580.9.11:2016 ($PM_{10}$) and AS/NZS 3580.9.12:2013 ($PM_{2.5}$). The monitoring station has been positioned in accordance with requirements listed in AS/NZS 3580.1.1:2016.

Monitoring at the Millmerran AQMS has started, however, at the time of reporting, insufficient measurement data was available.

Monitoring data from this location will be used to guide the detail design and finalisation of the construction approach for the Project to ensure that air quality impacts to sensitive receptors are avoided or minimised as much as possible.

#### 11.9.4.2 Dust deposition

**Baseline data**

Baseline dust deposition (TSP) monitoring will be conducted prior to the commencement of construction in proximity to the Commodore Mine. This baseline data will enable comparison with TSP data obtained during construction of the Project. Dust deposition monitoring will be completed at a small number of locations (< 5) adjacent to the Commodore Mine and nearby sensitive receptor locations.

Monitoring will occur for a period of three months and will aim to collect data representative of dust-generating activities that occur at the mine, such as blasting, to provide baseline data on the existing air environment. This data will provide an indication of the impact on the local air quality from the nearby Commodore Mine and Millmerran Power Station. Dust deposition monitoring will be conducted in accordance with *AS/NZ 3580.10.1:2003—Determination of Particulate Matter—Deposited matter—Gravimetric method* (Standards Australia, 2003).

**Construction phase monitoring**

Dust deposition (TSP) monitoring will be conducted during the active period of construction in proximity to the Commodore Mine (e.g. from Ch 120.0 km to Ch 128.0 km), at locations where baseline data was collected (refer above), to determine if construction results in significant dust impacts. Dust deposition monitoring will be in accordance with *AS/NZ 3580.10.1:2003—Determination of Particulate Matter—Deposited matter—Gravimetric method* (Standards Australia, 2003). The results of construction-phase dust deposition monitoring will be included in construction environmental reporting, as specified in Chapter 22: Outline Environmental Management Plan.

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.

**BORDER TO GOWRIE**

Figure 11.19: Millmerran monitoring location

**LEGEND**

- Millmerran AQMS
- Existing emission source
- Sensitive receptors
- 5 Chainage (km)
- Localities
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56



Date: 29/05/2020 Paper: A4
Author: FFJV GIS Scale: 1:50,000
Data Sources: FFJV

Map by: NCW Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_ARTC_Fig11.19_Millmerran_Monitoring_Location.mxd Date: 28/05/2020 14:33

## 11.10 Impact assessment summary

Potential construction phase impacts to air quality and sensitive receptors have been assessed qualitatively, as presented in Section 11.8.1, in accordance with the methodology introduced in Chapter 4: Assessment Methodology and described in Section 11.6.2.

This section provides a summary of the potential significance of construction phase impacts to air quality and sensitive receptors before and after the application of mitigation measures through future phases of Project delivery. A quantitative (compliance) assessment has been undertaken for potential operation impacts, as predicted concentrations at sensitive receptors have been assessed against legislative and other nominated air-quality goals (refer Section 11.5); therefore, operation-phase impacts are omitted from discussion in this section. The results of the quantitative assessment of potential operation impacts are detailed in Section 11.8.3 and mitigation measures for the operational phase of the Project are included in Section 11.9.

The initial impact assessment is undertaken on the assumption that the design considerations (or initial mitigation measures) factored into the reference design phase (refer Table 11.36) have been implemented.

Additional mitigation and management measures (refer Table 11.37) were then applied to future phases of the Project to further reduce the level of potential impact and derive a residual significance of impact.

The initial and residual significance of potential impacts are presented in Table 11.38 to demonstrate the effectiveness of mitigation measures. This table has been structured to maintain consistency with the IAQM methodology, which is activity based and, as such, earthworks and track-out are assessed across both the pre-construction and construction phase.

The IAQM construction dust assessment 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".*

Consistent with the IAQM statement, it is expected that with effective implementation of the proposed mitigation measures, the impacts to air quality with respect to dust deposition and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures, the construction of the Project is not anticipated to significantly adversely impact the environmental values of human health and the aesthetic environment.

