Appendix 68 Air Quality Impact Assessment – Larego Mine Region

Larego Mine Region

Air Quality Impact Assessment

Alcoa of Australia Limited

06 February 2025

→ **The Power of Commitment**

Project name		Alcoa Larego Region & Myara Region Social Surrounds Assessment					
Document title		Larego Mine Region | Air Quality Impact Assessment					
Project number		12632796					
File name		12632796-REP_Rev1_Larego_Air_Quality_Impact_Assessment.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S3	A	N Paul	J Forrest	On file	H Morgan		16/10/24
S4	0	N Paul	J Forrest	On file	S Elton	On file	26/11/24
S4	1	N Paul	J Forrest		A Clark		06/02/25

GHD Pty Ltd | ABN 39 008 488 373
Contact: Nikita Paul, Air Quality Consultant | GHD
999 Hay Street, Level 10
Perth, Western Australia 6000, Australia
T +61 8 6222 8222 | **F** +61 8 6222 8555 | **E** permail@ghd.com | **ghd.com**

© GHD 2025
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Executive summary

Alcoa of Australia Limited (Alcoa) is operating the Willowdale Mine in the Larego Mine Region in accordance with a Mining and Management Program (MMP) approved under Alcoa's State Agreements. This Air Quality Impact Assessment (AQIA) will inform a Social Surrounds Impact Assessment (SSIA) to support the MMP approval of the Willowdale Mine under Alcoa's State Agreements.

The AQIA investigated potential emissions of particulate matter and combustion pollutants that could arise from construction and mining operations within Larego Mine Region 5-year mine plan (2023-2027) (The Proposal). Emissions to air during construction of Larego Mine Region were assessed as relatively minor compared to operation and therefore a qualitative construction assessment approach was adopted. A quantitative approach utilising air quality dispersion modelling was adopted to assess the Larego Mine Region operations, as per the 5-year mine plan (2023-2027).

Air pollutants have been assessed in this report, with the main air pollutant from the Proposal being dust, assessed as total suspended particulates (TSP), particulate matter 10 micrometres or less in diameter (PM_{10}), and particulate matter 2.5 micrometres or less in diameter ($PM_{2.5}$), respirable crystalline silica (RCS) and dust deposition.

Dispersion modelling was conducted for incremental concentrations of TSP, PM_{10}, $PM_{2.5}$, RCS and dust deposition for the Larego Mine Region. A review of the proposed areas to be mined each year was undertaken to inform the selection of worst-case operational scenarios for modelled purposes. The following worst-case years of operation were selected to be modelled:

– Scenario 1 – Representing mining operations in 2025
– Scenario 2 – Representing mining operations in 2026
– Scenario 3 - Representing mining operations in 2027

The assessment demonstrates predicted ground level concentrations of incremental 24-hour and annually averaged TSP, PM_{10}, $PM_{2.5}$, and RCS were below the relevant criteria, except for one exceedance of the 24-hour TSP criteria at one receptor for Scenario 1.

Management and mitigation measures were recommended to reduce the likelihood and severity of any potential air quality impacts. Implementation of these measures is considered to effectively reduce air quality impacts from the construction and operation of the Larego Mine Region.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout the report.

Contents

1. Introduction **1**
1.1 Background 1
1.2 Purpose of this report 1
1.3 Scope of works 1
1.4 Limitations 1
1.5 Assumptions 2

2. Proposal background **3**
2.1 Proposal overview 3

3. Overview of assessment methodology **5**
3.1 General 5
3.2 Approach 5
3.2.1 Air quality species of interest 5
3.2.2 Construction methodology 6
3.2.3 Operation methodology 6
3.3 Modelled operational scenarios 7

4. Air quality criteria **9**
4.1 Legislative and policy context to the assessment 9
4.1.1 PM_{10} and $PM_{2.5}$ 9
4.1.2 Total suspended particulates (TSP) 9
4.1.3 Respirable crystalline silica (RCS) 10

5. Existing environment **11**
5.1 Site description 11
5.2 Sensitive receptors 11
5.3 Climate 15
5.3.1 Temperature 15
5.3.2 Rainfall 15
5.4 Background air quality 17
5.5 Respirable crystalline silica (RCS) 17
5.6 Fires and wood waste burning 17

6. Modelling methodology **19**
6.1 Meteorology 19
6.1.1 Representative meteorological year 19
6.1.2 Weather research and forecast model 19
6.1.3 WRF setup 20
6.1.4 CALMET 21
6.1.5 WRF model validation 23
6.1.6 CALMET model validation 23
6.2 Dust dispersion modelling methodology 29
6.3 CALPUFF configuration 29
6.3.1 Dispersion model settings 29

7. Air quality emissions **31**
7.1 Emissions overview 31

7.2 Mining equipment 32
7.3 Operational staging 32
7.4 Emissions estimations 33
7.5 Modelled source locations 37
7.6 Management zone restrictions 37
8. Construction impacts 41
8.1 Construction overview 41
8.2 Construction impacts 41
8.2.1 Gaseous emissions 41
8.2.2 Construction dust emissions 41
9. Operational impacts 42
9.1 Gaseous emissions 42
9.2 Operational dust emissions 42
10. Modelling results 43
10.1 Predicted dust concentrations 43
10.1.1 Scenario 1 43
10.1.2 Scenario 2 53
10.1.3 Scenario 3 63
10.2 Predicted dust deposition 73
10.3 Modelling results summary 78
11. Management and mitigation measures 79
11.1 Construction dust management 79
11.2 Operational dust management 79
11.3 Mining sensitivity zones 79
12. Conclusion 82
13. References 83

Table index

Table 4.1 Air NEPM PM_{10} and $PM_{2.5}$ criteria 9
Table 4.2 TSP and dust deposition criteria 9
Table 4.3 RCS criteria 10
Table 5.1 Sensitive receptor locations 11
Table 5.2 Area burnt from wildfires and prescribed burns in recent years 18
Table 6.1 WRF model parameters 20
Table 6.2 Meteorological modelling parameters – CALMET 21
Table 6.3 Stability category relationship to wind speed, and stability characteristics 27
Table 7.1 Summary of dust emission sources 31
Table 7.2 Summary of mining equipment and purpose 32
Table 7.3 Mine pit development and mining matrix 33
Table 7.4 Rehabilitation matrix 33
Table 7.5 Summary of plant and equipment allocation to each operational activity 34
Table 7.6 Assumptions for Scenario 1, Scenario 2 and Scenario 3 34
Table 7.7 Summary of emissions inventory 36

Table 10.1	Predicted dust concentrations for Scenario 1	43
Table 10.2	Predicted dust concentrations for Scenario 2	53
Table 10.3	Predicted dust concentrations for Scenario 3	63
Table 10.4	Predicted dust deposition per scenario (annual average, g/m^2/month)	73

Figure index

Figure 2.1	Larego Mine Region location	4
Figure 3.1	Larego Mine Region mine plan	8
Figure 5.1	Existing environment and monitoring locations	13
Figure 5.2	Sensitive receptors considered in this assessment	14
Figure 5.3	Monthly average temperature (°C) measured at Dwellingup BoM station (Station ID: 009538), 1935-2023	15
Figure 5.4	Monthly total rainfall (mm) at Dwellingup station (Station ID-009538), 1957 to 2023 (BoM, 2024)	16
Figure 6.1	Modelling domain locations and topography (m above sea level)	21
Figure 6.2	CALMET land use data (as surface roughness)	22
Figure 6.3	Exaggerated terrain data used for CALMET modelling (coordinates in m)	23
Figure 6.4	CALMET extracted wind data for Larego Mine Region at (X,Y) – (412273, 6349664)	25
Figure 6.5	Dwellingup meteorological station wind data (March 2018 – February 2019)	26
Figure 6.6	Stability class distribution predicted by CALMET for Larego Mine Region	28
Figure 6.7	Mixing heights predicted by CALMET at Larego Mine Region	29
Figure 7.1	Modelled source locations for Scenario 1	38
Figure 7.2	Modelled source locations for Scenario 2	39
Figure 7.3	Modelled source locations for Scenario 3	40
Figure 10.1	Predicted maximum 24-hour average TSP concentration Scenario 1	45
Figure 10.2	Predicted annual average TSP concentration Scenario 1	46
Figure 10.3	Predicted maximum 24-hour average PM_{10} concentration Scenario 1	47
Figure 10.4	Predicted annual average PM_{10} concentration Scenario 1	48
Figure 10.5	Predicted maximum 24-hour average $PM_{2.5}$ concentration Scenario 1	49
Figure 10.6	Predicted annual average $PM_{2.5}$ concentration Scenario 1	50
Figure 10.7	Predicted maximum 24-hour average RCS concentration Scenario 1	51
Figure 10.8	Predicted annual average RCS concentration Scenario 1	52
Figure 10.9	Predicted maximum 24-hour average TSP concentration Scenario 2	55
Figure 10.10	Predicted annual average TSP concentration Scenario 2	56
Figure 10.11	Predicted maximum 24-hour average PM_{10} concentration Scenario 2	57
Figure 10.12	Predicted annual average PM_{10} concentration Scenario 2	58
Figure 10.13	Predicted maximum 24-hour average $PM_{2.5}$ concentration Scenario 2	59
Figure 10.14	Predicted annual average $PM_{2.5}$ concentration Scenario 2	60
Figure 10.15	Predicted maximum 24-hour average RCS concentration Scenario 2	61
Figure 10.16	Predicted annual average RCS concentration Scenario 2	62
Figure 10.17	Predicted maximum 24-hour average TSP concentration Scenario 3	65
Figure 10.18	Predicted annual average TSP concentration Scenario 3	66
Figure 10.19	Predicted maximum 24-hour average PM_{10} concentration Scenario 3	67
Figure 10.20	Predicted annual average PM_{10} concentration Scenario 3	68

Figure 10.21 Predicted maximum 24-hour average $PM_{2.5}$ concentration Scenario 3 69
Figure 10.22 Predicted annual average $PM_{2.5}$ concentration Scenario 3 70
Figure 10.23 Predicted maximum 24-hour average RCS concentration Scenario 3 71
Figure 10.24 Predicted annual average RCS concentration Scenario 3 72
Figure 10.25 Predicted annual average dust deposition Scenario 1 75
Figure 10.26 Predicted annual average dust deposition Scenario 2 76
Figure 10.27 Predicted annual average dust deposition Scenario 3 77
Figure 11.1 MSZ components Larego 80
Figure 11.2 Consolidated MSZ Larego 81

Appendices

Appendix A Detailed emission inventory
Appendix B RCS sampling report

Glossary of abbreviations and terms

Abbreviation	Definition
°C	Temperature in degrees Celsius
µg/m^3	Micrograms per cubic metre
Alcoa	Alcoa of Australia Limited
AQIA	Air Quality Impact Assessment
BSEC	Bauxite Strategic Executive Committee
CO	Carbon monoxide
DMP	Dust Management Plan
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
ERD	Environmental Review Document
GHD	GHD Pty Ltd
GLC	Ground level concentrations
g/m^2/month	Grams per square metre per month
g/s	Grams per second
ha	Hectares
ITAG	Independent Technical Advisory Group
kg/yr	Kilograms per year
Mtpa	Million tonnes per annum
MSZ	Mining Sensitivity Zone
NEPC	National Environment Protection Council
NGER	National Greenhouse and Energy Reporting
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPI	National Pollutant Inventory
NSW	New South Wales
NSZ	Noise Sensitivity Zone
$PM_{2.5}$	Particulate matter 2.5 micrometres or less in diameter
PM_{10}	Particulate matter 10 micrometres or less in diameter
RCS	Respirable crystalline silica
Site	Myara Mine Region
SO_2	Sulphur dioxide
The Proposal	Construction and mining operations within Larego Mine Region 5-year mine plan (2023-2027)
tpa	Tonnes per annum
TSP	Total suspended particulates
Willowdale Mine	Willowdale Bauxite Mine
WRF	Weather Research and Forecast model

1. Introduction

1.1 Background

Alcoa of Australia Limited (Alcoa) is operating the Willowdale Mine in the Larego Mine Region in accordance with a Mining Management Program (MMP) assessed under Alcoa's State Agreements. The MMP is subject to progressive update and approval on an annual basis by the Independent Technical Advisory Group (ITAG) and is then endorsed for Ministerial approval with the Bauxite Strategic Executive Committee (BSEC) advising the Minister as part of this process. Alcoa has committed to undertake a social surrounds assessment to support this MMP.

Larego Mine Region is located within the Shires of Waroona and Harvey and is situated east of the townsite of Yarloop and north-east of Harvey.

Alcoa has engaged GHD to conduct the social surrounds assessment including supporting technical studies, in accordance with the EPA Environmental Factor Guideline: Social Surroundings.

1.2 Purpose of this report

This Air Quality Impact Assessment (AQIA) will inform a Social Surrounds Impact Assessment (SSIA) to support the Mining and Management Program (MMP) approval of the Willowdale Mine under Alcoa's State Agreements.

1.3 Scope of works

The scope of works for this AQIA is as follows:

– Complete a desktop assessment, including the assessment of the existing air quality and nearby sensitive receptors.
– Use prognostic meteorological data to generate a meteorological input file for air dispersion modelling.
– Prepare an emissions inventory based on select scenario years.
– Qualitatively assess air quality impacts during construction.
– Quantitively assess air quality impacts by conducting air dispersion modelling for select scenarios for the following:
    - Total suspended particulates (TSP)
    - Particulate matter 10 micrometres or less in diameter (PM_{10})
    - Particulate matter 2.5 micrometres or less in diameter ($PM_{2.5}$)
    - Respirable crystalline silica (RCS)
    - Deposited dust
– Assess predicted ground level concentrations (GLCs) at sensitive receptors against the relevant air quality criteria.
– Where required, outline additional in principle mitigation measures for consideration.
– Prepare an AQIA for Larego Mine Region (this report).

1.4 Limitations

This report has been prepared by GHD for Alcoa of Australia Limited and may only be used and relied on by Alcoa of Australia Limited for the purpose agreed between GHD and Alcoa of Australia Limited as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Alcoa of Australia Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Alcoa of Australia Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.5 Assumptions

This AQIA relied on information provided by Alcoa as the basis of assumptions for the air dispersion modelling:

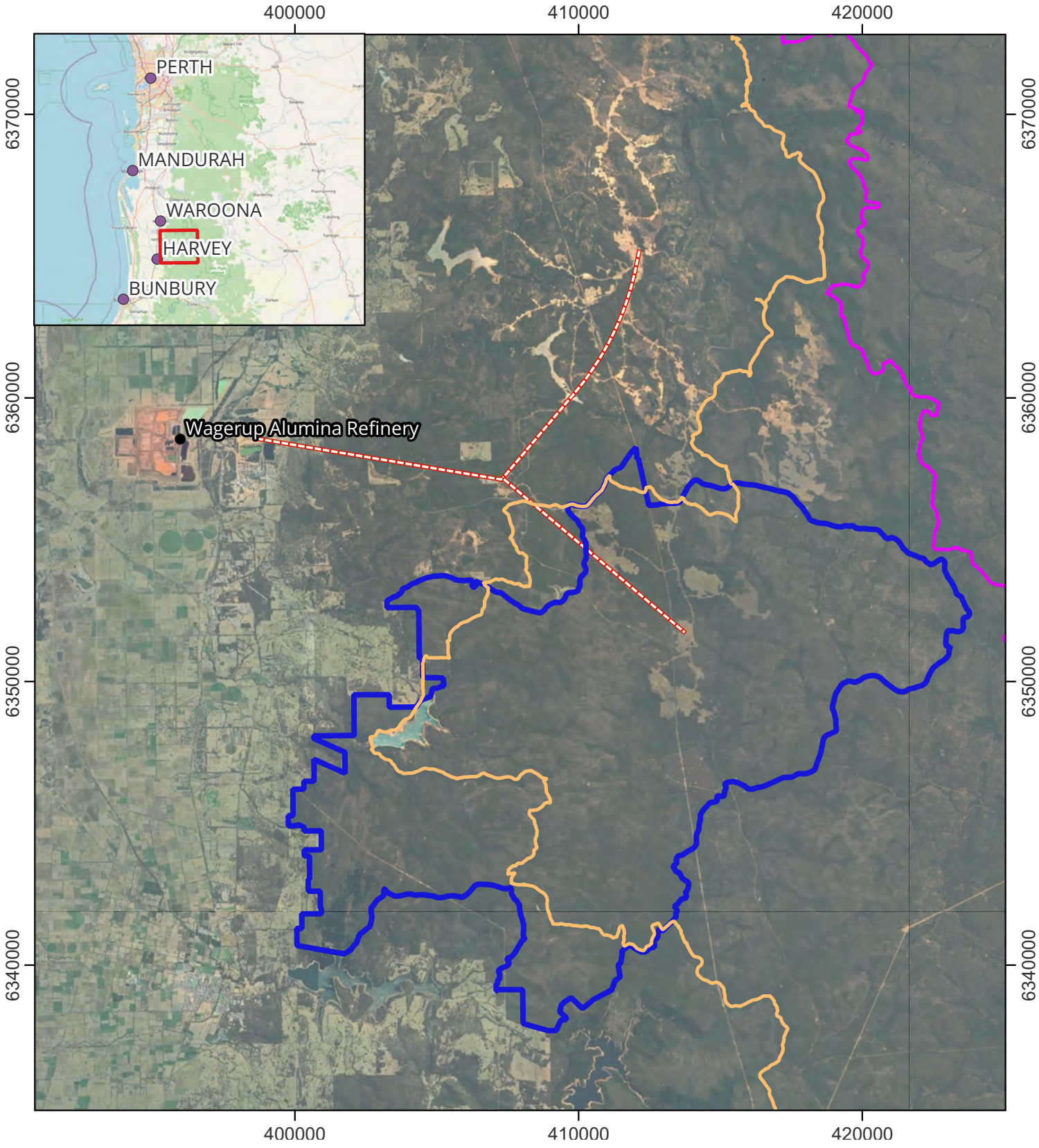
– Annual outputs for each year were provided by Alcoa.
– Geospatial information of mine planning were provided by Alcoa
– Prognostic meteorological data prepared by mathematical models are representative of Larego Mine Region.

2. Proposal background

2.1 Proposal overview

Alcoa is operating the Willowdale Mine in Larego Mine Region in accordance with a Mining Management Program approved under Alcoa's State Agreements. This AQIA will inform a SSIA to support the MMP assessment of the Willowdale Mine under Alcoa's State Agreements. The Proposal utilised as the basis for this AQIA consists of mining activities identified within the Larego Mine Region five-year mine plan (2023-2027).

Larego Mine Region comprises an area of approximately 23,436 ha and lies within the Dwellingup State Forest. It is surrounded by Lane Poole Reserve to the north and east and rural areas associated with the towns of Wagerup, Yarloop and Cookernup to the west as indicated in Figure 2.1.



Legend

- Munda Biddi Trail
- Bibbulmun Track
- Mine Region
- Alcoa refinery
- Existing conveyor
- Townsite

Paper Size ISO A4

0 1 2 3 4 5 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Laregro Mine Region
Air Quality Impact Assessment

Larego Mine Region location

Project No. **12632796**
Revision No. **A**
Date. **14/10/2024**

FIGURE 2.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregro.qgz
Print Date: 14/10/2024

Data Source:Google Earth Imagery 2024, ADD OTHER DATA SOURCES HERE!!!!

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

3. Overview of assessment methodology

3.1 General

This AQIA for the Proposal was completed in accordance with EPA and contemporary guidance to predict dust emissions and impact on ambient air quality. The atmospheric dispersion modelling evaluates potential worst case impacts from the Proposal and outlines how these impacts can be managed. The assessment was undertaken with consideration to the following legislation and guidance:

– *Draft Guideline: Dust Emissions* (DWER, 2021)
– *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) (NEPC, 2021)
– *Environmental Factor Guideline – Air Quality* ((EPA WA, 2020)
– *Draft Guideline: Air Emissions* (DWER, 2019)
– *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Approved Methods) (EPA NSW, 2022)
– *A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and Other Related Activities* (DEC, 2011)
– *Protocol for Environmental Management. State Environment Protection Policy (Air Quality Management): Mining and Extractive Industries* (Mining PEM) (EPA Vic, 2007)
– *Air Quality Modelling Guidance Notes* (Department of Environment, 2006)
– *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986): Separation Distances Between Industrial and Sensitive Land Uses* (EPA WA, 2005)
– *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (Kwinana EPP), (EPA WA, 1999)
– *National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual for Mining* (NPI, 2012).

3.2 Approach

3.2.1 Air quality species of interest

There is potential for the following air quality emissions to occur through clearing of native vegetation and soil disturbance from construction, mining and rehabilitation activities associated with Proposal:

– Dust, including TSP, PM_{10}, $PM_{2.5}$, dust deposition and RCS.
– Products of combustion from plant and vehicles, including oxides of nitrogen (NO_x), nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2).

Dust emissions

Dust was identified as the primary emission to air during construction and operation at Larego Mine Region. Dust emissions could be generated during the following activities:

– Mine pit development activities including soil stripping, drilling and blasting via use of mobile earth moving equipment including excavators, dozers, loaders and scrapers
– Mining activities including material extraction and handling using mobile earth moving equipment
– Mine pit rehabilitation activities including landscaping, soil return and contour ripping via use of mobile earth moving equipment
– Transportation of extracted material including wheel generated dust from vehicle movements on unsealed surfaces
– Upkeep of haul routes via use of graders
– Material loss from transfer points
– Material processing activities including crushing of ore
– Windblown dust from exposed excavation haulage and stockpile areas

Products of combustion

Products of combustion resultant from the Proposal would occur from combustion engine exhaust (both diesel and petrol fuelled plant, equipment and vehicles) and blasting activities.

Combustion exhaust emissions are expected to be transient, mobile and distributed over Larego Mine Region (i.e. emissions would occur for short periods of time and would not be concentrated in any particular location). Due to the low sulphur content of Australian diesel, SO_2 emissions will not be significant. However, annual SO_2 emissions will be captured through annual reporting of National Pollutant Inventory (NPI) substances.