**TABLE 11.38 IMPACT ASSESSMENT FOR POTENTIAL AIR QUALITY IMPACTS ASSOCIATED WITH CONSTRUCTION**

| | | | | Initial significance[2] | | Residual significance[3] | |
|---|---|---|---|---|---|---|---|
| Activity | Aspect[1] | Potential impact | Receptor sensitivity | Emission magnitude | Significance | Emission magnitude | Significance |
| Demolition | All dust-generating sources associated with demolition | Dust soiling | Medium | Small | Low | Small | Low |
| | | Human health | Low | Small | Negligible | Small | Negligible |
| Earthworks associated with pre-construction and construction phase | All dust-generating sources associated with pre-construction and construction phase earthworks | Dust soiling | Medium | Large | Medium | Small | Low |
| | | Human health | Low | Large | Low | Small | Negligible |
| Construction | All dust-generating sources associated with construction phase for the Project | Dust soiling | Medium | Large | Medium | Small | Low |
| | | Human health | Low | Large | Low | Small | Negligible |
| Track-out associated with pre-construction and construction phase | All dust-generating sources associated with pre-construction and construction phase traffic associated with the Project | Dust soiling | Medium | Large | Medium | Medium | Low |
| | | Human health | Low | Large | Low | Medium | Low |

**Table notes:**

1. Refer Table 11.37 for reference to the proposed additional mitigation measures relevant to each aspect.
2. Includes implementation of initial mitigation measures specified in Table 11.36.
3. Assessment of residual risk once the mitigation measures identified in Table 11.36 and Table 11.37 have been applied.

## 11.11 Cumulative impacts

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered. This section provides a discussion on the potential for cumulative impacts in relation to air quality during the construction phase of the Project. As stated in Section 11.6.4.1, the assessment of operation phase air quality impacts has incorporated the emission contributions of existing or planned developments that are, or will be, a significant source of pollutants of interest that are also relevant to the Project. The potential cumulative impacts to air quality during operation of the Project are presented in Table 11.33. Therefore, the cumulative impact discussion in this section is confined to construction-phase impacts.

Further details on the potential for cumulative impacts to arise as a result of the Project, in combination with others, is presented in Chapter 21: Cumulative Impacts. Details on the assessment methodology for cumulative impacts is presented in Chapter 4: Assessment Methodology.

A total of 23 projects were initially identified as having the potential to contribute to cumulative impacts in combination with the Border to Gowrie Project. These projects are either currently operational, expected to undergo future expansion or are currently going through an approval process.

Dust is predicted to be the primary emission from the Project during construction. The IAQM guidance document specifies that receptors located 350 m or more from a dust-generation source are expected to have a sensitivity to human health impacts that is 'low' (refer to Table 11.26). Therefore, for the purposes of construction air quality, projects that directly interface the Border to Gowrie Project and will have temporal overlap in construction or expansion activities are considered to have the potential to result in cumulative impacts. Only 5 of the initial 23 projects identified meet these criteria. These projects are listed in Table 11.39.

**TABLE 11.39 PROJECTS CONSIDERED FOR THE CUMULATIVE IMPACT ASSESSMENT**

| Projects | Location | Description | Construction dates |
|---|---|---|---|
| InterLinkSQ | 13 km west of Toowoomba<br>The northern limit of the Project is situated adjacent to the InterLinkSQ site | A 200 ha transport, logistics and business hub. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways. | 2018–TBC |
| Commodore Mine and Millmerran Power Station | Domville, Queensland<br>The Project is aligned adjacent to potential future coal reserves for the mine | The Commodore Mine is an open-cut coal mine, which provides coal for the 850 MW Millmerran Power Station (Mininglink, n.d.).<br>The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 M homes (Power Technology, 2018). | Operational, but subject to possible future expansion of footprint |
| North Star to NSW/QLD Border (Inland Rail) | Rail alignment from North Star, NSW to the NSW/QLD border<br>Adjoins the Project at its southern limit | New 37 km rail corridor to connect North Star (NSW) to the QR Rail South West Rail Line just north of the NSW/QLD border. | 2021–2024 |
| Gowrie to Helidon (Inland Rail) | Rail alignment from Gowrie to Helidon, Queensland<br>Adjoins the Project at its northern limit | New 26 km dual-gauge track between Gowrie (northwest of Toowoomba) and Helidon (east of Toowoomba), extending through the LGAs of Toowoomba and Lockyer Valley. The Project includes a 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range. | 2021–2025 |
| Asterion Medicinal Cannabis Facility | Wellcamp, Queensland<br>Located adjacent to the eastern construction footprint boundary of the Project. The facility will be located between the Project and the Toowoomba Wellcamp Airport | A high-tech medicinal cannabis cultivation, research and manufacturing facility. The project involves construction of a 40-hectare glasshouse to produce 20,000 plants per day at full capacity. Medicinal-grade cannabis grown at the facility will be manufactured into a range of medicinal products, including single patient packs, cannabis oils, gels, salts and related products, destined solely for the medicinal market. The facility will be powered by renewable energy. | 2020–2021 |

With the exception of InterLinkSQ and the Asterion Medicinal Cannabis Facility, the operational cumulative impacts of the projects listed in Table 11.39 have been explicitly included in the quantitative air quality impact assessment. The operations of the InterLinkSQ and Asterion Medicinal Cannabis Facility are not anticipated to generate significant emissions and do not require assessment.

An assessment of cumulative impacts that may arise from the projects listed in Table 11.39 in combination with the construction of the Project is presented in Table 11.40.

Due to the mostly isolated nature of construction phase emissions from the Project, the potential for cumulative impacts to arise with adjoining projects is considered to be low. Where cumulative impacts have been assessed as low significance, there are unlikely to be long-term cumulative impacts, providing that all assessable projects apply mitigation measures that are consistent with those proposed for this Project. Consequently, the potential for cumulative impacts to arise will be managed through implementation of mitigation measures specified in Table 11.37.

Consultation with potentially affected landowners and other stakeholders, including proponents of non-Inland Rail projects that interface with this Project, may result in additional mitigation measures of relevance being identified during the detail design process. In such instances, additional mitigation measures will be incorporated into relevant components of the CEMP, if appropriate.

**TABLE 11.40 CUMULATIVE IMPACT ASSESSMENT FOR AIR QUALITY**

| Project | Potential cumulative impact | Aspect | Relevance factor | Sum of relevance factors | Impact significance | Comments and management measures |
|---|---|---|---|---|---|---|
| InterLinkSQ | Emissions of air pollutants, specifically dust (construction) | Probability of the impact | Medium (2) | 6 | Low | The potential for cumulative impacts to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Dust Management Sub-plan, as a component of the CEMP for the Project.<br>ARTC will consult with InterLinkSQ regarding scheduling of construction activities, to avoid the simultaneous undertaking of dust-generating activities, where possible. |
| | | Duration of the impact | Medium (2) | | | |
| | | Magnitude/intensity of the impact | Low (1) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |
| Commodore Mine and Millmerran Power Station | Emissions of air pollutants, specifically dust (construction) | Probability of the impact | Medium (2) | 6 | Low | The potential for cumulative impacts to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through:<br>▶ Development and implementation of a Dust Management Sub-plan, as a component of the CEMP for the Project<br>▶ Establishing a local baseline for particulate matter, using data collected from the Millmerran AQMS<br>▶ Undertaking dust deposition (TSP) monitoring while construction activities occur in proximity to the Commodore Mine (e.g. from Ch 120.0 km to Ch 128.0 km)<br>▶ Consultation with Intergen regarding scheduling of construction activities to avoid the simultaneous undertaking of dust-generating activities, where possible. |
| | | Duration of the impact | Medium (2) | | | |
| | | Magnitude/intensity of the impact | Low (1) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |

| Project | Potential cumulative impact | Aspect | Relevance factor | Sum of relevance factors | Impact significance | Comments and management measures |
|---|---|---|---|---|---|---|
| North Star to NSW/QLD Border (Inland Rail) | Emissions of air pollutants, specifically dust (construction) | Probability of the impact | Low (1) | 6 | Low | The potential for cumulative impacts to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Dust Management Sub-plan, as a component of the CEMP for the Project.<br>A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction, either from a single project or a combination of adjoining Inland Rail projects. |
| | | Duration of the impact | Medium (2) | | | |
| | | Magnitude/intensity of the impact | Medium (2) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |
| Gowrie to Helidon (Inland Rail) | Emissions of air pollutants, specifically dust (construction) | Probability of the impact | Low (1) | 6 | Low | The potential for cumulative impacts to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Dust Management Sub-plan, as a component of the CEMP for the Project.<br>A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction, either from a single project or a combination of adjoining Inland Rail projects. |
| | | Duration of the impact | Medium (2) | | | |
| | | Magnitude/intensity of the impact | Medium (2) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |
| Asterion Medicinal Cannabis Facility | Emissions of air pollutants, specifically dust (construction) | Probability of the impact | Low (1) | 5 | Low | The potential for cumulative impacts to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Dust Management Sub-plan, as a component of the CEMP for the Project.<br>ARTC will consult with Asterion regarding scheduling of construction activities to avoid the simultaneous undertaking of dust generating activities, where possible. |
| | | Duration of the impact | Medium (2) | | | |
| | | Magnitude/intensity of the impact | Low (1) | | | |
| | | Sensitivity of the receiving environment | Low (1) | | | |

**Table notes:**
Relevance factors between 1 and 3 were determined using professional judgement to select most appropriate relevance factor for each aspect and summing the relevance factors.
Sum of relevant factors definition:

- Low (1–6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general Project monitoring program.
- Medium (7–9): Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
- High (10–12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

## 11.12 Conclusions

This chapter has been prepared to address sections 11.127 to 11.138 of the ToR. In doing so, the objective of this AQIA has been to outline how the Project will be designed, constructed, operated and maintained in a manner that ensures protection of the environment, in particular air quality and environmental values that may be adversely impacted by air quality.