Blasting activities are of short duration and occur irregularly. Blasting will be managed via a blasting management plan in line with current mining operations. In addition, blasting would be guided by weather modelling and Bureau of Meteorology (BoM) data (nowcasting) and forecasting to occur opportunistically during favourable weather conditions (when winds are not blowing towards sensitive receptors and during periods of favourable dispersion).

On this basis, emissions of combustion pollutants were considered relatively minor compared to dust emission rates and could be mitigated via implementation of appropriate management measures. Consequently, emission of combustion pollutants was assessed qualitatively in this assessment.

3.2.2 Construction methodology

Air emissions related to construction are short-lived in nature compared with operational emissions. Once construction has concluded in a particular area (to allow mining in sub-area of the mine region, has concluded in a particular area), construction activity would transition into a new area. The construction activity location varies from year to year and occurs for a sub-period of a year. In this instance, construction emissions have been qualitatively assessed. Impacts and management measures to minimise potential impacts during construction of the Proposal are provided in Sections 8 and 11, respectively.

3.2.3 Operation methodology

The assessment adopted a quantitative approach using air quality dispersion modelling to assess the operation (encompasses mine pit development, mine pit operation and mine pit rehabilitation) of the Proposal. Alcoa proposes that operational activities associated with the Proposal would be staged over several years where select areas would be mined each year as shown in Figure 3.1. Once mining has concluded in a particular area, operations would transition into a new area. The mining locations vary from year to year.

For assessment purposes, GHD selected worst case operational scenarios to assess impacts from the Proposal. A review of the indicative mine plan and mining schedule was undertaken to select the worst case operational years (refer to Section 3.3). The reason for this assessment approach was if compliance with appropriate ambient air quality standards is predicted for the worst case scenarios, then it would be reasonable to assume potential risk of unacceptable adverse impacts for the other years of operation would be less likely or significant. The worst case scenarios were selected with consideration to mining location and scale of operation where worst case air quality impacts are anticipated (i.e. when the amount of material being mined close to sensitive receptors is highest) and with consideration to the maximum exposed area.

Dispersion modelling was undertaken for the selected worst case operational scenarios utilising the emission rates derived in Section 7. Predicted air quality impacts are assessed in Section 10.

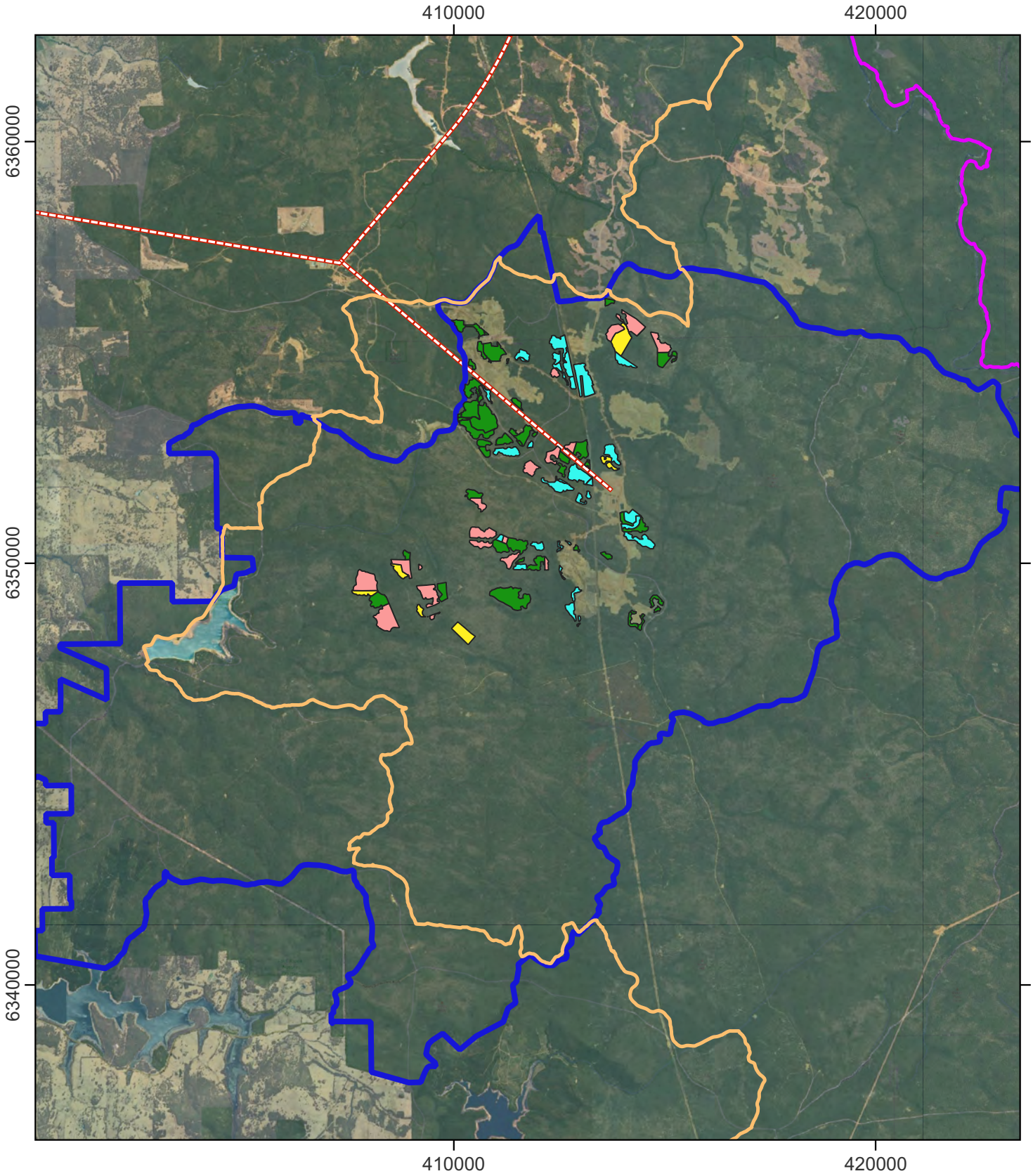
3.3 Modelled operational scenarios

Alcoa provided information including the mining schedule, equipment numbers, haul routes and geospatial information of mine planning for Larego Mine Region 5-year mine plan 2023-2027. Data was provided for the period between 2024 to 2027 in the form of spatial data. GHD reviewed the information to identify worst case scenarios for modelling and assessment purposes. Scenarios 1, 2 and 3 were considered due to the large exposed area contributing to wind erosion emissions.

– Scenario 1 – Represents mining 10.5 Mtpa in 2025. This includes the areas being developed, currently mining, undergoing rehabilitation and open exposed areas.
– Scenario 2 – Represents mining 10.4 Mtpa in 2026. This includes the areas being developed, currently mining undergoing rehabilitation and open exposed areas.
– Scenario 3 - Represents mining 10.8 Mtpa in 2027. This includes the areas being developed, currently mining undergoing rehabilitation and open exposed areas.

The Larego Mine Region 5-year mine plan is shown in Figure 3.1.

The method of material transportation remains the same for both scenarios. Trucks transport ore to the crusher and the processed ore is transported via conveyor to the Wagerup Alumina Refinery. Additionally, mining equipment fleet numbers were provided by Alcoa and highest number of mining fleet across the years was chosen for the assessment as conservative estimate.



Legend

- Munda Biddi Trail
- Bibbulmun Track
- Existing conveyor
- Mine Region

Scheduled pits

- 2024
- 2025
- 2026
- 2027

Paper Size ISO A4

0 1 2 3 4 5 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Larego Mine Region mine plan

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

FIGURE 3.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine region, conveyor; DBCA: trails.
Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

4. Air quality criteria

4.1 Legislative and policy context to the assessment

DWER (2019) lists ambient air quality guideline values for a range of pollutants. The criteria used for the quantitative air quality modelling assessment are consistent with this list and reference the primary source below, where available. As fugitive dust (deposition) is not discussed by DWER (2019), the Draft Guideline – Dust Emissions (DWER, 2021) are referenced.

The relevant legislation and government guidance for the quantitative air quality modelling assessment of Larego Mine Region are:

– *Draft Guideline – Dust Emissions* (DWER, 2021)
– *Air NEPM* (NEPC, 2021)
– *Draft Guideline: Air Emissions* (DWER, 2019)
– *Approved Methods* (EPA NSW, 2022)
– *Mining PEM* (EPA Vic, 2007)
– *Kwinana EPP* (EPA WA, 1999)

4.1.1 PM_{10} and $PM_{2.5}$

The Air NEPM was developed to provide benchmark standards and goals for ambient air quality to ensure all Australians have protection from the potential health effects of air pollution. Air NEPM standards have been developed for NO_2, CO, SO_2, photochemical oxidants (as ozone), lead and particulate matter (as PM_{10} and $PM_{2.5}$). As the pollutants of concern for this quantitative assessment are particulates, Air NEPM standards for particulate matter are shown in Table 4.1.

Table 4.1 Air NEPM PM_{10} and $PM_{2.5}$ criteria

Pollutant	Averaging period	Maximum concentration (µg/m^3)
PM_{10}	24-hour	50
	Annual	25
$PM_{2.5}$	24-hour	25
	Annual	8

4.1.2 Total suspended particulates (TSP)

The *Draft Guideline – Dust Emissions*, Kwinana EPP and Approved Methods have been used for this assessment, with concentration and deposition limits for Total Suspended Particulates (TSP) as indicated in Table 4.2.

Table 4.2 TSP and dust deposition criteria

Pollutant	Averaging period	Maximum concentration	Guideline
TSP	24-hour	90 µg/m^3	Kwinana EPP[1]
	Annual	90 µg/m^3	Approved Methods
Deposited dust	Annual	2 g/m^2/30 days (maximum increase)	Draft Guideline – Dust Emissions
	Annual	4 g/m^2/30 days (maximum total)	

[1] 90 µg/m^3 relates to the Standard for Areas B and C, where standard is the concentration of atmospheric waste which is desirable not to exceed (EPA WA, 1999)

4.1.3 Respirable crystalline silica (RCS)

There is currently a 24-hour average ambient air quality guideline value for silica as a fraction of $PM_{2.5}$[2] (DWER, 2019), noting the document is in draft form and should only be used as a guideline.

Although the 24-hour silica criterion is referred to as a standalone product (i.e. silica), as opposed to respirable crystalline silica (RCS), it is considered applicable for use in this assessment.

In Victoria, the Mining PEM (EPA Vic, 2007) sets out statutory requirements for managing emissions to air for mining or extractive operations, including RCS (as $PM_{2.5}$). The criteria are shown in Table 4.3.

Table 4.3 RCS criteria

Pollutant	Averaging period	Maximum concentration (µg/m^3)	Guideline
Silica (as a fraction of $PM_{2.5}$)	24-hour	9.2	*Draft Guideline – Air emissions*
RCS (as a fraction of $PM_{2.5}$)	Annual	3	*Mining PEM*

[2] Ambient air quality guideline values (AGVs) were developed by DWER based on the approved health guidelines of Western Australia's Department of Health (DoH) and the Approved Methods. The AGV for silica generally should be met at, or everywhere within the modelling domain (excluding industry premises).

5. Existing environment

5.1 Site description

Larego Mine Region is located within the Shires of Waroona and Harvey and is located to the east of the townsite of Yarloop and north east of Harvey. Larego Mine Region lies within the Dwellingup State Forest and is surrounded by Lane Poole Reserve to the north and east and towns of Wagerup, Yarloop and Cookernup to the west.

5.2 Sensitive receptors

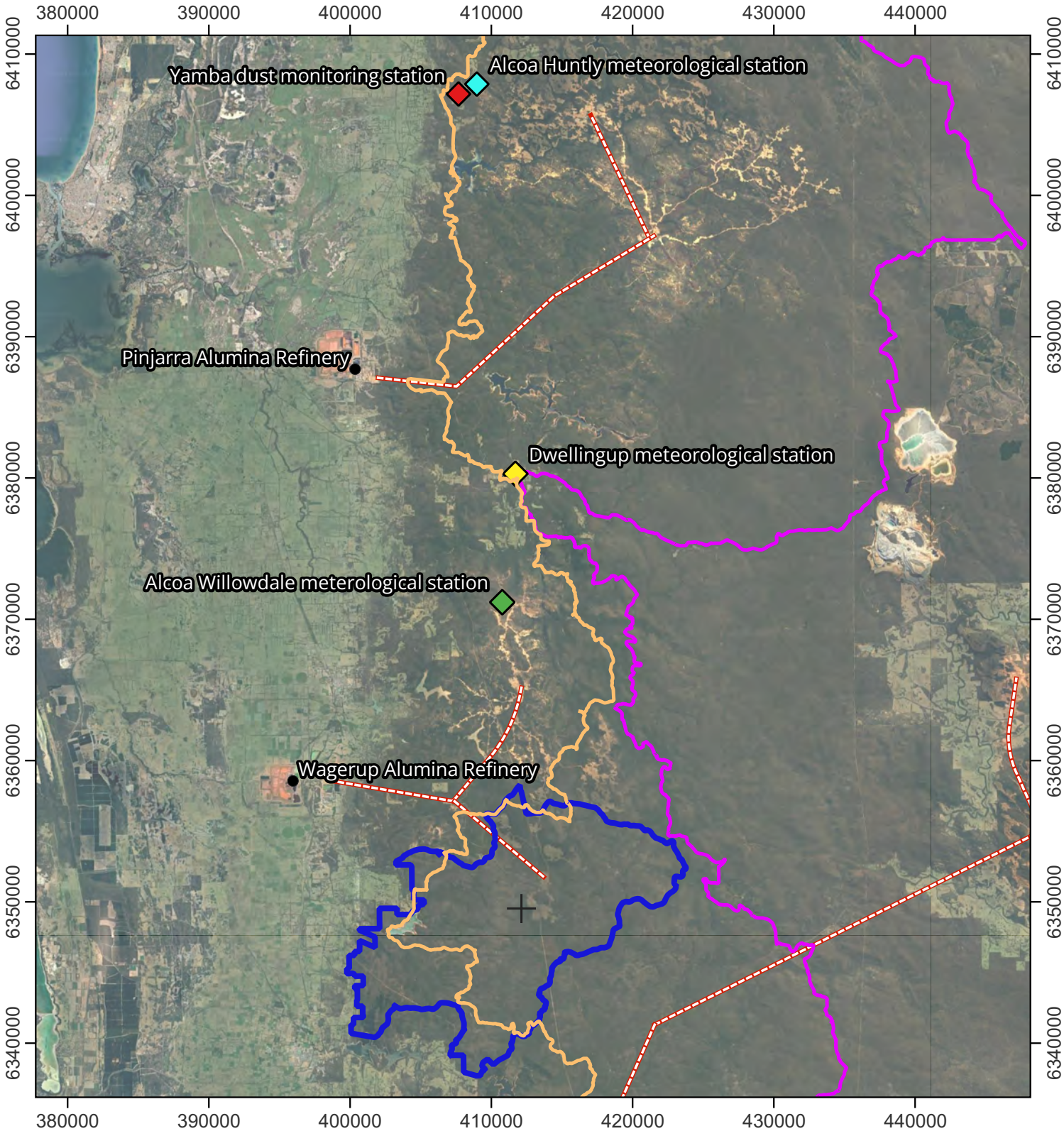
Consistent with the *Guideline: Dust emissions* (DWER, 2021), sensitive receptors were defined as a location where people live or regularly spend time, and which are therefore sensitive to emissions from industry with implications for human health or amenity. They include, but are not limited to, residences, healthcare establishments, places of accommodation, places of study, childcare facilities, shopping centres, places of recreation, and some public buildings.

A total of 36 sensitive receptors were identified for inclusion in the quantitative air quality modelling assessment. The identified receptors are presented in Table 5.1 with a location (in Universal Transverse Mercator coordinates), address and description. The locations of sensitive receptors in Larego Mine Region are shown in Figure 5.2.

Table 5.1 Sensitive receptor locations

ID	Easting (metres)	Northing (metres)	Address	Description
R1	414446.4	6347715	Hoffman Mill	Campground
R2	403783.4	6347451	Logue Brook Campground	Campground
R3	413571.9	6374278	Nanga Bush Camp	Campground
R4	411851	6364933	Willowdale Orion office	Workplace
R5	404964.3	6358243	Waterous Scout Campsite	Campground
R6	399869.2	6339352	Gibbs Pool Amphitheatre	Recreational
R7	400323.3	6341756	Wildflower Ridge Walk	Recreational
R8	403928.6	6347760	Lake Brockman Tourist Park	Recreational
R9	404581.9	6349570	Lake Brockman Campsite	Campground
R10	403174.3	6351619	431 Black Rock Road, Yarloop	Residential
R11	403631.5	6351153	450 Black Rock Road, Yarloop	Residential
R12	404451.6	6350085	Address not known	Residential
R13	406571.2	6353674	Alcoa owned Residential	Residential
R14	404382.1	6353892	883 Hoffman Road, Hoffman	Residential
R15	409158.5	6353091	Alcoa owned Residential	Residential
R16	403318.5	6357352	1143 Bancell Road, Wagerup	Residential
R17	416282.5	6363472	Bidjar Ngoulin Campsite	Campground
R18	414900.5	6369782	Nanga Townsite	Campground
R19	419274.7	6362872	Bibbulmun Track Murray Campsite	Campground
R20	407402.5	6368353	1078 Nanga Brook Road, Waroona	Residential
R21	406185.7	6358156	268 Bancell Road, Wagerup	Residential
R22	405891.3	6355134	314 Wagerup-Willowdale Road, Wagerup	Residential
R23	406334.5	6367495	323 Scarp Road, Waroona	Residential

ID	Easting (metres)	Northing (metres)	Address	Description
R24	407026	6370081	851 Nanga Brook Road, Waroona	Residential
R25	406980.6	6371404	847A Nanga Brook Road, Waroona	Residential
R26	410101.4	6374681	21 Oro Road, Dwellingup	Residential
R27	404905.4	6364382	24 Prince Road, Waroona	Residential
R28	413349.3	6374613	Lane Poole Reserve	Recreational
R29	414231.5	6373582	Baden Powell Campsite	Campground
R30	415727.2	6370225	Nanga Mill Campground	Campground
R31	416537.5	6369897	Stringers Campground	Campground
R32	426537.8	6353000	Dookanelly Campsite	Campground
R33	416450.6	6371024	Island Pool rest area	Recreational
R34	416570.7	6371928	Chuditch Campground	Campground
R35	416147.6	6372512	Charlies Flat Campground	Campground
R36	415798.1	6373291	Bob’s Crossing rest area	Recreational



Legend

- Munda Biddi Trail
- Bibbulmun Track
- Mine Region
- Existing conveyor
- Alcoa Huntly meteorological station
- Yamba dust monitoring station
- Alcoa Willowdale meteorological station
- Dwellingup meteorological station
- Location of CALMET validation
- Alcoa Refineries

Paper Size ISO A4

0 2 4 6 8 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Existing monitoring locations

Project No. **12632796**
Revision No. **A**
Date. **14/10/2024**

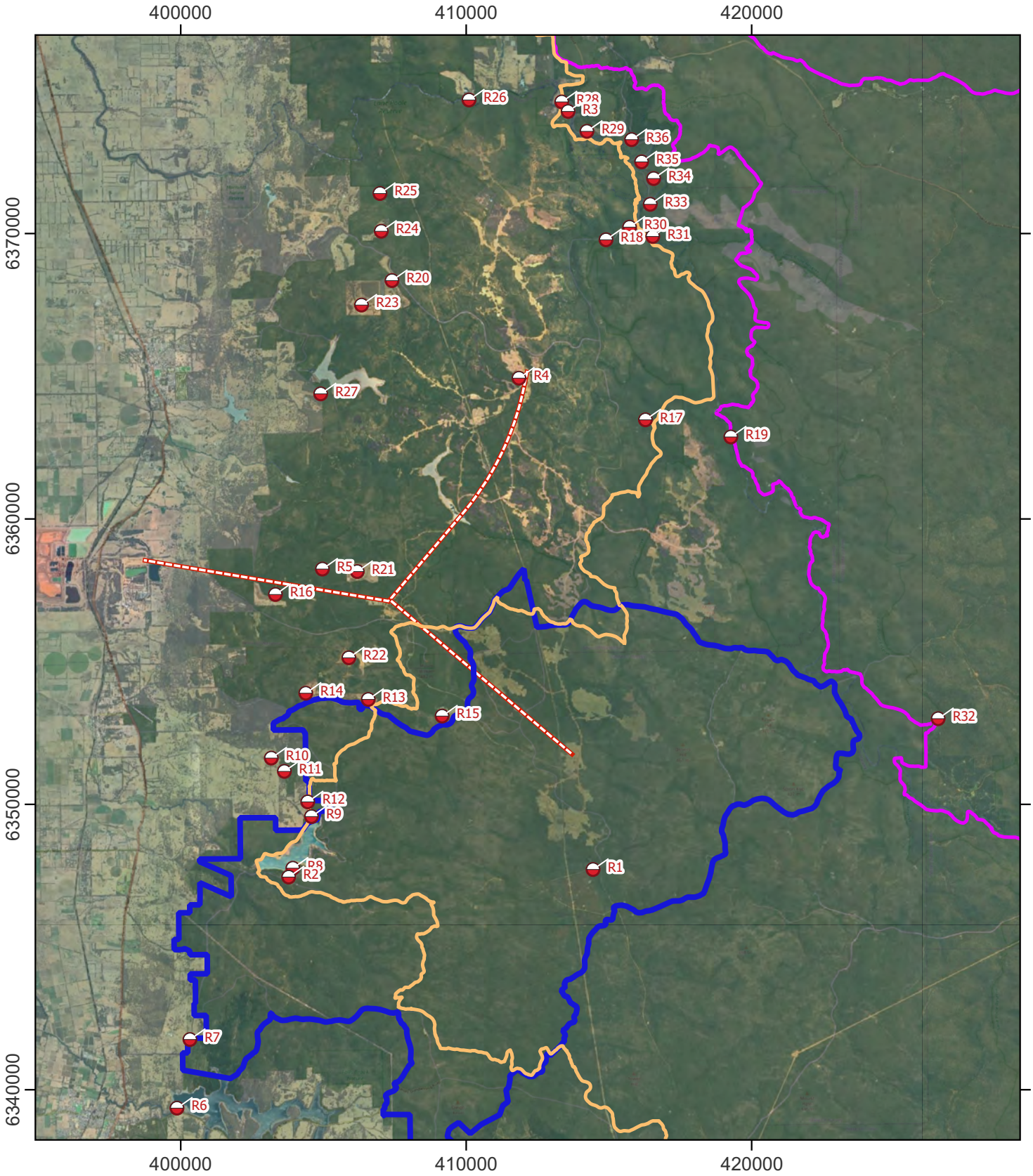
FIGURE 5.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregо.qgz
Print Date: 14/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: Alcoa dust monitor and meterologica station locations, conveyor, mine region; DBCA:trails; BoM: Dwellingup meteorological station location

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Legend

Munda Biddi Trail | Bibbulmun Track | Existing conveyor | Mine Region | Sensitive receptor

Paper Size ISO A4

0 1 2 3 4 5 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Laregro Mine Region
Air Quality Impact Assessment

Sensitive receptors considered in this assessment

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

FIGURE 5.2

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregro.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine region, conveyor; DBCA: trails; GHD: sensitive receptors.
Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

5.3 Climate

Larego Mine Region is located in a Mediterranean climate, with cool wet winters and hot dry summers. Larego Mine Region falls within the “Temperate” Köppen classification with a distinctly dry (and hot) summer (BoM, 2023). Rainfall is strongly seasonal, most falling during the winter months of June, July and August.

BoM operates a climate station in Dwellingup and the station is located approximately 23 km north of the boundary of Larego Mine Region. This climate station started operating since 1934 and hence has a large dataset to determine long-term averages.

5.3.1 Temperature

The temperature data for Dwellingup station is presented in Figure 5.3. The analysis identifies a seasonal temperature profile typical of the Mediterranean climate, with cooler winter months of June to August and warmer summer months of December to February.

The mean maximum temperature ranges from 15°C in July to 29.8°C in January over the measured period of 1957 to 2023. The highest daily temperature was measured as 43.5°C on 23 February 1991 (BoM, 2024).The mean minimum temperature ranges from 5.5°C in July to 14.3°C in January over the measured period of 1957 to 2023. The lowest daily temperature measured at the station was -3.9°C recorded on 29 July 1962 (BoM, 2024).

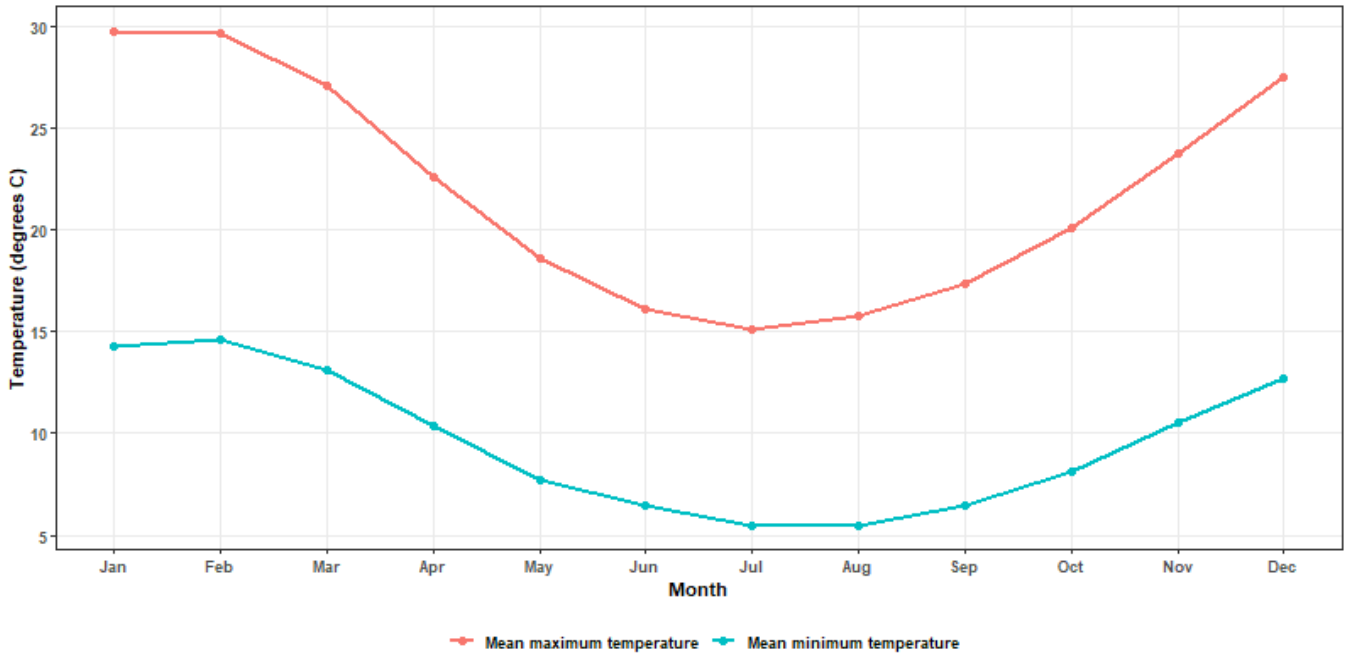


Figure 5.3 Monthly average temperature (°C) measured at Dwellingup BoM station (Station ID: 009538), 1935-2023

5.3.2 Rainfall

The range of total monthly rainfall at Dwellingup Station is shown in Figure 5.4, with rainfall ranging from 16.1 mm in January to 234.9 mm in July over the measured period of 1957 to 2023. The wettest period occurred during winter months from June to August, while driest period occurred during summer months from December to February.

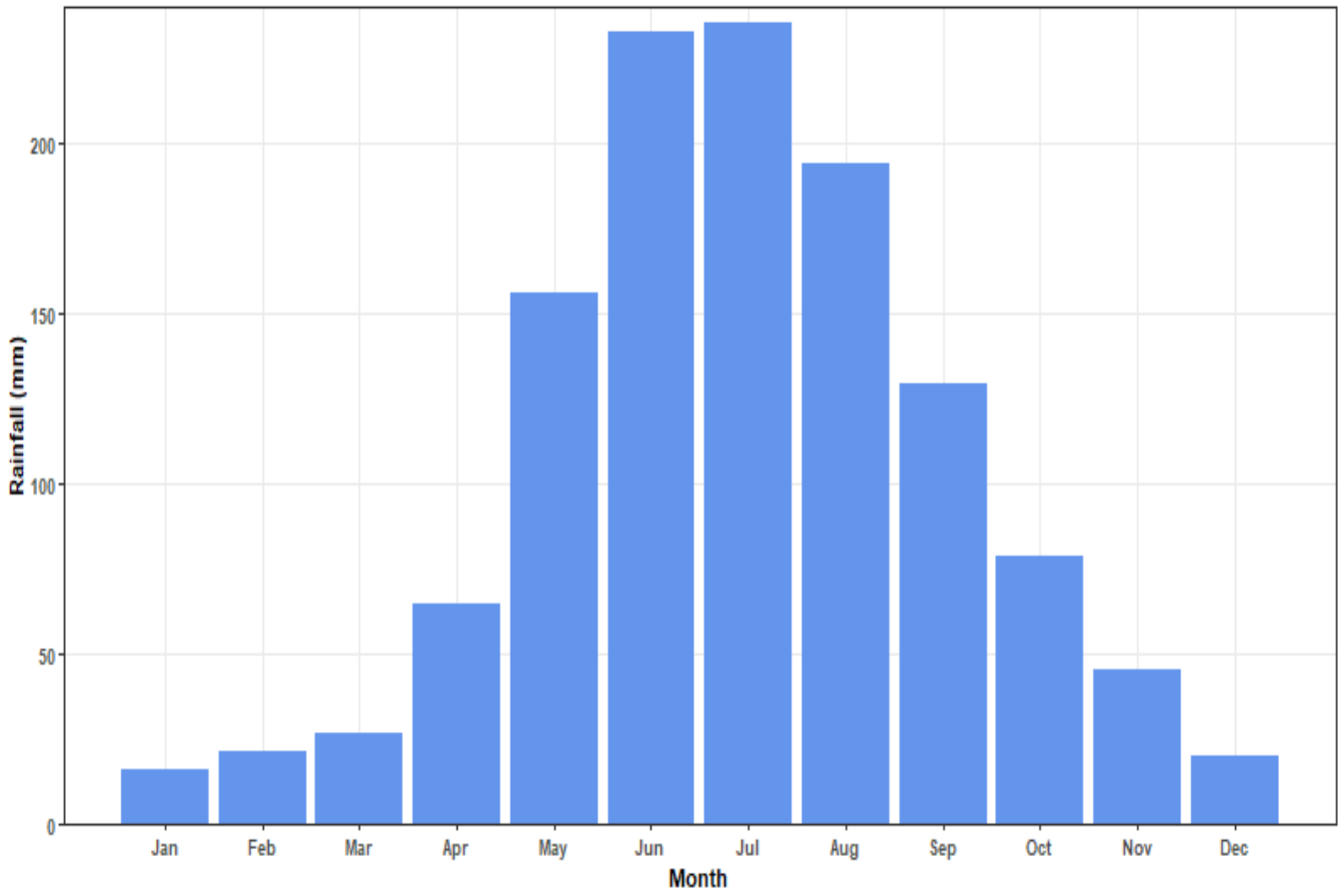


Figure 5.4 Monthly total rainfall (mm) at Dwellingup station (Station ID-009538), 1957 to 2023 (BoM, 2024)

5.4 Background air quality

There is no background air quality monitoring data within the local ambient airshed available for this assessment. Sources contributing to Larego Mine Region's local airshed will therefore be assessed qualitatively.

Air quality within the Larego Mine Region is considered to be typical of a rural area located within close proximity to a mine (existing Alcoa operations). The dominant dust sources influencing air quality in the local area would likely include:

– Agriculture activities including wind eroded dust from cleared areas
– Motor vehicle emissions from heavy duty vehicles but also potentially from light vehicles
– Domestic fuel burning (gas, liquid and solid)
– Regional events such as dust storms and dust events during harvest
– Bushfires and fuel reduction burns such as prescribed burning

The National Pollutant Inventory (NPI) database provides details on industrial emissions of over 4000 facilities across Australia. The requirement to return emissions estimates to the NPI is determined by the activities/processes being undertaken at the facility, and whether those processes exceed process specific emission thresholds.

A search on the NPI database under the Local Government Area Shire of Harvey and Shire of Waroona identified a number of industrial emissions to the local airshed. Sources to air emissions in Shire of Harvey included waste treatment, dairy product manufacturing, gas supply, meat and meat product manufacturing, non-ferrous metal manufacturing and electricity generation. Sources to air emissions in Shire of Waroona included metal ore mining, non-ferrous metal manufacturing, electricity generation and gas supply.

5.5 Respirable crystalline silica (RCS)

RCS concentration is not routinely recorded at Alcoa Yamba Drive ambient air monitoring station. However, as a part of the assessment for *Pinjarra Alumina Refinery Revised Proposal Air Quality Impact Assessment for Huntly Mine – Myara North* (GHD, 2021b), a week long monitoring event for RCS was conducted in February 2021. The objective of the monitoring event was to determine the RCS/$PM_{2.5}$ ratio. After the monitoring event, the RCS fraction of $PM_{2.5}$ was determined to be 2.2 percent. The RCS fraction of 2.2 percent was then applied to the $PM_{2.5}$ 24-hour maximum and the annual average to provide indicative RCS background concentrations. The RCS monitoring campaign was undertaken by GHD (2021a) and shown in Appendix B.

5.6 Fires and wood waste burning

As discussed in Section 5.4, bushfires and prescribed burning are a significant contributor to particulate emissions into the local airshed. A review of recent bushfire and prescribed burning activity recorded in the Department of Biodiversity, Conservation and Attractions (DBCA) Fire History database was undertaken and the approximate area of burning that occurred each year for the last 10 years (2013 to 2023) within 25 and 50 km of Larego Mine Region is presented in Table 5.2.

Up to 2023, it is understood that preparatory activities included land clearing, harvesting of merchantable timber and burning of wood waste residues (residues consist of unusable material such as treetops, stumps and under storage). The practice of burning wood waste residue has now ceased and is not expected to occur in Larego Mine Region. Wood waste residue is now predominantly mulched and used for dust suppression or sold to commercial users. Alcoa is not expected to contribute further to particulate emissions in the local airshed that result from fires and wood waste burning as they no longer burn wood waste residue.

Table 5.2 Area burnt from wildfires and prescribed burns in recent years

Year	Area of wildfires and prescribed burns based on proximity to Larego Mine Region (ha)	
	Within 25 km	Within 50 km
2013	4356	19,308
2014	597	15,889
2015	17,025	77,407
2016	71,275	121,252
2017	7588	24,343
2018	14,986	26,025
2019	5212	22,569
2020	7541	26,545
2021	9075	33,198
2022	6879	20,842
2023	6363	19,818

6. Modelling methodology

6.1 Meteorology

A meteorological file generated by GHD, as part of previous air quality assessments for Alcoa, was used for this assessment. Detailed information regarding the generation of the meteorological file is provided in the following sections.

6.1.1 Representative meteorological year

The US EPA's *Meteorological Monitoring Guidance for Regulatory Modelling Applications* (2000) recommends when determining meteorological data as input to dispersion modelling to review consecutive years from the most recent and readily available five-year period to inform selection of a representative period at least one year in duration for modelling purposes (when site-specific, Viz on-site, data are available). The closest meteorological station is Dwellingup meteorological station, located approximately 23 km north of Larego Mine Region, as shown in Figure 5.1.

To determine the most representative year for modelling, an analysis of meteorological monitoring data was completed by GHD. Representativeness is defined as "*the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application*" (US EPA, 2000).

The following years were excluded as they were not considered to be representative of a typical year:

– 2019 calendar year was excluded due to an above average amount of east to south easterly winds
– 2017 calendar year was excluded due to stronger winds than average
– 2016 calendar year was excluded due to an abnormally dry period
– 2015 calendar year was excluded based on the strongly positive Indian Ocean Dipole (IOD) and El Niño coinciding, resulting in below average rainfall
– The monthly rain analysis between March 2018 to February 2019 observed the least extreme prevailing weather (that brings coastal fringe rain). Observations included:
    - Annual rain within 10 percent of the annual mean, observed to be 7 percent drier
    - Winter rain (during June, July and August) within 18 mm of the long-term mean. The Mediterranean climate is where winter rain dominates.

Based on the above, the most representative meteorological year from the previous five years was determined to be the 12-month period between March 2018 to February 2019.

Site representative meteorological data used to drive the dispersion model was generated by the Weather Research and Forecast model (WRF) and CALMET meteorological models at Larego Mine Region.

6.1.2 Weather research and forecast model

The process of developing the WRF datasets involved a nested approach for three domains, with their centre at Oakley South meteorological station at Pinjarra Refinery. Although Oakley South was the centre of the modelling grid, data was extrapolated specifically for the location of Larego Mine Region and Dwellingup meteorological station to allow verification with observations. The output from WRF is processed through the post-processing tool CALWRF, prior to input to CALMET to translate the output in a format compatible with CALPUFF.

For this assessment, WRF was used to produce the meteorological fields required as prognostic data for CALMET for 2018-19, assessed as the most representative meteorological year. The third (inner) domain of WRF covers the location of Dwellingup meteorological station with the simulated WRF output used as input to CALMET for generating finer resolution meteorological data.

6.1.3 WRF setup

WRF pre-processing system (WPS)

WRF meteorological datasets for the period 2018-19 were developed using initialising data sourced from the University Corporation for Atmospheric Research (UCAR) National Centre's for Environmental Prediction (NCEP) Final (FNL) Operational Model Global Tropospheric Analyses[3] and was used for Global Climate Modelling data. FNL data is on 18 x 18 grids prepared operationally every six hours. FNL data is synthesized with the same model that NCEP uses in the Global Forecast System (GFS). However, FNL data is prepared about an hour after the GFS is initialised, to allow inclusion of more observational data. GFS is run earlier in support of time critical forecast demands and uses the FNL from the previous 6-hour cycle as part of its initialisation.

FNL was used in this instance to assist with improving the performance of the WRF simulation. The WRF pre-processing system (WPS) provides a basis for data initialisation, both spatially and temporally at the start of the WRF simulation. Parameters used to initialise WRF include surface pressure, sea level pressure, geopotential height, temperature, sea surface temperature, soil values, ice cover, relative humidity, u- and v- winds, vertical motion, vorticity and ozone.

WRF

The WRF configuration had topo_wind=1 (TWIND1), which aims to correct the high wind speed bias seen in WRF (Jimenez and Dudhia 2011). The scheme not only allows for representing the drag associated with the unresolved orography, but also improves the model representation of the increase in speed of the flow over the tops of hills or mountains (such as found on the Darling Scarp).

WRF was run for one month at a time, for a total of 12 months. For each month, a two day spin up period was used to stabilise WRF.

Parameters used in the WRF model for this assessment are presented in Table 6.1. The modelling domain locations are shown in Figure 6.1.

Table 6.1 WRF model parameters

Parameterization scheme	Domain 1	Domain 2	Domain 3
Modelling domain	36 km	12 km	4 km
Grid resolution	82 x 82	85 x 82	100 x 100
Number of vertical levels	40	40	40
Cumulus	Kain-Fritsch	Kain-Fritsch	Kain-Fritsch
Longwave radiation	Rapid Radiative Transfer Model	Rapid Radiative Transfer Model	Rapid Radiative Transfer Model
Shortwave radiation	Dudhia	Dudhia	Dudhia
Surface layer	Monin-Obukhov	Monin-Obukhov	Monin-Obukhov
Land surface	Thermal Diffusion	Thermal Diffusion	Thermal Diffusion
Surface drag	On	On	On
Planetary boundary layer	YSU	YSU	YSU
Slope radiation	On	On	On
Soil layers	Thermal diffusion	Thermal diffusion	Thermal diffusion
Grid nudging	On	No	No

[3] (ds083.2 | DOI: 10.5065/D6M043C6) (https://rda.ucar.edu/datasets/ds083.2/#!description)

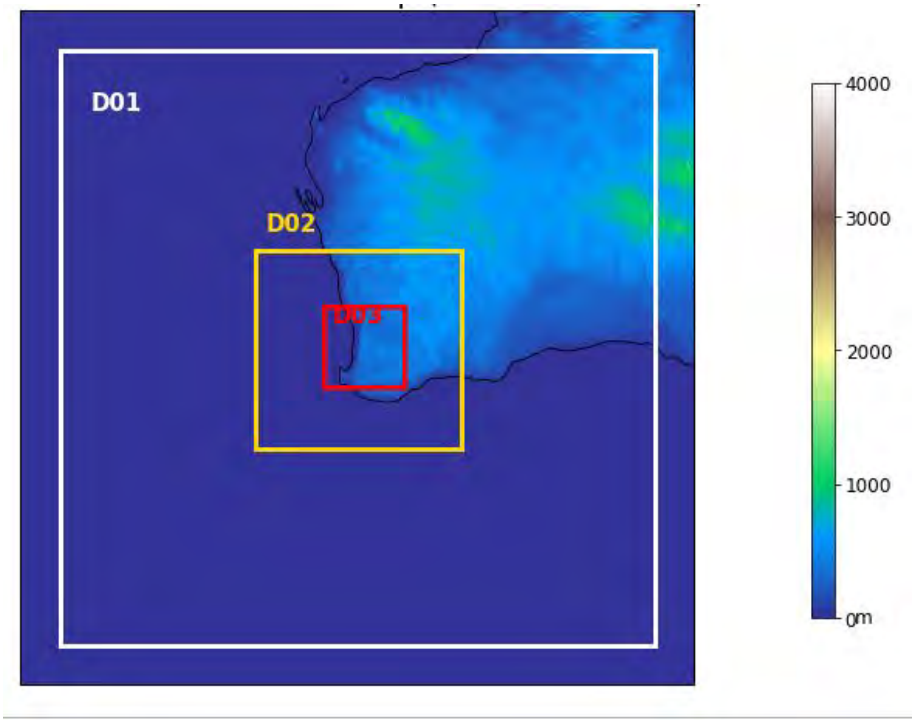


Figure 6.1 Modelling domain locations and topography (m above sea level)

6.1.4 CALMET

CALMET is a meteorological model that develops hourly winds and other meteorological fields on a three-dimensional gridded domain as required as inputs to the CALPUFF dispersion model. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included. The interpolated wind field is then modified within the model to account for the influences of topography, sea breezes, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly varying wind field thus reflects the influences of local topography and land uses.

The CALMET model was run for a 45 km by 45 km domain with a 0.5 km grid resolution. CALMET was run in "NOOBS" mode using prognostic data. WRF-generated three-dimensional meteorological data were used as the 'initial-guess' wind field. Local topography and land use information were used to refine the wind field predetermined by the WRF output. Land use data was sourced from Catchment Scale Land Use Mapping for Western Australia (Australian Bureau of Agricultural and Resource Economics and Sciences, 2021).

Table 6.2 shows the parameters used in the CALMET meteorological modelling. Land use and 3D terrain data used are presented in Figure 6.2 and Figure 6.3.

Table 6.2 Meteorological modelling parameters – CALMET

Parameter	Specification
Modelled period	1 March 2018 – 28 February 2019
Mode	No Observations (NOOBS = 2)
Domain origin (south-west corner, kilometres)	Easting: 403.852 km Northing: 6370.438 km
Domain size	90 x 90 at 0.5 km resolution (45 km x 45 km)
Number of vertical levels	11
Vertical levels (m)	20, 40, 80, 120, 160, 320, 640, 1200, 2000, 3000, 4000
CALMET settings for No Observations mode	TERRAD = 8 km

Parameter	Specification
Prognostic data	WRF wind simulations
Land use data	Land use data was sourced from Catchment Scale Land Use Mapping for Western Australia (Australian Bureau of Agricultural and Resource Economics and Sciences, 2021).
Terrain data	Terrain data was sourced from Lakes CALPUFF View.