The AQIA consisted of the following tasks:

- Identification of typical and peak operation train movements for the year 2040
- An analysis of the expected construction and operation activities from an air quality perspective
- Identification of the relevant ambient air quality goals that protect or enhance the environmental values of the air environment
- Discussion of existing air quality and local meteorology
- Identification of potential sources of air emissions associated with the Project
- Identification of nearby sensitive receptors
- Identification of potential air quality impacts, through:
  - A qualitative risk assessment of particulate emissions from construction works
  - A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements for peak train operations, including prediction of pollutant water concentrations in rainwater water tanks.
- Identification of mitigation and management measures to minimise potential air quality impacts, and assessment of the residual impact with the implementation of these measures.

For the assessment of construction-phase impacts, a qualitative construction dust risk assessment was undertaken in reference to the *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The risk of dust soiling and human health impacts due to particulate matter on surrounding areas were determined based on the scale of activities and proximity to sensitive receptors. The outcome of the assessment showed that that the residual risk with the proposed mitigation measures is low or negligible. Consistent with the IAQM guidance, it is expected that with effective implementation of the proposed mitigation measures the impacts to air quality with respect to dust deposition and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures, the construction of the Project is not anticipated to significantly adversely impact environmental values.

A Dust Management Sub-plan, as a component of the CEMP, will be required for the construction of the Project, to manage potential impacts from dust emissions. It is expected that implementation of mitigation measures and monitoring of the effectiveness of these mitigation measures will prevent exceedance of air quality goals and the residual impact with respect to dust soiling and human health will not be significant.

For the assessment of operation phase impacts, a quantitative dispersion modelling assessment was undertaken using the dispersion model CALPUFF. Diesel exhaust emissions from locomotives were estimated for projected peak train movements for the Project in 2040. Twelve months of representative meteorological input was developed for use in CALPUFF. Ground level concentrations of particulate matter, NO2, VOCs, and heavy metals were predicted using CALPUFF at nearby sensitive receptors. The assessment predicted that cumulative pollutant concentrations and deposition levels would be below the relevant air quality goals at all identified sensitive receptors for all pollutants of concern with the exception of 24-hour average $PM_{10}$. The air quality goal for 24-hour $PM_{10}$ is predicted to be exceeded by 0.1 µg/m$^3$ at a single sensitive receptor located approximately 1.1 km to the north of the existing Commodore Mine. The dominant source of $PM_{10}$ at the exceeding receptor is the Commodore Mine.

There is doubt regarding the quantum of emissions from the Commodore Mine due to the uncertainty in the emission estimation method used, and the absence of ambient monitoring data for the area local to the mine. To improve the understanding of background air quality at receptors near the mine, an air quality monitoring station has been installed at a residential dwelling on Millmerran–Inglewood Road, Millmerran, approximately 1.4 km to the north of Commodore Mine. Monitoring data from this location will be used to guide the detail design and finalisation of the construction approach for the Project to ensure that air quality impacts to sensitive receptors are avoided or minimised as much as possible.

Based on the intention of the EPP (Air), the operation of the Project is not expected to significantly adversely impact environmental values, including human health.

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

The impact of odour from agricultural trains using the Project alignment has been assessed qualitatively using FIDOL factors. Odour emissions from agriculture freight are considered unlikely to result in significant impact to neighbouring sensitive receptors due to the frequency and duration of the odour-generating event (train pass-by) and the predominantly rural nature of the AQIA area.

Mitigation measures have been recommended for the construction and operation phases of the Project. For the construction of the Project, emission sources will be transient and variable in nature and with differing proximity to sensitive receptors. Appropriate mitigation strategies are needed to address this variability. Key mitigation measures will be incorporated into the detail design, construction planning and operation phases of the Project.

The AQIA undertaken for the Project showed that with the application of mitigation measures identified in Section 11.9, the construction and operation of the Project can be managed in a way that air quality impacts to environmental values and sensitive receptors are maintained at an acceptable level.