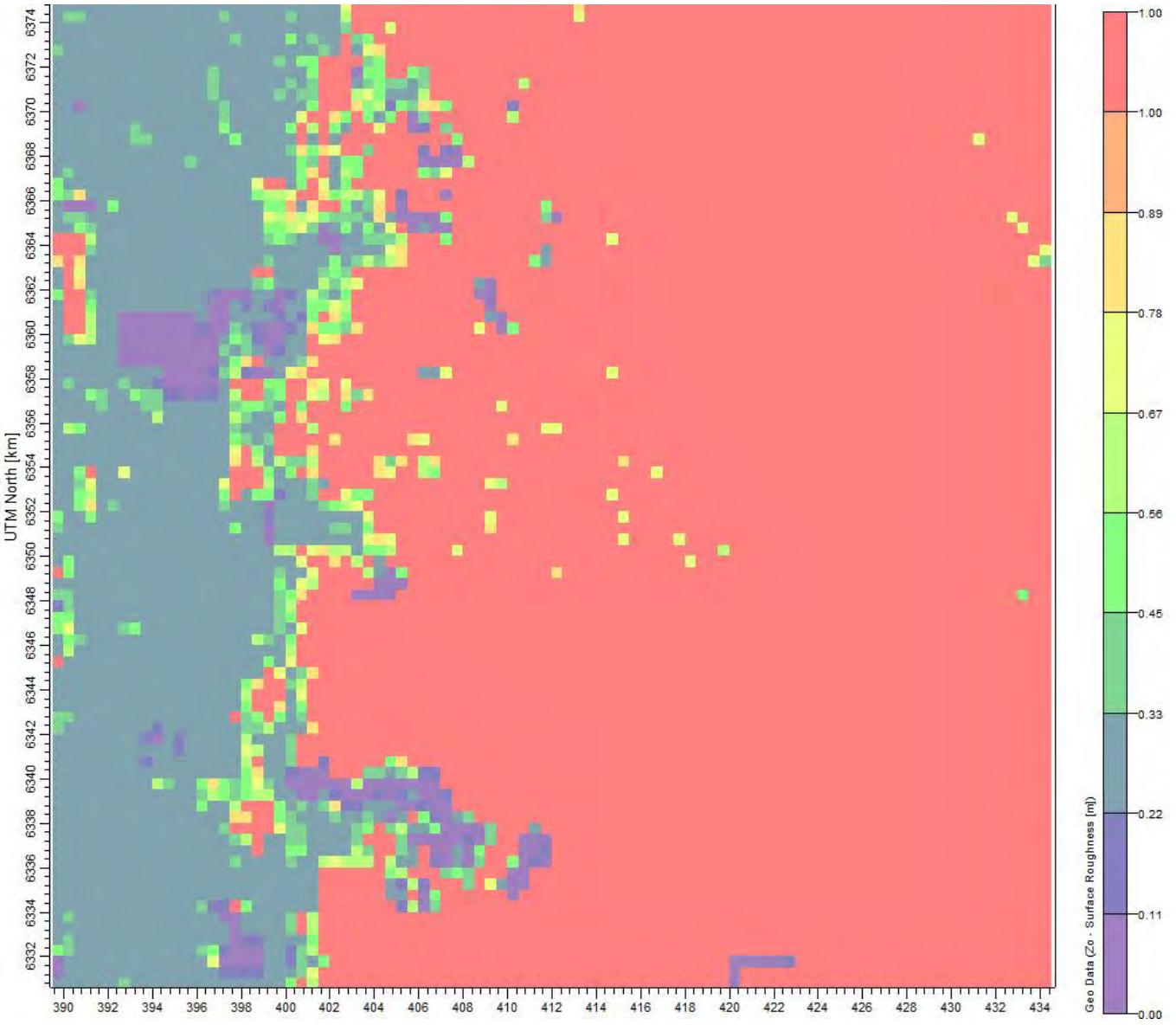


Figure 6.2 CALMET land use data (as surface roughness)

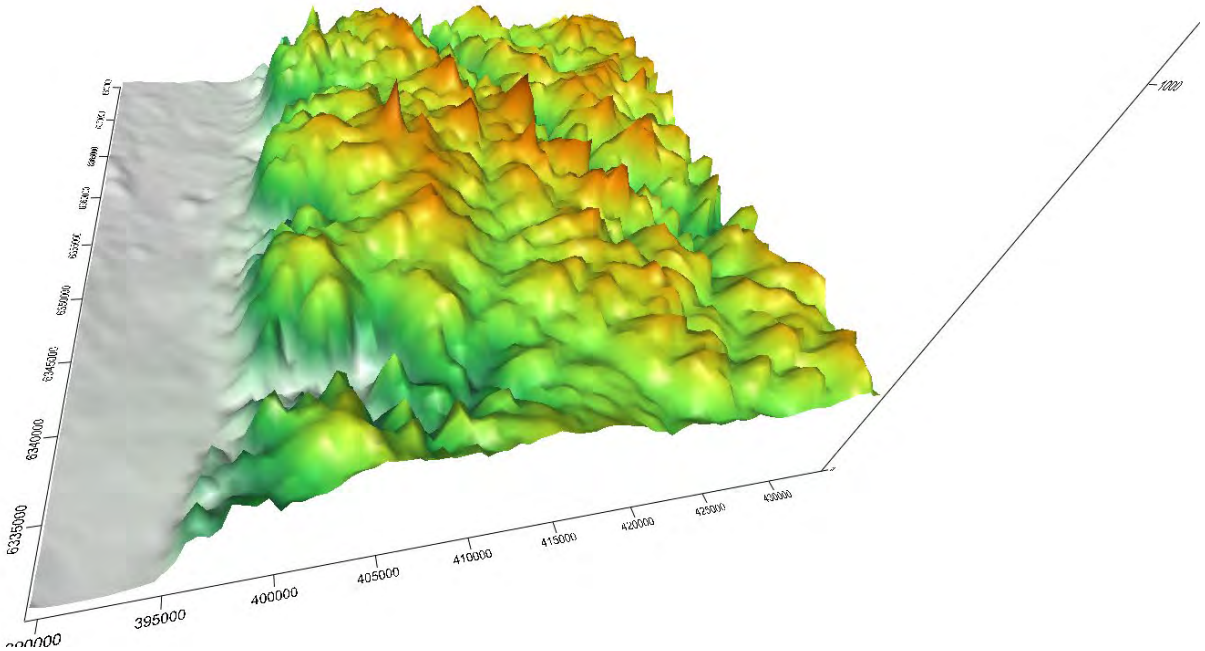


Figure 6.3 Exaggerated terrain data used for CALMET modelling (coordinates in m)

6.1.5 WRF model validation

WRF was assessed for validity in GHD (2021c), with this assessment summarising the findings. Overall, for the simulated meteorological year (March 2018 – February 2019):

– WRF simulated winds were stronger in comparison to the observations. WRF slightly overpredicted wind speeds, particularly for east and south easterly winds.
– Overall, WRF failed to capture the speed of the typical northerly winter wind flows or the south westerly coastal breeze wind speeds in the late spring.

WRF was considered acceptable to use as prognostic data in CALMET.

6.1.6 CALMET model validation

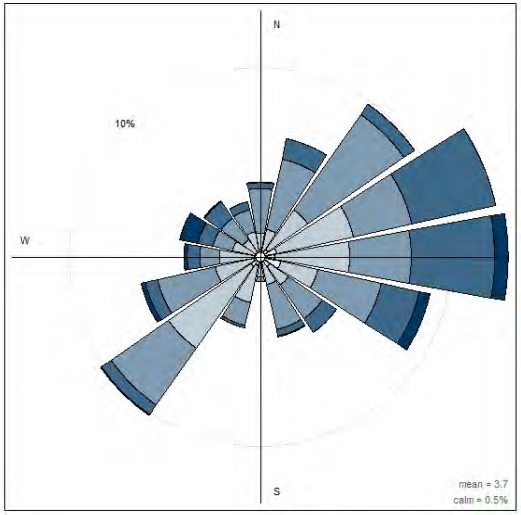
This section presents a summary of the key meteorological conditions predicted by CALMET at the Site.

Wind speed and direction

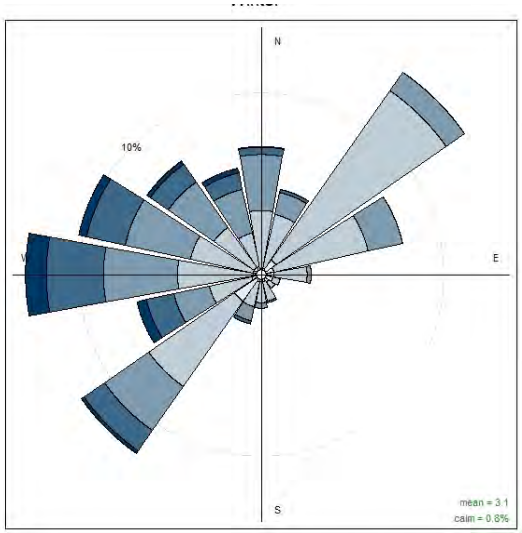
A summary of the annual and seasonal wind behaviour predicted by CALMET for the Larego Mine Region is presented in Figure 6.4. The wind speed and direction for Dwellingup meteorological station is presented in Figure 6.5. The average wind speed at the Dwellingup meteorological station for the modelled period was 4 m/s, which is higher than the average wind speed of 3.1 m/s predicted by CALMET at Larego Mine Region. The wind direction at the Dwellingup meteorological station is predominantly from south east for all seasons expect for winter when winds from north west are also dominant. The predicted wind direction at Larego Mine Region is predominantly from east and south west for all seasons expect for winter when winds from west are also dominant. This difference is likely representative of the difference in surface roughness between the surface station and Larego Mine Region.

Low wind speeds are associated with less atmospheric mixing and therefore can predict higher amounts of dust. Alternatively, higher wind speeds can generate windblown dust emissions from exposed surface areas and can also contribute to elevated ambient particulate concentrations.

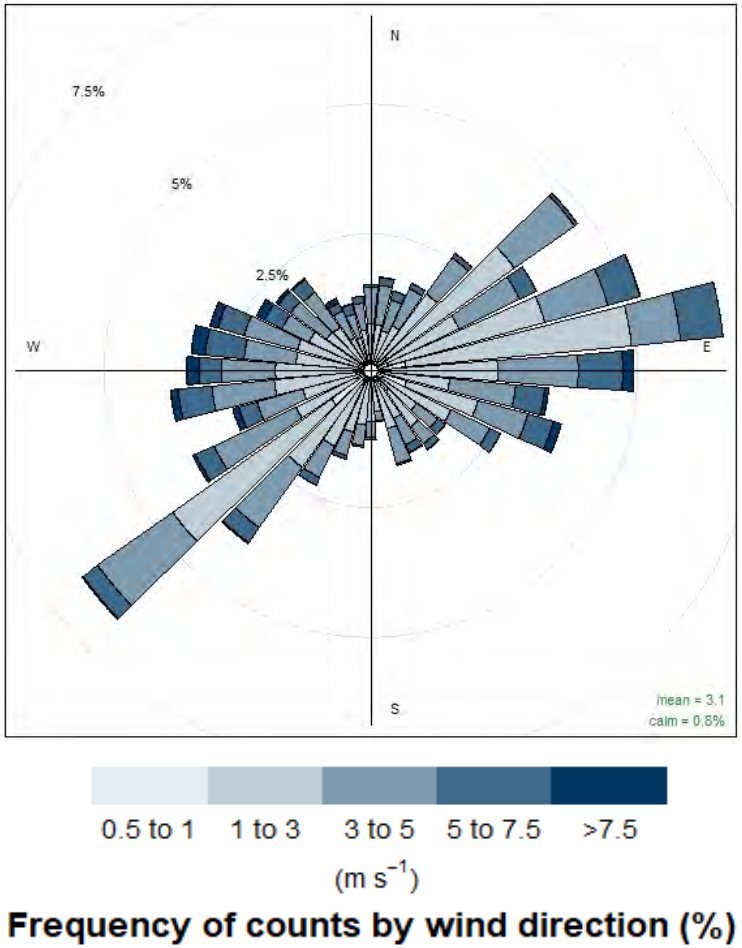
Autumn



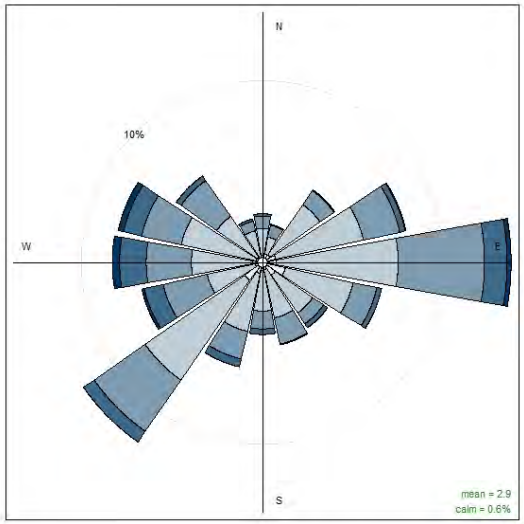
Winter



Annual



Spring



Summer

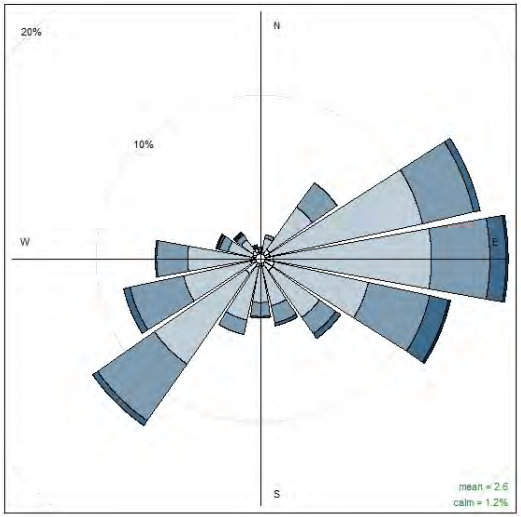
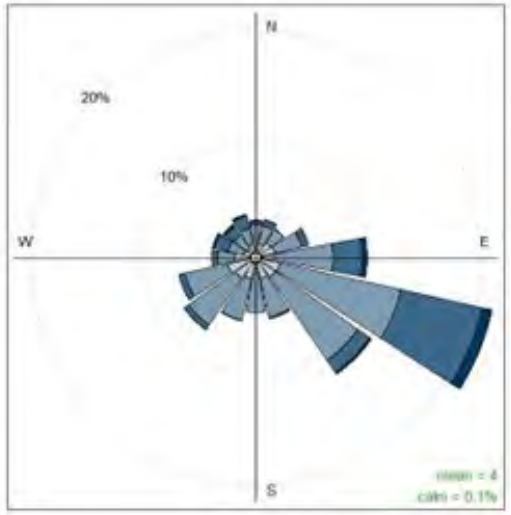
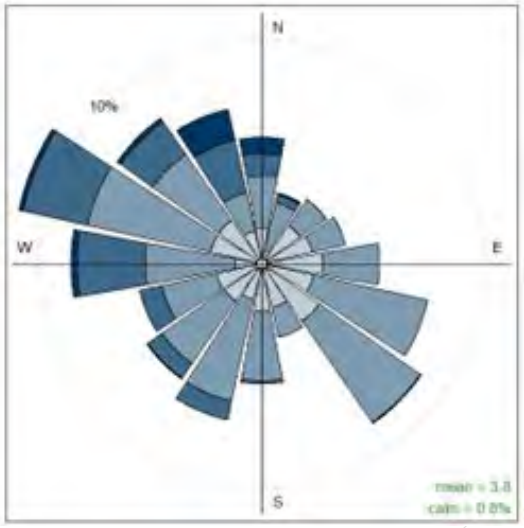


Figure 6.4 CALMET extracted wind data for Larego Mine Region at (X,Y) – (412273, 6349664)

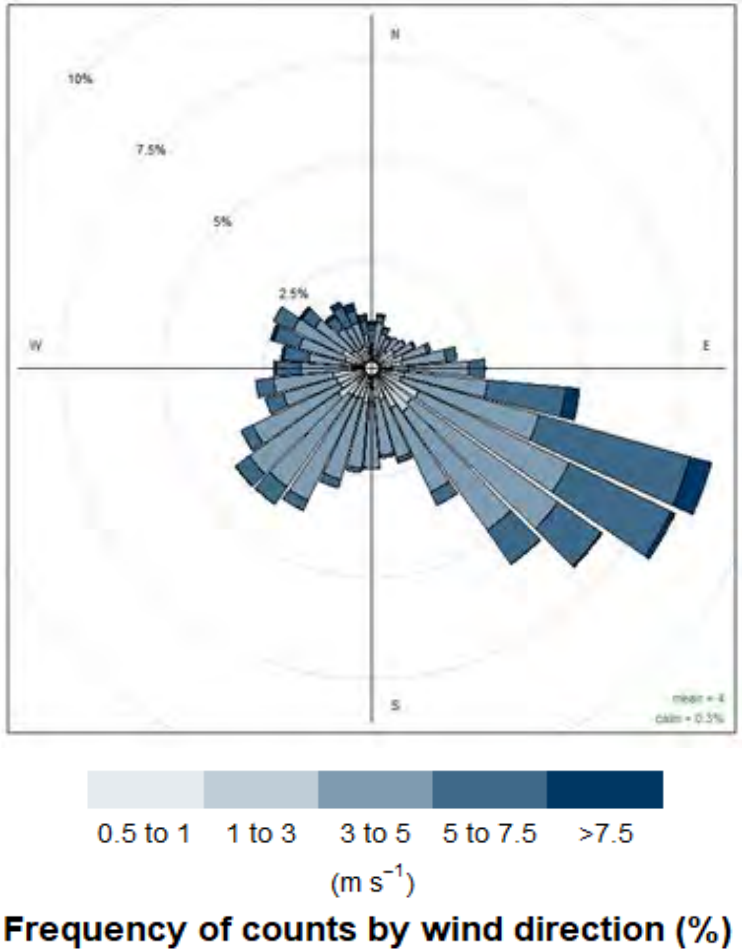
Autumn



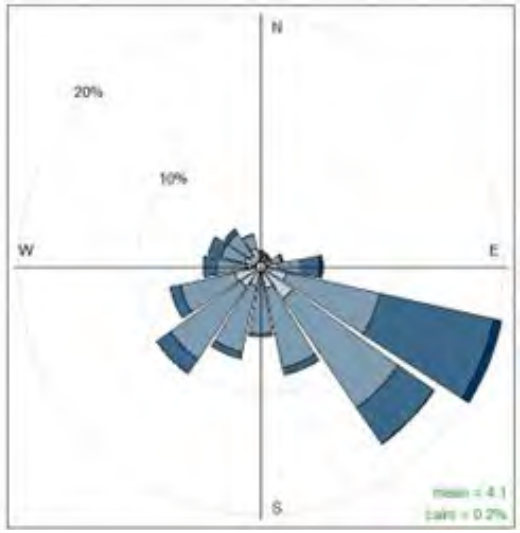
Winter



Annual



Spring



Summer

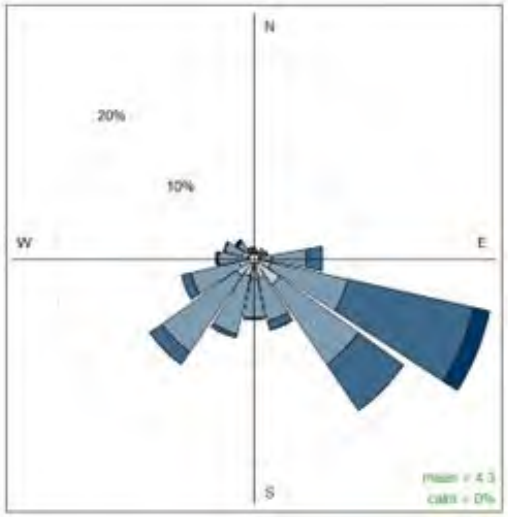


Figure 6.5 Dwellingup meteorological station wind data (March 2018 – February 2019)

Atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and insolation are used to define the stability category as shown in Table 6.3, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of each stability category.

Table 6.3 Stability category relationship to wind speed, and stability characteristics

Stability category	Wind speed range (m/s) a	Stability characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud
D	≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds or during periods of total cloud cover, or during the transitional twilight periods of dawn and dusk
E	3.4 – 5.4 [b]	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds
a: Data sourced from the Turner's Key to the P-G stability categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am) b: Assumed to only occur at night, during Net Radiation Index categories of –2.		

Figure 6.6 shows the frequency distribution of stability classes at Larego Mine Region as predicted by CALMET. The figure shows that stable atmospheres (E and F) occur for approximately 35 percent, unstable atmospheres (A, B and C) occur 27 percent and neutral conditions (D) occur 37 percent of the 2018-19 model year.

Worst case pollutant dispersion typically occurs during stability class E and F conditions due to relatively low amounts of turbulence and therefore low levels of pollutant dispersion and mixing with ambient air. Stability class E and F conditions generally occur during calm periods at night and early in the morning. Workers should be informed about what worst case pollutant dispersion conditions are, when they are likely to occur and if any specific mitigation measures should be implemented.

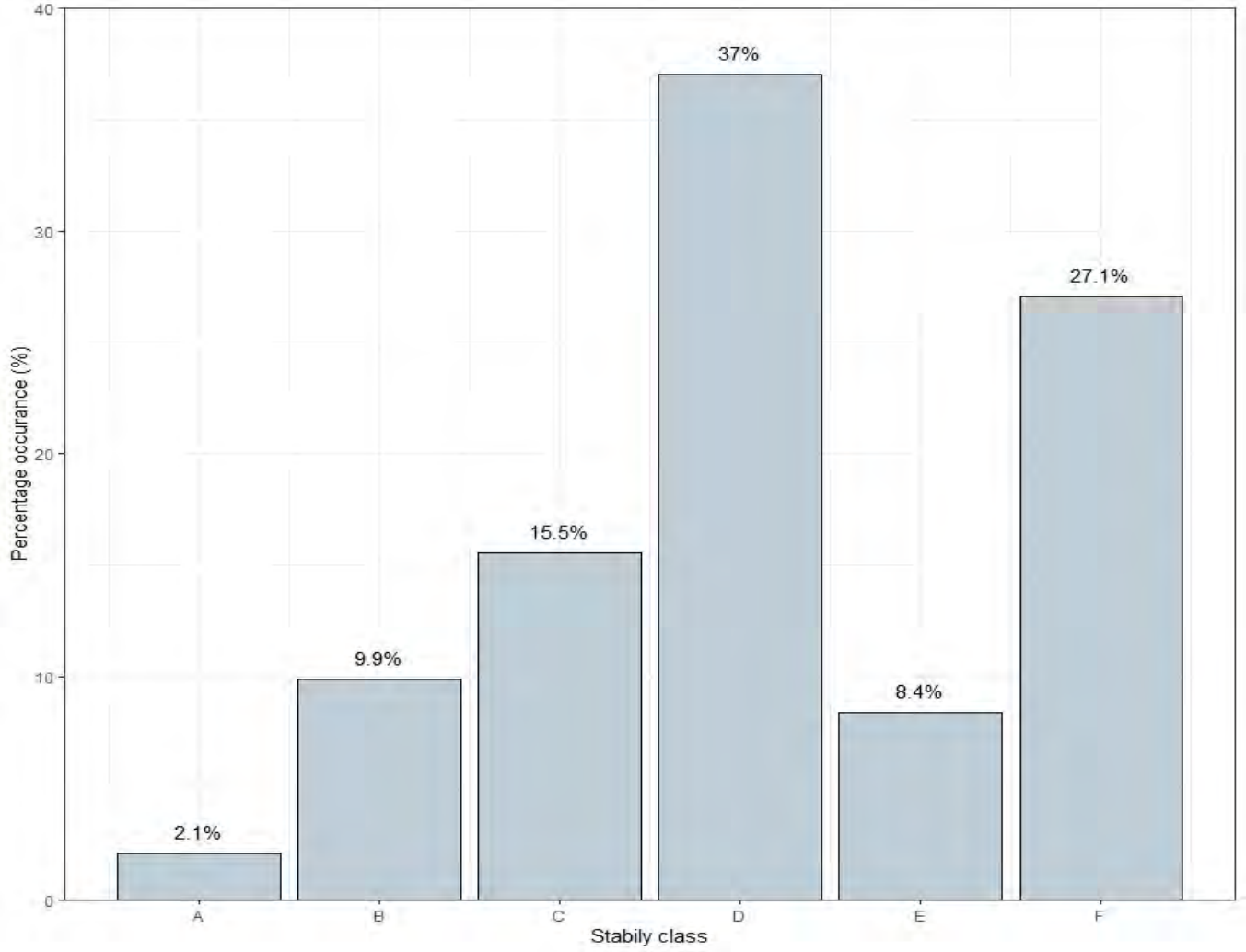


Figure 6.6 Stability class distribution predicted by CALMET for Larego Mine Region

Mixing height

Mixing height signifies the height above the surface of the earth throughout which a pollutant can be disperse. It is often associated with a sharp increase in temperature with height (inversion), and a sharp decrease in pollutant concentration.

A box plot of CALMET predicted mixing heights for Larego Mine Region is shown in Figure 6.7. During the night and early morning hours, mixing heights are lower with an average of approximately 417 m (7:00 pm to 7:00 am), which then increase after sunrise to an average of approximately 724 m during the day (7:00 am to 7:00 pm).

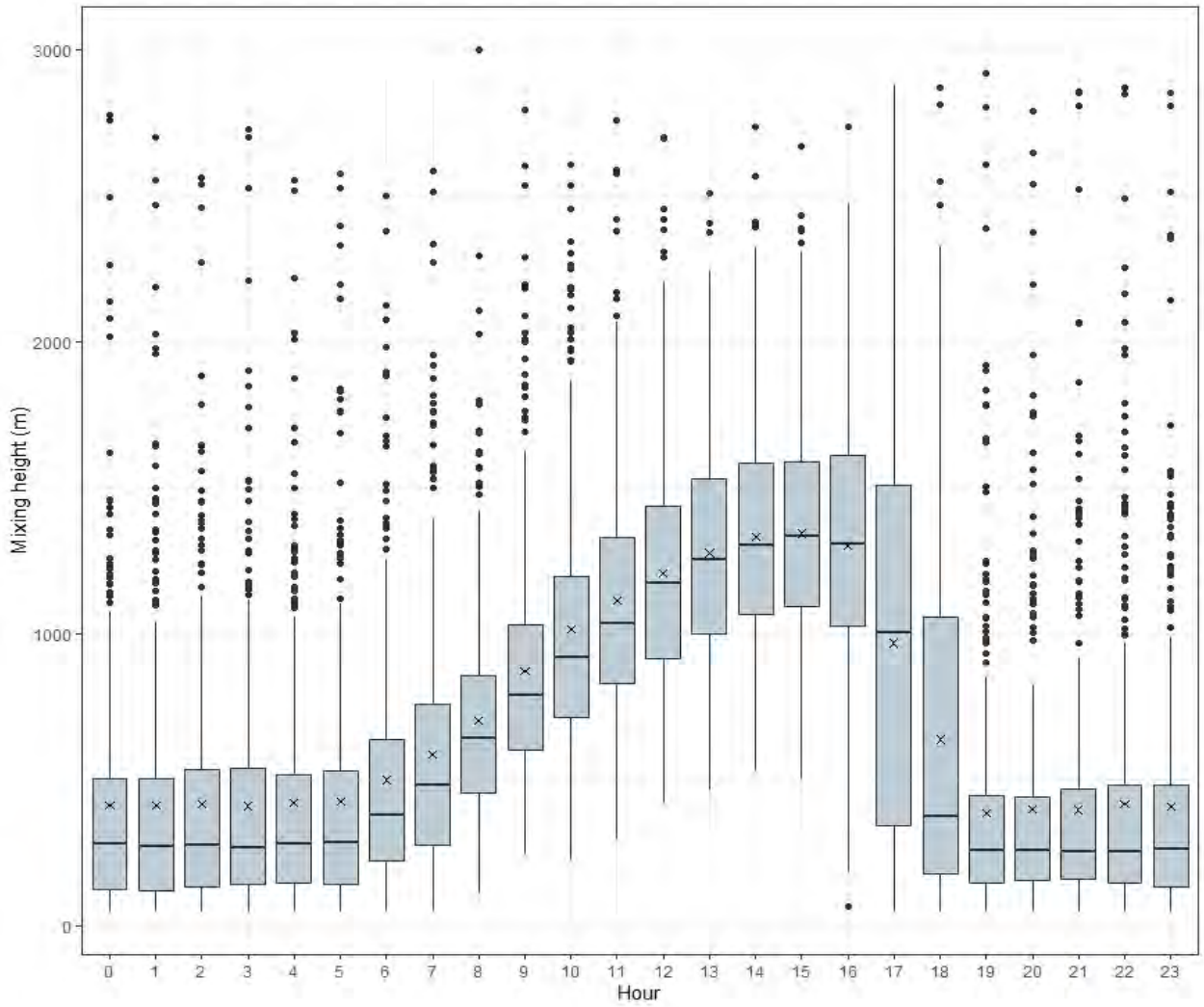


Figure 6.7 Mixing heights predicted by CALMET at Larego Mine Region

6.2 Dust dispersion modelling methodology

The dispersion model CALPUFF (v7.2.1) was used to simulate the dispersion characteristics of dust generated by the Proposal. CALPUFF uses the three-dimensional wind field from CALMET (Section 6.1.4) to simulate the dispersion of air pollutants and predicts ground level concentrations (GLCs). Modelling the pollutant concentrations with CALPUFF for the Proposal is consistent with Department of Environment (2006) and NSW EPA (2022); in addition to the air quality modelling for Alcoa's Pinjarra Refinery (GHD, 2021c).

6.3 CALPUFF configuration

The model parameters and inputs were:

– Meteorological configuration for WRF, CALWRF and CALMET is described in Section 6.1
– CALPUFF computational domain size of 45 km x 45 km with 0.5 km, and a sampling grid of 38 km x 38 km with 0.5 km spacing
– Method used to compute dispersion coefficients (MDISP) value of 3 was selected (model default)

6.3.1 Dispersion model settings

Predicted air quality impacts were modelled in accordance with the Approved Methods (EPA NSW, 2022) using CALPUFF. CALPUFF is a non-steady-state, Gaussian puff dispersion model widely accepted for use by DWER (Department of Environment, 2006) for application in environments where wind patterns and plume dispersion are

strongly influenced by complex terrain, the land sea interface or where there is a high frequency of stable, calm night time conditions.

CALPUFF model settings were selected with consideration of the recommendations provided in the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia (Barclay & Scire, 2011).

For this assessment, the CALPUFF dispersion model was used to predict ground level maximum (100th percentile) pollutant concentrations from the Proposal in accordance with air quality modelling guidance supplied in the Approved Methods (EPA NSW, 2022). The averaging period and percentile of each pollutant was chosen to align with its assessment criteria.

The grid size used in CALPUFF was equivalent to the CALMET domain (use of CALMET further discussed in Section 6.1.4). The same grid resolution of 500 m used for the CALMET model was used in CALPUFF, was used to present predicted pollutant concentrations. The CALPUFF dispersion model utilised a meteorological dataset of one year in duration.

The following model source parameter assumptions were adopted:

– Blasting was modelled as a volume source
– Operational mining pit activities including mine pit development, mining and mine pit rehabilitation (includes emissions from excavator, dozer, loader, scraper and drilling) were combined and modelled as volume sources for mine pit development, mining and mine pit rehabilitation respectively
– Wheel generated dust from haul trucks was modelled as a road source along proposed haulage routes into mine pits for loading
– Processing activities (crushing, screening and loading of stockpiles) were combined and modelled as a volume source
– Wind erosion from exposed areas was modelled as an area source

7. Air quality emissions

7.1 Emissions overview

Dust was identified as the primary emission to air that could occur during operation (operation encompasses clearing, mine pit development, mining and mine pit rehabilitation) of the Proposal. An overview of operational activities, including a description of the activity and identification of dust emission sources with potential to cause dust emissions, is provided in Table 7.1. Some variability of dust sources in each scenario is noted.

Table 7.1 Summary of dust emission sources

Operational activity	Activity description	Overview of dust emission sources
Clearing	– Vegetation clearing – Removal of topsoil/ overburden and handling/ stockpiling for use in mine pit rehabilitation	– Use of dozers to clear land – Use of excavators, loaders and scrapers to handle and stockpile topsoil/overburden
Mine pit development	– Drilling and blasting of caprock	– Use of drilling rig to drill holes in caprock – Blasting of caprock and removal of caprock via use of dozers – Use of excavators, loaders and scrapers to remove top layer of material
Mining	– Ore extraction and loading for transportation	– Use of excavators to extract ore – Loading of ore into haul trucks
Mine pit rehabilitation	– Landscaping including pre-ripping of compacted pit floors and unmined areas, regrading and burying of rocks – Overburn return including dumping and spreading of soil – Contour ripping	– Use of dozers and winged or multi-tine to landscape mined pits – Dumping of overburden to mined areas in summer – Use of excavators, loaders and scrapers to handle/spread topsoil/overburden over rehabilitation area – Contour ripping via multi-tine
Transportation of extracted material/ore	– Transportation of ore from pit to crusher using mine haulage trucks	– Wheel generated dust from vehicle movements on unsealed surfaces (mine haul truck and low loaders) – Use of graders to maintain haulage routes
Material processing	– Ore processing including crushing and resizing of material	– Crushing and resizing of material – Transfer of processed material to conveyor
Exposed areas	– Exposed area with no vegetation ground cover – Stockpile of mined/processed material	– Windblown dust from exposed mine pits and stockpile areas

7.2 Mining equipment

A summary of the proposed mining equipment with a description of purpose is provided in Table 7.2.

Table 7.2 Summary of mining equipment and purpose

Type	Purpose
Water carts	Apply dust suppression watering to unsealed haul roads
Graders	Maintain haul roads
Drill rigs	Explorative investigation and preparation for blasting
Excavator	Excavation and handling of material
Mine haul trucks	Transportation of material
Loaders	Handling of material
Scrapers	Handling of material
Dozers	Ripping of caprock and handling of material
Low loaders	Transportation of plant and equipment
Crusher/sizer	Crushes material to desired size for transport

7.3 Operational staging

Mine pit development, mining and mine pit rehabilitation would occur concurrently in different pits throughout the operational area of the Proposal. Chronologically, at a particular mine pit, clearing occurs first, mine pit development second, followed by mining, then once all material has been extracted the areas remain untouched until rehabilitation begins in a staged approach.

A matrix that characterises the sequence of mine development, mining and rehabilitation throughout the Proposal is provided in Table 7.3 and Table 7.4. Definitions for the terms used in the matrix are provided below:

– **Future** – Future mining is planned for this mine pit. No dust emissions would occur from these areas.
– **Mine development** – Mine pit is undergoing development. Dust emissions from mine pit development and wind erosion would occur.
– **Mining** – Mine pit is undergoing mining. Dust emissions from mining operations and wind erosion would occur. However, mining equipment is only modelled as active for the first year of mining.
– **Rehabilitation underway** – Mine pit is undergoing rehabilitation. Dust emissions from mine pit rehabilitation and wind erosion would occur.
– **First year after completed rehabilitation** – Mine pit rehabilitation is completed and slightly reduced dust emissions from wind erosion would occur.
– **Second year after completed rehabilitation** – Mine pit rehabilitation is completed and some vegetation established. Dust emissions from wind erosion, although reduced by establishment of vegetation, would occur.
– **Third year after completed rehabilitation** – Mine pit rehabilitation is completed and dust emissions are significantly reduced by established vegetation.

Table 7.3 Mine pit development and mining matrix

Model scenario year	Scheduled mine pit year[4]			
	Year 1 - 2024	Year 2 - 2025	Year 3 - 2026	Year 4 - 2027
Year 1 – 2024	Mine development	Future	Future	Future
Scenario 1	Mining	Mine development	Future	Future
Year 2 – 2025				
Scenario 2	Mining	Mining	Mine development	Future
Year 3 – 2026				
Scenario 3	Rehabilitation underway	Mining	Mining	Mine development
Year 4 – 2027				

Table 7.4 Rehabilitation matrix

Model scenario year	Scheduled rehab pit year[5]					
	2021	2022	2023	2024	2025	2026
Year 1 – 2024	Third year after completed rehabilitation	Second year after completed rehabilitation	First year after completed rehabilitation	Rehabilitation underway	Future rehabilitation	Future rehabilitation
Scenario 1	-	Third year after completed rehabilitation	Second year after completed rehabilitation	First year after completed rehabilitation	Rehabilitation underway	Future rehabilitation
Year 2 – 2025						
Scenario 2	-	-	Third year after completed rehabilitation	Second year after completed rehabilitation	First year after completed rehabilitation	Rehabilitation underway
Year 3 – 2026						
Scenario 3	-	-	-	Third year after completed rehabilitation	Second year after completed rehabilitation	First year after completed rehabilitation
Year 4 – 2027						

A summary of each scenario is provided below:

– Scenario 1, or Year 2 in mining schedule – Mine pit development and mining would occur in Year 2 and Year 1 clearing pits respectively. Mine pit rehabilitation would occur in pits scheduled for rehabilitation in 2025.

– Scenario 2, or Year 3 in mining schedule – Mine pit development would occur in Year 3 pits and mining would occur in Year 2 and Year 1 pits. Mine pit rehabilitation would occur in pits scheduled for rehabilitation in 2026.

– Scenario 3, or Year 4 in mining schedule – Mine pit development would occur in Year 4 pits and mining would occur in Year 3 and Year 2 pits. Mine pit rehabilitation is assumed to occur in Year 1 pits.

7.4 Emissions estimations

Dust emissions were estimated based on:

– Activity rates linked to annual material extraction rates provided in the mining schedule, and

– Documented emissions factors and control efficiencies provided in the:

  - National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual for Mining (Australian Government, 2012)

[4] Timing of each stage is variable and the below is for modelling purposes only
[5] Timing of each stage is variable and the below is for modelling purposes only

- United States Environmental Protection Agency (US EPA) Air Emissions Factors and Quantification AP42 Section 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing

The emissions inventory was prepared based on the following assumptions, noting that a detailed account of all mitigation measures assumed is provided in Appendix A.

– A material moisture content of eight percent and silt content of 10 percent was assumed, based on advice from Alcoa.

– Total plant and equipment quantities were provided by Alcoa and were allocated to mine pit development, mining and mine pit rehabilitation and are summarised in Table 7.5. Mine development and mining plant and equipment were modelled as active for all allowable hours based on their allocated pit.

Table 7.5 Summary of plant and equipment allocation to each operational activity

Operational activity	Plant/equipment	Quantity
Clearing and mine pit development	Drill rigs	2
	Excavators	2
	Loaders	1
	Scrapers	3
	Dozers	7
Mining	Excavators	3
Mine pit rehabilitation	Excavators	2
	Loaders	1
	Scrapers	2
	Dozers	4

Assumptions relating to mine pit development, mining and mine pit rehabilitation are summarised in Table 7.6.

Table 7.6 Assumptions for Scenario 1, Scenario 2 and Scenario 3

Operational activity	Parameter	Scenario 1	Scenario 2	Scenario 3
Mine development	Mine development area	282.9 ha	168.7 ha	53.6 ha
	Topsoil/overburden removal depth	0.7 m	0.7 m	0.7 m
	Volume of material removed	1,980,114 m^3	1,180,866 m^3	374,897 m^3
	Topsoil/overburden density	1.5 t/m^3	1.5 t/m^3	1.5 t/m^3
	Tonnes of topsoil/ overburden removed	3 Mtpa	1.8 Mtpa	0.6 Mtpa
	Material handled by excavators, loaders and scrapers	3 Mtpa	1.8 Mtpa	0.6 Mtpa
Mining	Mining throughput	10.5 Mtpa	10.4 Mtpa	10.8 Mtpa
	Material handled by excavators and loaded to haul trucks	10.5 Mtpa	10.4 Mtpa	10.8 Mtpa
Mine pit rehabilitation	Mine rehabilitation area	201.8 ha	234.8 ha	173.1 ha
	Overburden return depth	0.4 m	0.4 m	0.4 m

Operational activity	Parameter	Scenario 1	Scenario 2	Scenario 3
	Volume of topsoil/ overburden returned	807,343 m^3	939,281 m^3	692,371 m^3
	Density of material	1.5 t/m^3	1.5 t/m^3	1.5 t/m^3
	Tonnage of topsoil/ overburden returned	1.2 Mtpa	1.4 Mtpa	1 Mtpa
	Material handled by excavators, loaders and scrapers	1.2 Mtpa	1.4 Mtpa	1 Mtpa

Assumptions common across both scenarios include:

– 33 holes are drilled each hour. Each drill rig drills small holes per hour, with each hole 0.127 m diameter and up to 1.8 m depth.
– For modelling purposes, it was assumed that the blast would occur between 12:00 pm and 1:00 pm each day, however blasting may occur between 9:00 am and 4:00 pm; thereby avoiding stable conditions with temperature inversions. A maximum blast area equal to 678 ha was applied from 2024 to 2027, equating to a maximum daily blast area of 0.46 ha, assuming blasting occur every day. Splitting over up to three blasting locations per day equates to an average blast size of 1548 m^2 and average blast hole depth of 1.8 m.
– Dozers operate for all allowable hours in their allocated pit.
– For mine pit rehabilitation, it was assumed that dust emissions from contour ripping via winged or multi-tine would be equivalent to that of a dozer. Therefore, dust emissions from contour ripping was modelled based on emissions factors used for dozers. It was assumed that dozers operated for all allowable hours in their allocated pit.

Assumptions relating to haulage routes include:

– Total vehicle kilometres travelled (VKT) of haul trucks was calculated by the average haul distance of the scenario multiplied by the required number of trips per hour. Mine truck haul distance was calculated as distance between the mining pit and crusher.
– Level 2 watering (>2 $L/m^2/h$) which achieves a 75 percent reduction in dust emissions was assumed to be applied to all haul routes.
– Light vehicles are primarily used to transport personnel to and from mine pits (e.g. at shift change overs) while most significant dust generating activities, such as mobile earth moving equipment are paused. Light vehicles are also used by supervision, maintenance, environmental, health and safety personnel on a non-routine basis. Dust emissions from light vehicles are therefore considered minor and irregular and were not included in dispersion modelling.

Assumptions relating to material processing at the crusher include all material is processed via the screen and crusher. The crusher was assumed to be enclosed with water sprays.

Assumption relating to wind erosion include:

– Mining pits undergoing mine pit development, active mining and rehabilitation were assumed to be exposed and would contribute to unmitigated wind-blown dust.
– Open areas that are yet to undergo rehabilitation would contribute to unmitigated wind-blown dust.
– Overburden was assumed to be applied and minor regrowth assumed in the first year after completion of rehabilitation, which achieved 30 percent reduction in dust emissions.
– More regrowth was assumed in the second year after completion of rehabilitation, which along with overburden achieved 60 percent reduction in dust emissions.
– Establishment of revegetation was assumed in the third year after completion of rehabilitation, which achieved 90 percent reduction in dust emissions.
– The use of specific TSP, PM_{10}, $PM_{2.5}$ and RCS emissions factors were prioritised where available, however if sufficient data was not available, the following emissions ratios were assumed:

- $PM_{2.5}/PM_{10}$ ratio of 0.1 was assumed based on the findings of *Evaluation of Residue Dust Emissions Pinjarra and Kwinana Refineries* (Air Assessments, 2008)
- $RCS/PM_{2.5}$ ratio of 0.022 was assumed based on the findings of *Alcoa Huntly Expansion Environmental Approval Respirable Crystalline Silica Ambient Air Monitoring Results* (GHD, 2021a)

A summary of the dust emissions inventory for the Proposal is provided in Table 7.7 and a detailed emission inventory is provided in Appendix A. Dust management practises were assumed from information provided by Alcoa.

Table 7.7 Summary of emissions inventory

Activity	Emission rate per source (g/s)				Total source emission (t) for mine operation period			
	TSP	PM_{10}	$PM_{2.5}$	RCS	TSP	PM_{10}	$PM_{2.5}$	RCS
Scenario 1 – Year 2								
Mine development (blasting)	11.2	5.8	0.6	0.01	14.7	7.6	0.8	0.02
Mine development	8.5	2.0	0.2	4.50×10^{-3}	269	64.5	6.4	0.1
Mining	0.2	0.1	0.01	2.12×10^{-4}	6.8	3.0	0.3	0.01
Mine rehabilitation	4.7	1.1	0.1	2.43×10^{-3}	73.3	17.3	1.7	0.04
Mine facilities	19.4	4.0	0.4	0.01	611.4	124.9	12.5	0.3
Exposed areas	160.8	80.4	8.0	0.2	5,070.9	2,535.5	253.5	5.6
Haul roads	31.2	9.2	0.9	0.02	982.5	290.6	29.1	0.6
Total	**235.9**	**102.6**	**10.3**	**0.2**	**7028.8**	**3043.4**	**304.3**	**6.7**
Scenario 2 – Year 3								
Mine development (blasting)	11.2	5.8	0.6	0.01	14.7	7.6	0.8	0.02
Mine development	7.4	1.7	0.2	3.84×10^{-3}	232.9	55.1	5.5	0.1
Mining	0.2	0.1	0.01	2.11×10^{-4}	6.8	3.0	0.3	0.01
Mine rehabilitation	4.9	1.2	0.1	2.59×10^{-3}	77.4	18.5	1.9	0.04
Mine facilities	19.4	4.0	0.4	0.01	610.8	124.8	12.5	0.3
Exposed areas	162.9	81.4	8.1	0.2	5,135.9	2,568	256.8	5.6
Haul roads	42.2	12.5	1.2	0.03	1332.3	393.9	39.4	0.9
Total	**248.2**	**106.7**	**10.7**	**0.2**	**7410.8**	**3170.8**	**317.1**	**7**
Scenario 3 – Year 4								
Mine development (blasting)	11.2	5.8	0.6	0.01	14.7	7.6	0.8	0.02
Mine development	6.2	1.4	0.1	3.19×10^{-3}	196.5	45.7	4.6	0.1
Mining	0.2	0.1	0.01	2.18×10^{-4}	7.1	3.1	0.3	0.01

Activity	Emission rate per source (g/s)				Total source emission (t) for mine operation period			
	TSP	PM_{10}	$PM_{2.5}$	RCS	TSP	PM_{10}	$PM_{2.5}$	RCS
Mine rehabilitation	4.4	1.0	0.1	2.29×10^{-3}	69.8	16.3	1.6	0.04
Mine facilities	20.0	4.1	0.4	0.01	630.4	128.8	12.9	0.3
Exposed areas	145.7	72.9	7.3	0.2	4,596.1	2,298.1	229.8	5.1
Haul roads	45.3	13.4	1.3	0.03	1427.8	422.1	42.2	0.9
Total	**233.1**	**98.7**	**9.9**	**0.2**	**6942.4**	**2921.7**	**292.2**	**6.4**

7.5 Modelled source locations

An indicative 5-year mine plan was provided by Alcoa, which formed the basis for plant and equipment allocation. Allocation was based on anticipated worst case location, where areas located in closer proximity to sensitive receptors were allocated a larger portion of the available equipment.

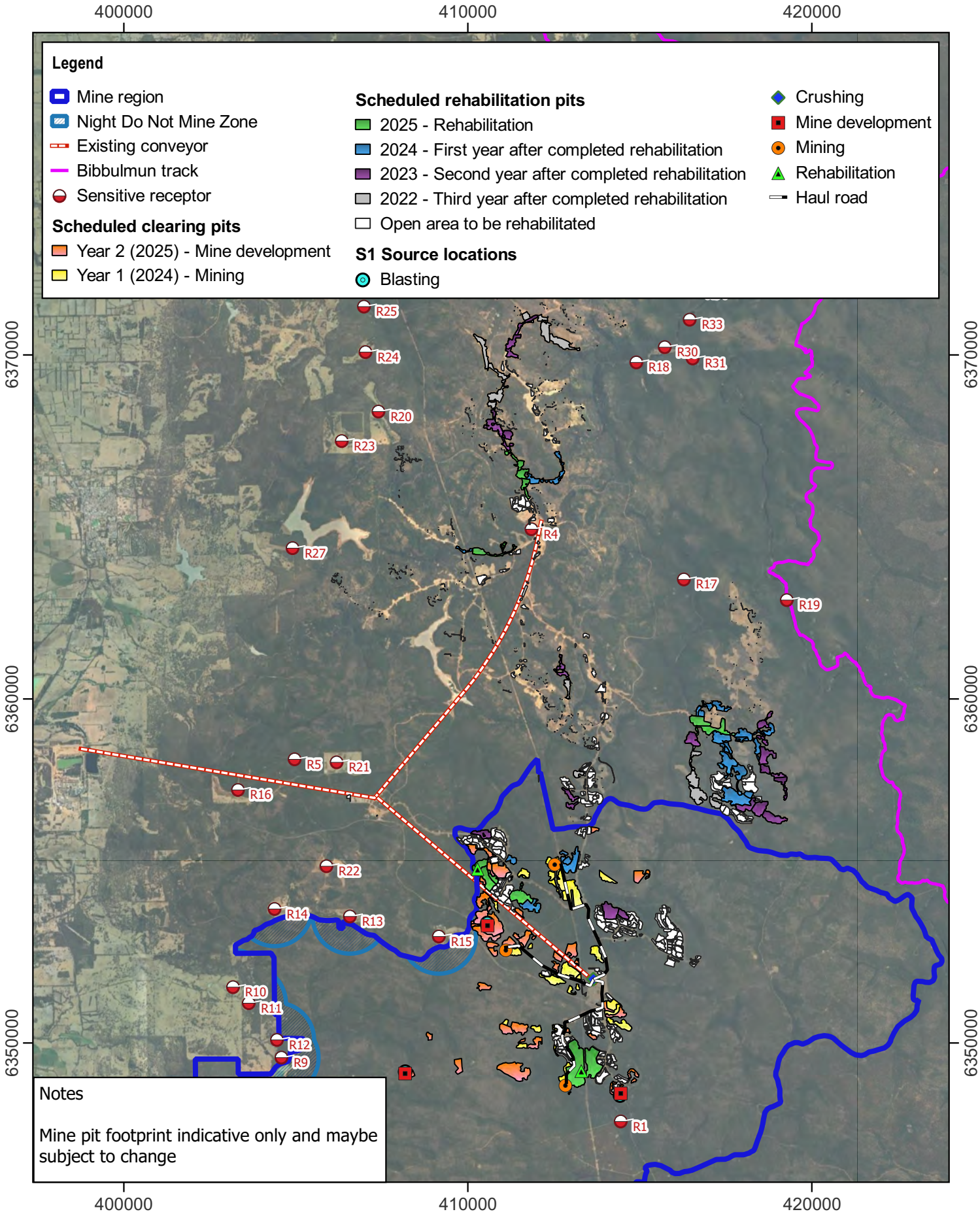
For Scenario 1 (Year 2), mine pit development was modelled from Year 2 pits and mining from Year 1 pits. For Scenario 2 (Year 3), mine pit development was modelled from Year 3 pits and mining from Year 2 pit. For Scenario 3 (Year 4) mine development was modelled from Year 4 pits, mining from Year 3 pits and rehabilitation from Year 1 pits. Larger number of mine development plant/equipment were allocated to mine pits closer to receptors along the west and south of Larego Mine Region. All plant/equipment were generally placed close to mine region border along west or south due to presence of sensitive receptors in these directions.

This approach was adopted to assess the potential worst case impacts. It is acknowledged that plant and equipment would operate at these worst case locations for a limited duration and would be relocated when mining activities have been completed in that area. Consequently, the approach adopted in this assessment is considered conservative as plant and equipment are located in their anticipated worst case location for the entire modelling duration. However, in reality plant and equipment will move about the entire extent of the mine pit.

For each mine pit in all scenarios, all individual equipment were combined and modelled as a single volume source e.g. All mine development equipment within a pit area is combined as a single mine development source. Modelled source locations are shown in Figure 7.1, Figure 7.2 and Figure 7.3.

7.6 Management zone restrictions

Management zones for sensitive receptors close to Larego Mine Region were created as part of this SSIA to help exclude mining at night time. This Management zone is referred to as ‘Night do not mine zone’. No mine areas overlapped with the ‘Night do not mine zone’ management zone and hence all sources were placed outside this zone.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Modelled source locations for Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

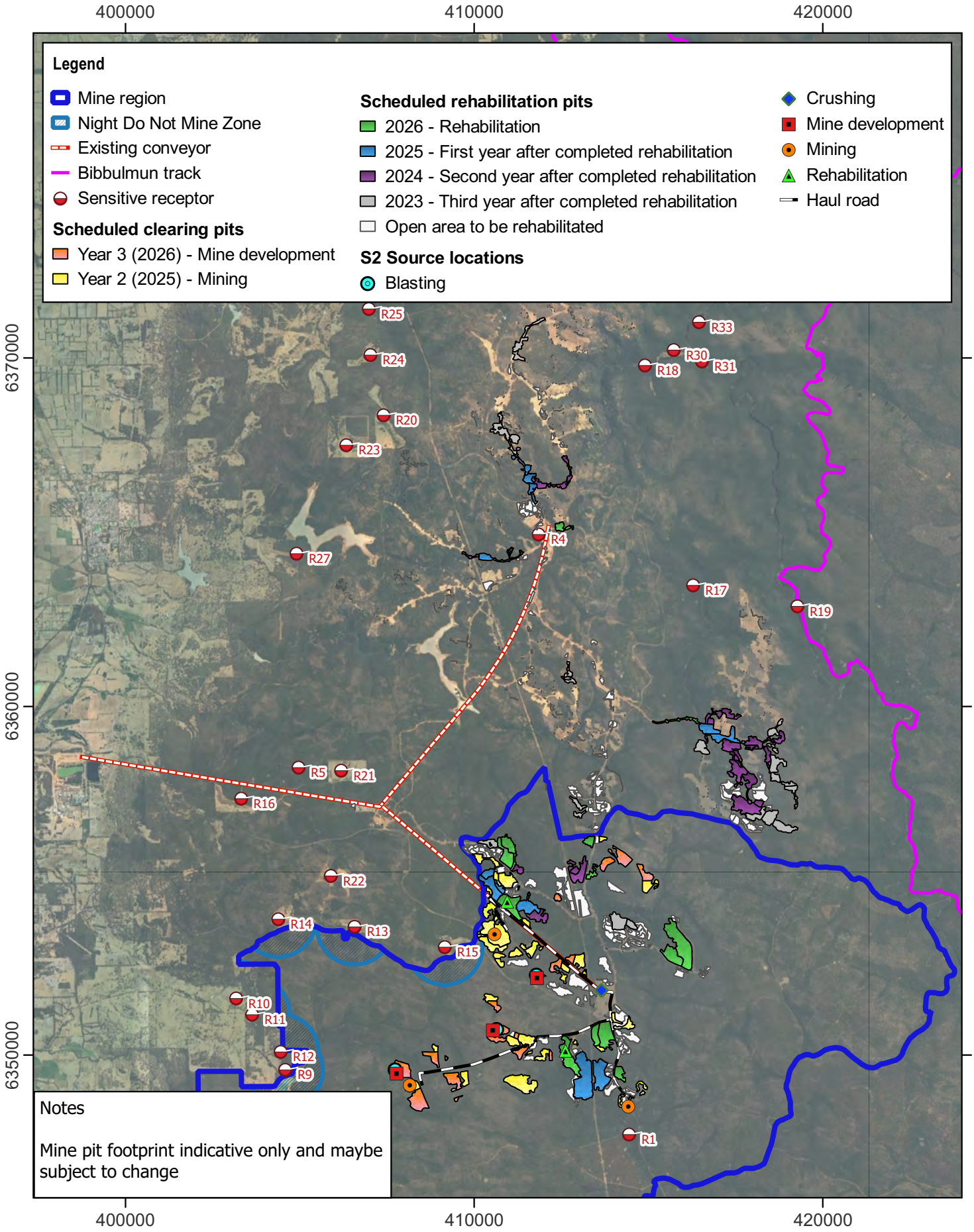
FIGURE 7.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, sensitive receptors; DBCA: trails.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Modelled source locations for Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

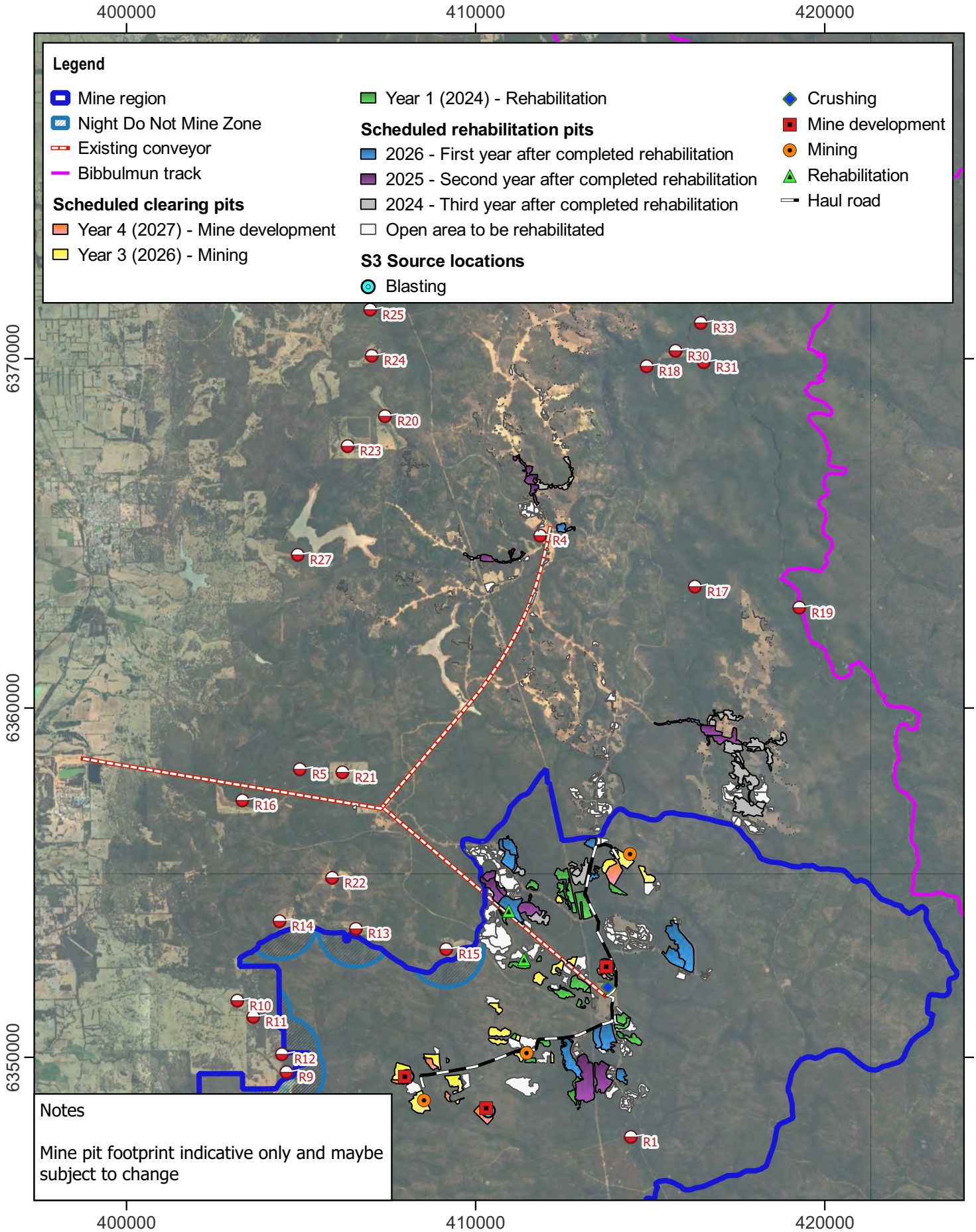
FIGURE 7.2

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, sensitive receptors; DBCA: trails.

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Created By: npaul



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Modelled source locations for Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

FIGURE 7.3

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, sensitive receptors; DBCA: trails.

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Created By: npaul

8. Construction impacts

This section outlines the qualitative assessment of emissions from development of Larego Mine Region. Potential air quality impacts during construction and site establishment activities would include heavy vehicle exhausts emissions and dust generation from heavy equipment during earthworks, and wind erosion from disturbed soil surfaces.

8.1 Construction overview

Construction would generally occur during day hours from Monday to Saturday. Construction during nighttime hours and Sundays would be avoided as far as practicable but may be required, subject to the construction program.

The development of Larego Mine Region may require a series of new haul roads. The haul roads would connect the proposed mine pits to the existing crusher located within Larego Mine Region. It is expected that haul road construction would entail cut and fill operations with the potential for blasting in selected areas.

Construction waste would be recycled and/or disposed off-site at licensed facilities, as per current procedures/practices. All wastes would be stored temporarily in bins, skips and tanks/drums, with hazardous wastes appropriately segregated.

8.2 Construction impacts

8.2.1 Gaseous emissions

Gaseous emissions from heavy machinery and equipment during construction would consist of products of combustion, including NOx, SO_2, PM_{10} and volatile organic compounds (VOCs).

Vehicle emissions would arise from diesel powered equipment used during construction. Emissions from heavy equipment will be minimised by ensuring all vehicles onsite are well maintained, operated efficiently and undergo regular maintenance.

It is anticipated that emissions from vehicles onsite would be discontinuous and varied in location, and as such, are not considered to represent a significant source of emissions in comparison to the operations within Larego Mine Region. However, the emissions will still be captured in the annual NPI reporting.

8.2.2 Construction dust emissions

The construction process would involve the operation of loaders, dozers, graders, excavators and trucks. The equipment would be used to excavate and remove material from construction areas and deposit and spread the material onsite (cut and fill).

Dust has potential to be generated during these activities as material is transported, spread and compacted onsite. The key dust causing mechanisms are:

- Vehicular movements on unsealed roads/track during working hours
- Clearing of vegetation
- Earthmoving activities
- Drilling and blasting
- Dust lift-off from wind on cleared areas and/or stockpiles
- Wind erosion dust emissions from exposed and disturbed soil surfaces under elevated wind speeds during construction (all hours with elevated wind speeds)

Dust emissions may be reduced by managing the level of disturbance from equipment movement and operation and by implementing management controls to reduce elevated dust emissions. Management and mitigation measures are provided in Section 11.

9. Operational impacts

9.1 Gaseous emissions

Gaseous emissions from heavy machinery and equipment during operation of Larego Mine Region would consist of products of combustion, including NO_x, SO_2, PM_{10} and volatile organic compounds (VOCs).

Vehicle emissions would arise from diesel powered plant and equipment used during operation. It is anticipated that emissions from vehicles onsite would be discontinuous and varied in location. Emissions from heavy equipment will be minimised by ensuring all vehicles onsite are well maintained, operated efficiently and undergo regular maintenance.

Therefore, gaseous emissions (from plant, equipment, and vehicles) during operation of Larego Mine Region are considered manageable and relatively minor. Consequently, no air quality impacts from gaseous emissions are anticipated. However, emissions will still be captured in the annual NPI reporting.

9.2 Operational dust emissions

Dust emissions from the operation of Larego Mine Region were quantitatively assessed using air quality dispersion modelling. The results of the modelling are presented in Section 10.

10. Modelling results

Air quality dispersion modelling was undertaken to predict potential worst case incremental and cumulative air quality impacts from the Proposal in accordance with the methodology outlined in Sections 3 and 6. The averaging period and percentile presented for each air quality species were selected based on the appropriate assessment criteria (refer Section 4).

The model predictions for each scenario are presented as tabulated results providing ground level concentrations at each sensitive receptor and as contour plots to illustrate the predicted pattern of dispersion. For each scenario, contour plots of predicted GLCs are provided in this section to show the general pattern of dispersion.

Predicted dust concentrations are presented in Section 10.1 and predicted dust deposition results are presented in Section 10.2.

10.1 Predicted dust concentrations

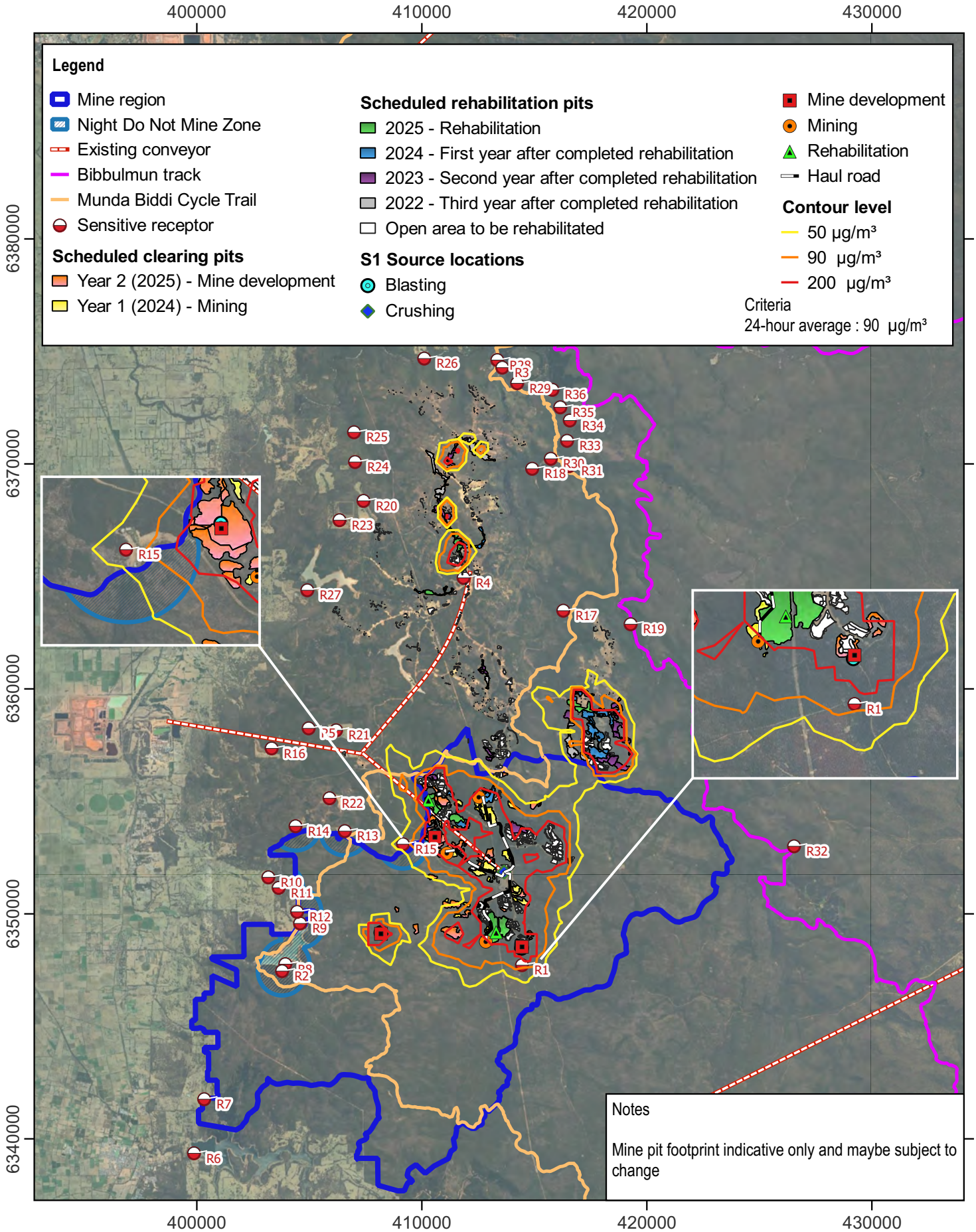
10.1.1 Scenario 1

Predicted incremental dust concentrations for Scenario 1, which is modelled as Year 2 of mining operations, are provided in Table 10.1. TSP maximum incremental 24-hour average concentrations predicted exceedance at R01 (highlighted in red). The exceedance occurred only once and on 22 February 2019. This is likely due to placement of mine development, mining and rehabilitation source in the worst case location relative to R01 and more area in southern pits contributing to unmitigated wind erosion emissions. Predicted incremental concentrations for PM_{10}, $PM_{2.5}$ and RCS were in compliance with the assessment criteria for all receptors. The contour plots for predicted incremental 24-hour and annual averages of TSP, PM_{10}, $PM_{2.5}$ and RCS ground level concentrations are provided in Figure 10.1 to Figure 10.8.

Table 10.1 Predicted dust concentrations for Scenario 1

Receptor	Predicted incremental air quality concentration (µg/m³) Scenario 1							
Pollutant	TSP		PM_{10}		$PM_{2.5}$		RCS	
Averaging period	24-hour	Annual	24-hour	Annual	24-hour	Annual	24-hour	Annual
Assessment criteria	90	90	50	25	25	8	10	3
R01	109.7	8.1	40.1	3.1	4.0	0.3	0.09	0.01
R02	3.5	0.3	1.5	0.1	0.2	0.01	3.36×10^{-3}	2.46×10^{-4}
R03	1.5	0.1	0.7	0.05	0.1	4.96×10^{-3}	1.46×10^{-3}	1.09×10^{-4}
R04	19.8	1.4	9.9	0.7	1.0	0.1	0.02	1.47×10^{-3}
R05	5.0	0.4	2.1	0.2	0.2	0.02	4.69×10^{-3}	3.82×10^{-4}
R06	0.7	0.04	0.3	0.02	0.03	1.83×10^{-3}	6.25×10^{-4}	4.03×10^{-5}
R07	1.8	0.1	0.8	0.03	0.1	2.54×10^{-3}	1.72×10^{-3}	5.59×10^{-5}
R08	3.5	0.3	1.5	0.1	0.2	0.01	3.37×10^{-3}	2.61×10^{-4}
R09	4.8	0.4	1.8	0.2	0.2	0.02	3.93×10^{-3}	3.33×10^{-4}
R10	1.9	0.2	0.8	0.1	0.1	0.01	1.66×10^{-3}	1.89×10^{-4}
R11	2.0	0.2	0.8	0.1	0.1	0.01	1.72×10^{-3}	2.24×10^{-4}
R12	6.0	0.4	2.2	0.2	0.2	0.02	4.77×10^{-3}	3.37×10^{-4}
R13	9.0	1.0	3.6	0.4	0.4	0.04	0.01	8.98×10^{-4}
R14	4.4	0.4	1.7	0.2	0.2	0.02	3.84×10^{-3}	4.09×10^{-4}
R15	67.1	5.8	24.4	2.5	2.4	0.3	0.05	5.60×10^{-3}
R16	2.0	0.2	0.9	0.1	0.1	0.01	1.89×10^{-3}	2.43×10^{-4}

Receptor	Predicted incremental air quality concentration (µg/m^3) Scenario 1							
Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**RCS**	
Averaging period	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
Assessment criteria	**90**	**90**	**50**	**25**	**25**	**8**	**10**	**3**
R17	6.5	0.8	2.8	0.3	0.3	0.03	0.01	7.70×10^{-4}
R18	2.3	0.3	1.2	0.1	0.1	0.01	2.54×10^{-3}	2.89×10^{-4}
R19	7.3	0.6	3.3	0.3	0.3	0.03	0.01	5.53×10^{-4}
R20	3.0	0.2	1.3	0.1	0.1	0.01	2.93×10^{-3}	2.57×10^{-4}
R21	6.2	0.5	2.7	0.2	0.3	0.02	0.01	5.23×10^{-4}
R22	5.0	0.8	2.2	0.3	0.2	0.03	4.87×10^{-3}	7.45×10^{-4}
R23	3.1	0.2	1.4	0.1	0.1	0.01	3.05×10^{-3}	2.20×10^{-4}
R24	2.0	0.2	0.9	0.1	0.1	0.01	2.00×10^{-3}	1.78×10^{-4}
R25	1.4	0.1	0.6	0.1	0.1	0.01	1.35×10^{-3}	1.27×10^{-4}
R26	1.2	0.1	0.6	0.03	0.1	3.43×10^{-3}	1.23×10^{-3}	7.55×10^{-5}
R27	1.9	0.2	0.8	0.1	0.1	0.01	1.70×10^{-3}	1.99×10^{-4}
R28	1.5	0.1	0.7	0.0	0.1	4.53×10^{-3}	1.44×10^{-3}	9.96×10^{-5}
R29	1.5	0.1	0.7	0.1	0.1	0.01	1.48×10^{-3}	1.29×10^{-4}
R30	2.4	0.2	1.0	0.1	0.1	0.01	2.25×10^{-3}	2.31×10^{-4}
R31	3.3	0.2	1.6	0.1	0.2	0.01	3.43×10^{-3}	2.39×10^{-4}
R32	1.9	0.2	0.9	0.1	0.1	0.01	1.92×10^{-3}	2.20×10^{-4}
R33	2.9	0.2	1.3	0.1	0.1	0.01	2.85×10^{-3}	1.94×10^{-4}
R34	2.9	0.2	1.3	0.1	0.1	0.01	2.88×10^{-3}	1.82×10^{-4}
R35	2.5	0.2	1.1	0.1	0.1	0.01	2.51×10^{-3}	1.64×10^{-4}
R36	2.2	0.2	1.0	0.1	0.1	0.01	2.22×10^{-3}	1.54×10^{-4}



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average TSP concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

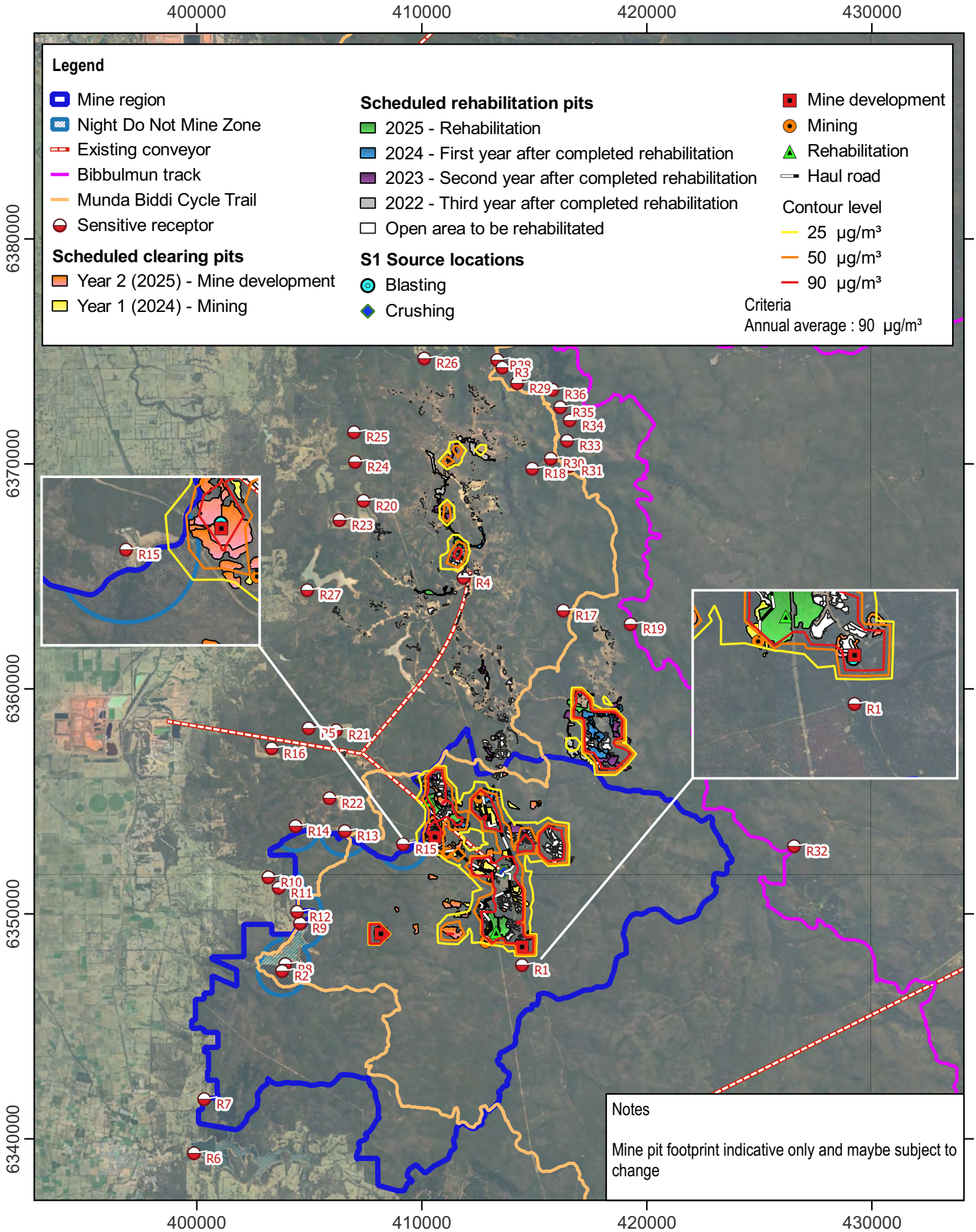
FIGURE 10.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Laregro Mine Region
Air Quality Impact Assessment

Predicted annual average TSP concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **07/10/2024**

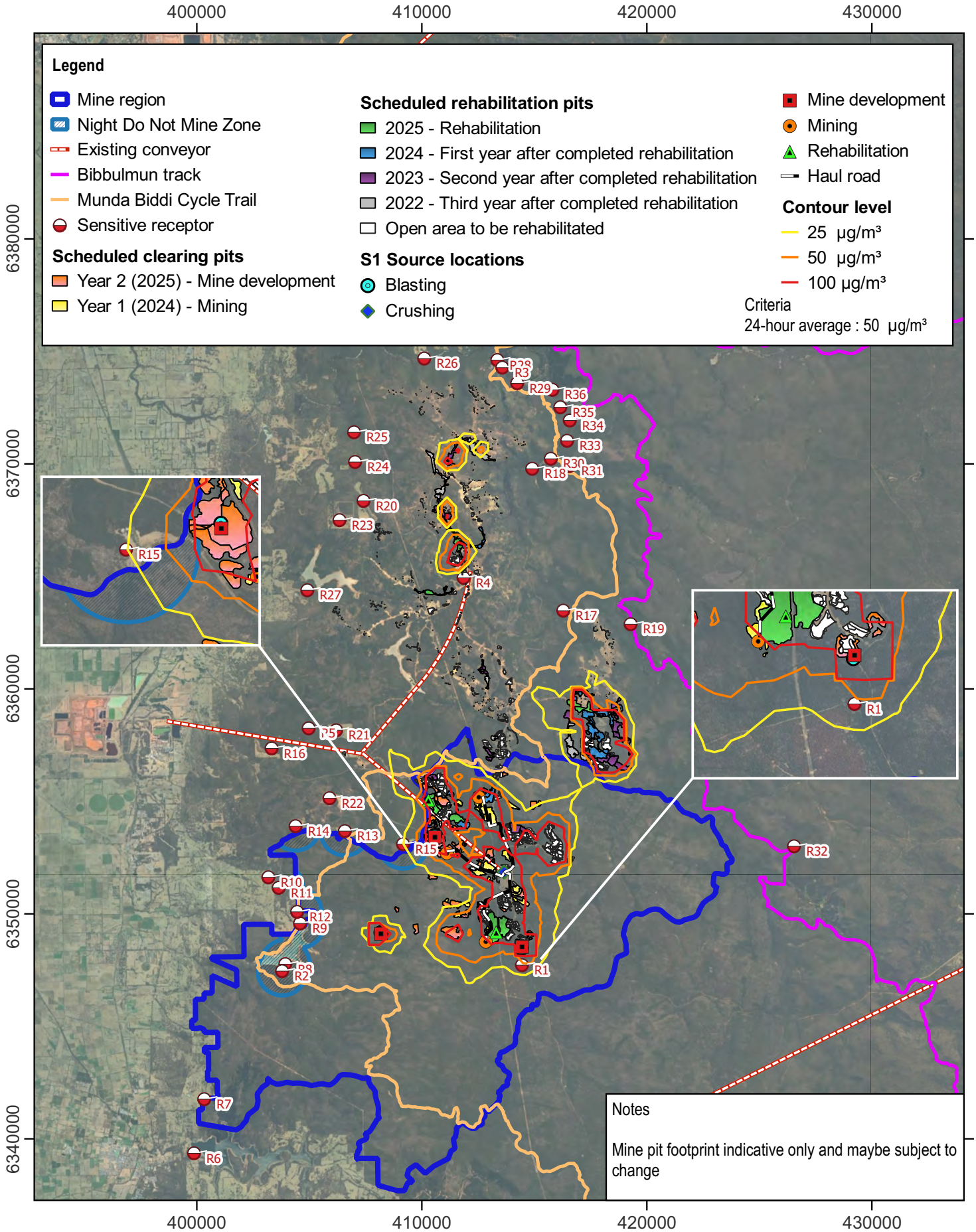
FIGURE 10.2

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregro.qgz
Print Date: 07/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM10 concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

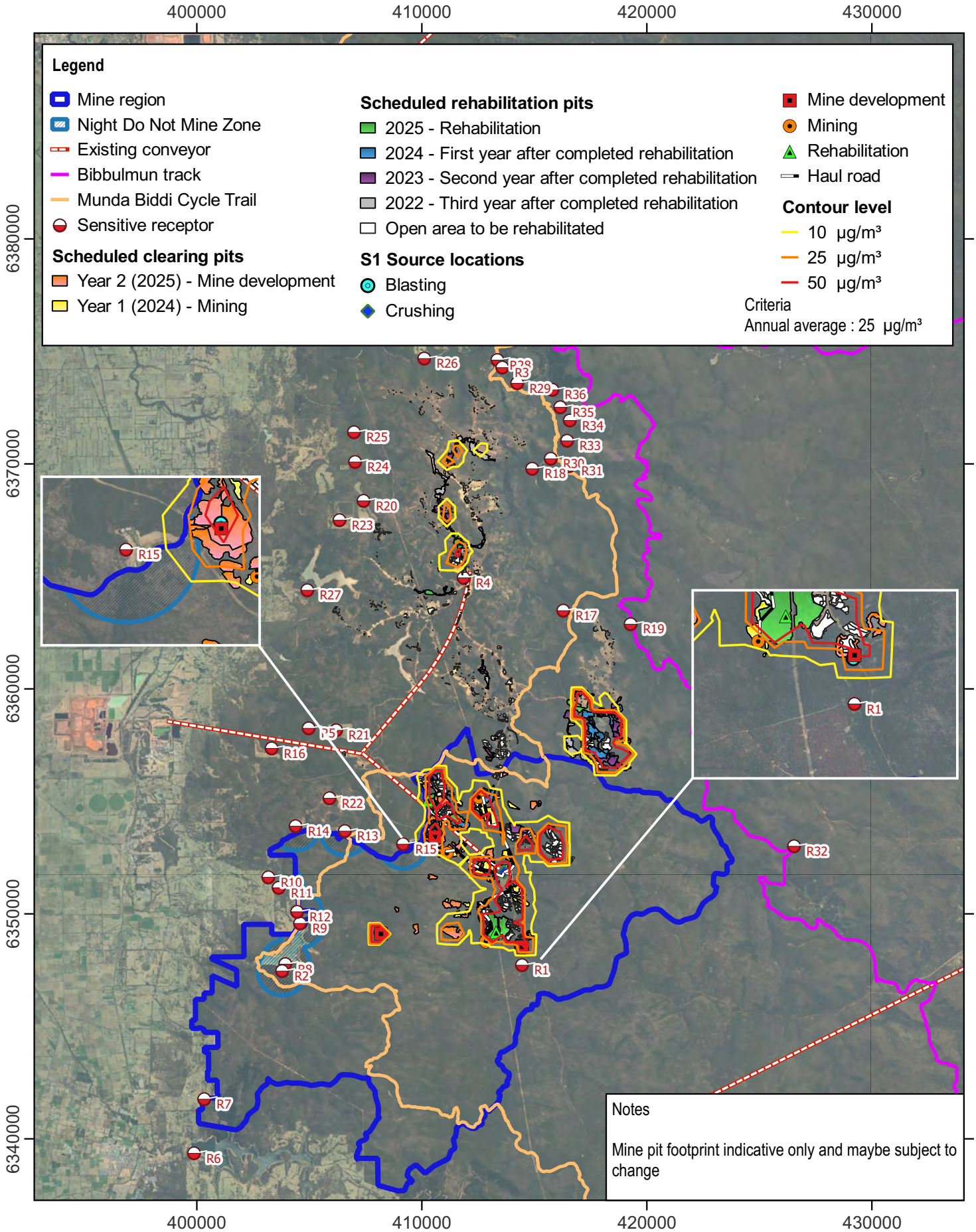
FIGURE 10.3

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average PM10 concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

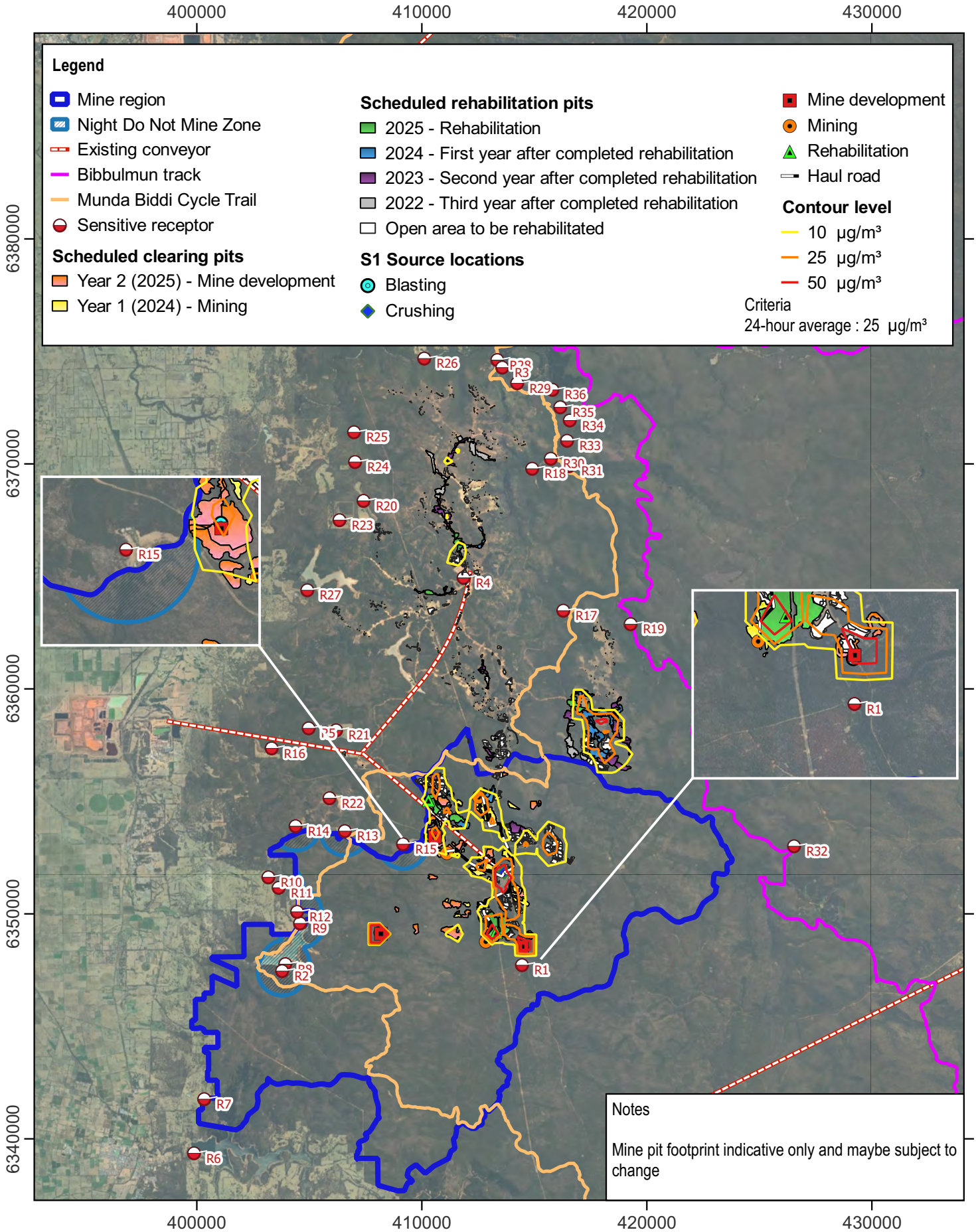
FIGURE 10.4

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM2.5 concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

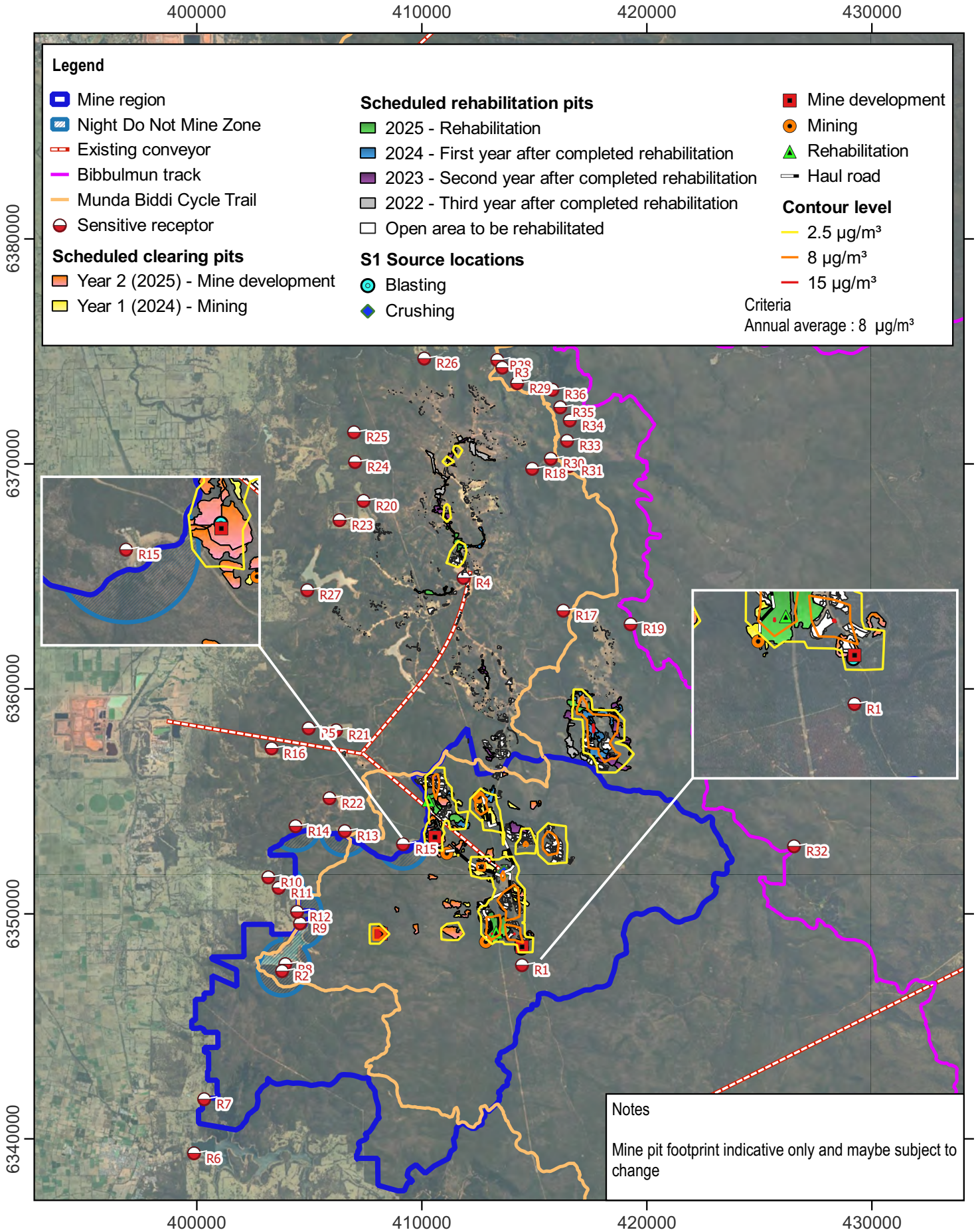
FIGURE 10.5

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average PM2.5 concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

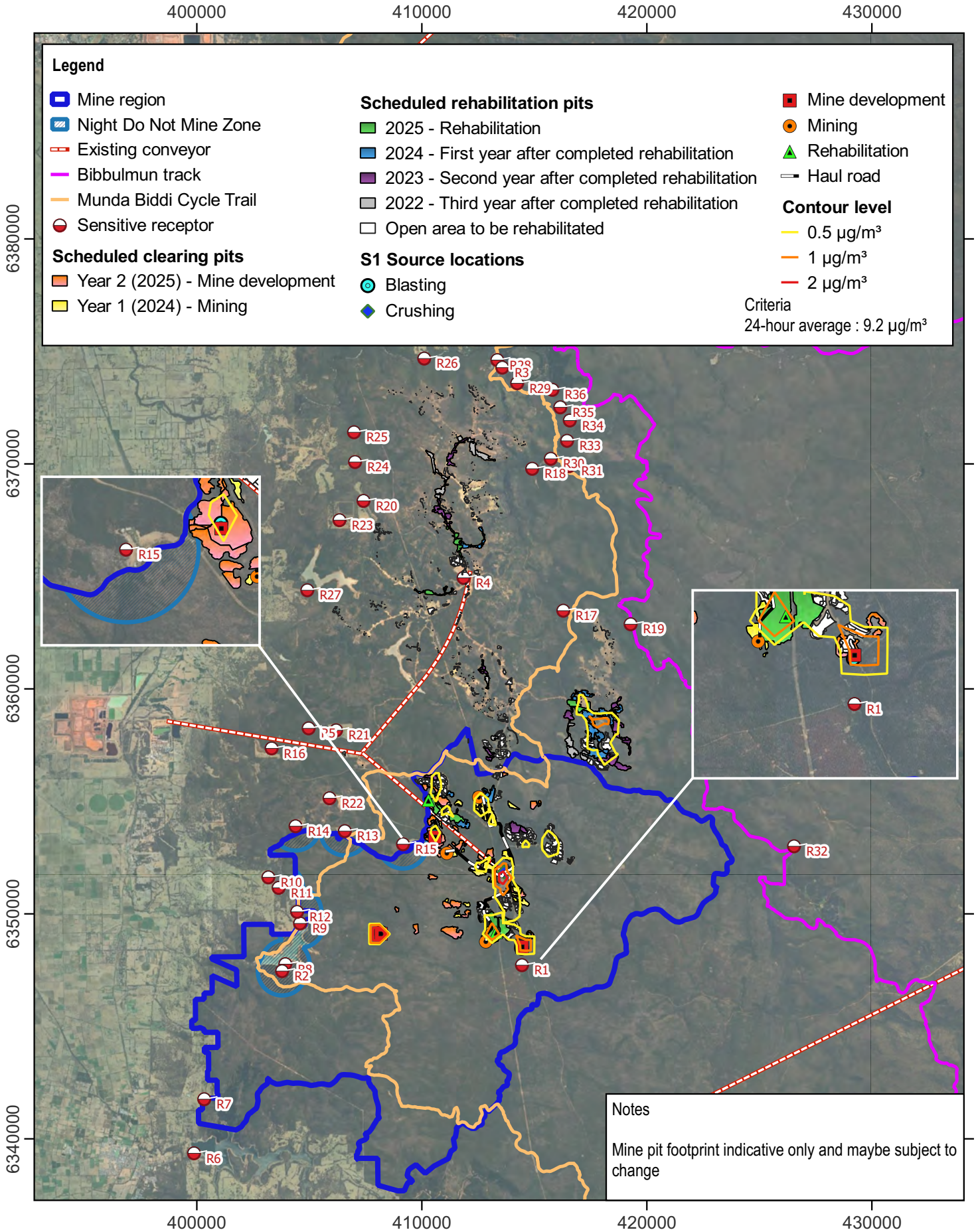
FIGURE 10.6

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average RCS concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

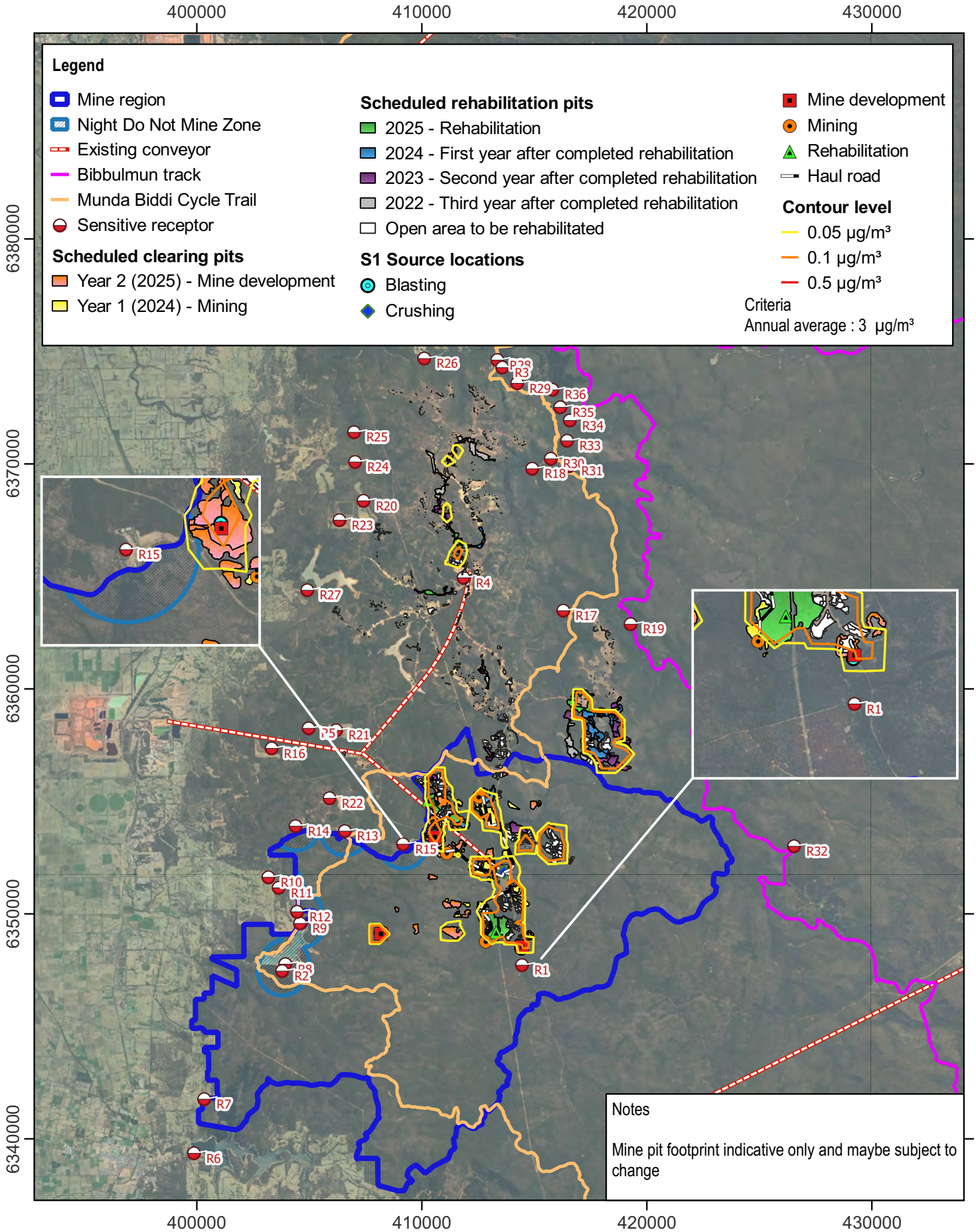
FIGURE 10.7

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average RCS concentration Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

FIGURE 10.8

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

10.1.2 Scenario 2

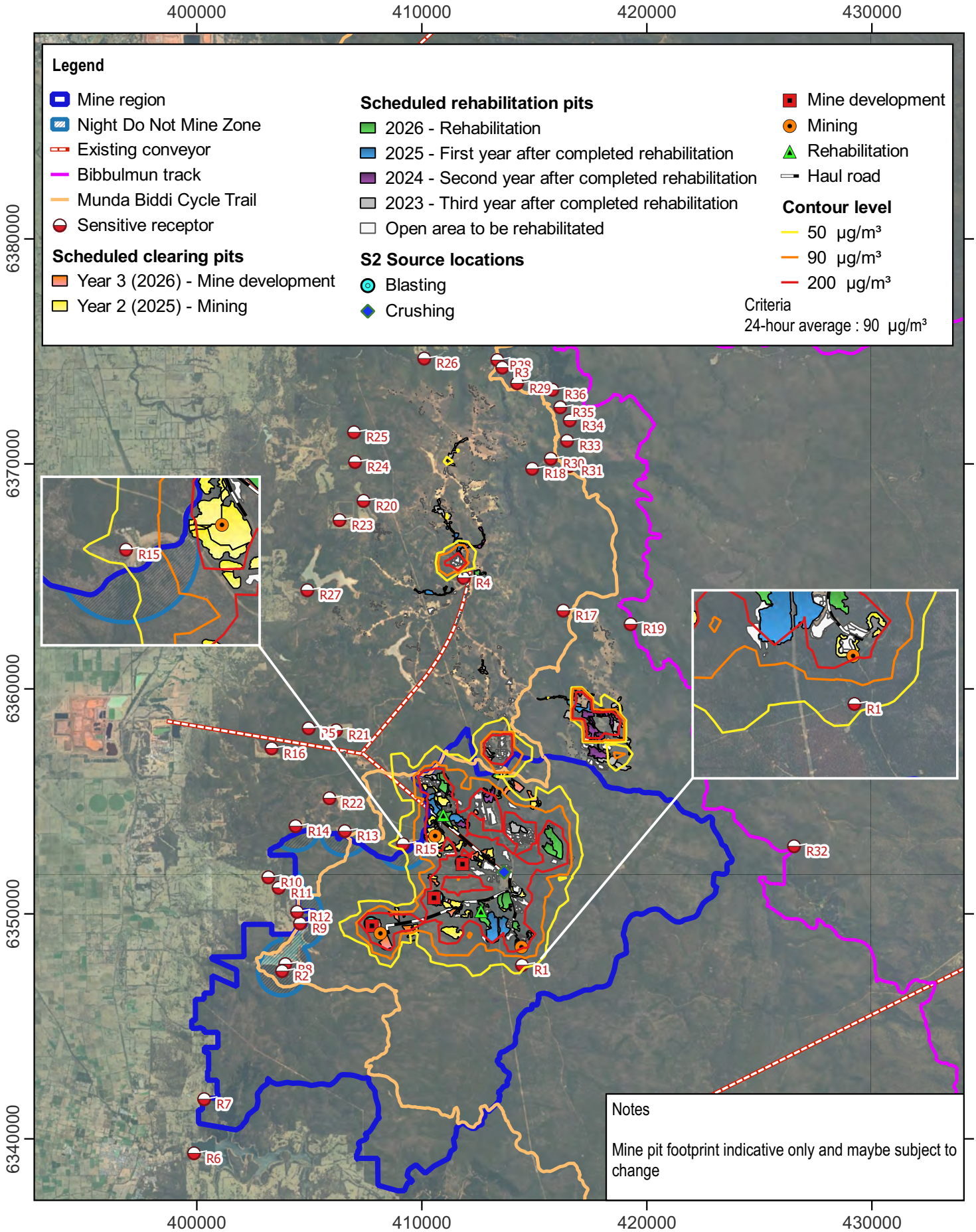
Predicted incremental dust concentrations for Scenario 2, which is modelled as Year 3 of mining operations, are provided in Table 10.2.

Predicted incremental concentrations for TSP, PM_{10}, $PM_{2.5}$ and RCS were in compliance with the assessment criteria for all receptors. The contour plots for predicted incremental 24-hour and annual averages of TSP, PM_{10}, $PM_{2.5}$ and RCS ground level concentrations are provided in Figure 10.9 to Figure 10.16.

Table 10.2 Predicted dust concentrations for Scenario 2

Receptor	Predicted incremental air quality concentration (µg/m3) Scenario 2							
Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**RCS**	
Averaging period	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
Assessment criteria	**90**	**90**	**50**	**25**	**25**	**8**	**10**	**3**
R01	64.2	4.5	28.0	1.9	2.8	0.2	0.1	4.27×10^{-3}
R02	4.5	0.4	1.8	0.2	0.2	0.02	3.87×10^{-3}	3.45×10^{-4}
R03	1.3	0.1	0.6	0.03	0.1	0.00	1.24×10^{-3}	7.38×10^{-5}
R04	20.4	2.3	10.2	1.1	1.0	0.1	2.24×10^{-2}	2.44×10^{-3}
R05	5.3	0.4	2.4	0.2	0.2	0.02	5.19×10^{-3}	3.89×10^{-4}
R06	0.6	0.0	0.3	0.02	0.03	0.00	5.62×10^{-4}	3.96×10^{-5}
R07	1.5	0.1	0.6	0.03	0.1	0.00	1.41×10^{-3}	5.79×10^{-5}
R08	4.6	0.4	2.0	0.2	0.2	0.02	4.44×10^{-3}	3.79×10^{-4}
R09	9.5	0.6	3.5	0.2	0.3	0.02	7.60×10^{-3}	5.46×10^{-4}
R10	2.2	0.3	0.9	0.1	0.1	0.01	1.95×10^{-3}	2.59×10^{-4}
R11	2.6	0.4	1.0	0.1	0.1	0.01	2.30×10^{-3}	3.22×10^{-4}
R12	7.0	0.6	2.8	0.2	0.3	0.02	6.15×10^{-3}	5.48×10^{-4}
R13	11.0	1.2	4.5	0.5	0.4	0.1	9.87×10^{-3}	1.15×10^{-3}
R14	5.2	0.5	2.1	0.2	0.2	0.02	4.65×10^{-3}	5.07×10^{-4}
R15	60.7	6.6	24.6	3.0	2.5	0.3	0.1	0.01
R16	2.3	0.3	1.0	0.1	0.1	0.01	2.12×10^{-3}	2.50×10^{-4}
R17	5.4	0.5	2.2	0.2	0.2	0.02	4.93×10^{-3}	5.18×10^{-4}
R18	3.1	0.2	1.4	0.1	0.1	0.01	3.03×10^{-3}	1.87×10^{-4}
R19	5.2	0.4	2.2	0.2	0.2	0.02	4.75×10^{-3}	3.92×10^{-4}
R20	2.6	0.2	1.2	0.1	0.1	0.01	2.56×10^{-3}	1.97×10^{-4}
R21	7.5	0.6	3.3	0.2	0.3	0.02	7.26×10^{-3}	5.36×10^{-4}
R22	5.4	0.8	2.4	0.4	0.2	0.04	5.29×10^{-3}	8.18×10^{-4}
R23	3.0	0.2	1.3	0.1	0.1	0.01	2.87×10^{-3}	1.88×10^{-4}
R24	1.7	0.1	0.7	0.1	0.1	0.01	1.60×10^{-3}	1.26×10^{-4}
R25	1.2	0.1	0.5	0.04	0.1	0.00	1.17×10^{-3}	8.93×10^{-5}
R26	1.2	0.1	0.5	0.02	0.1	0.00	1.12×10^{-3}	5.24×10^{-5}
R27	2.2	0.2	0.9	0.1	0.1	0.01	2.07×10^{-3}	1.92×10^{-4}
R28	1.1	0.1	0.5	0.03	0.05	0.00	1.08×10^{-3}	6.67×10^{-5}
R29	1.7	0.1	0.7	0.04	0.1	0.00	1.65×10^{-3}	8.76×10^{-5}
R30	2.6	0.2	1.2	0.1	0.1	0.01	2.55×10^{-3}	1.64×10^{-4}

Receptor	Predicted incremental air quality concentration (µg/m3) Scenario 2							
Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**RCS**	
Averaging period	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
Assessment criteria	**90**	**90**	**50**	**25**	**25**	**8**	**10**	**3**
R31	2.4	0.2	1.0	0.1	0.1	0.01	2.14×10^{-3}	1.63×10^{-4}
R32	2.0	0.2	0.8	0.1	0.1	0.01	1.82×10^{-3}	1.67×10^{-4}
R33	2.1	0.1	0.9	0.1	0.1	0.01	1.92×10^{-3}	1.38×10^{-4}
R34	2.0	0.1	0.9	0.1	0.1	0.01	1.89×10^{-3}	1.26×10^{-4}
R35	2.0	0.1	0.9	0.1	0.1	0.01	1.92×10^{-3}	1.14×10^{-4}
R36	2.2	0.1	1.0	0.05	0.1	4.70×10^{-3}	2.11×10^{-3}	1.03×10^{-4}



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average TSP concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

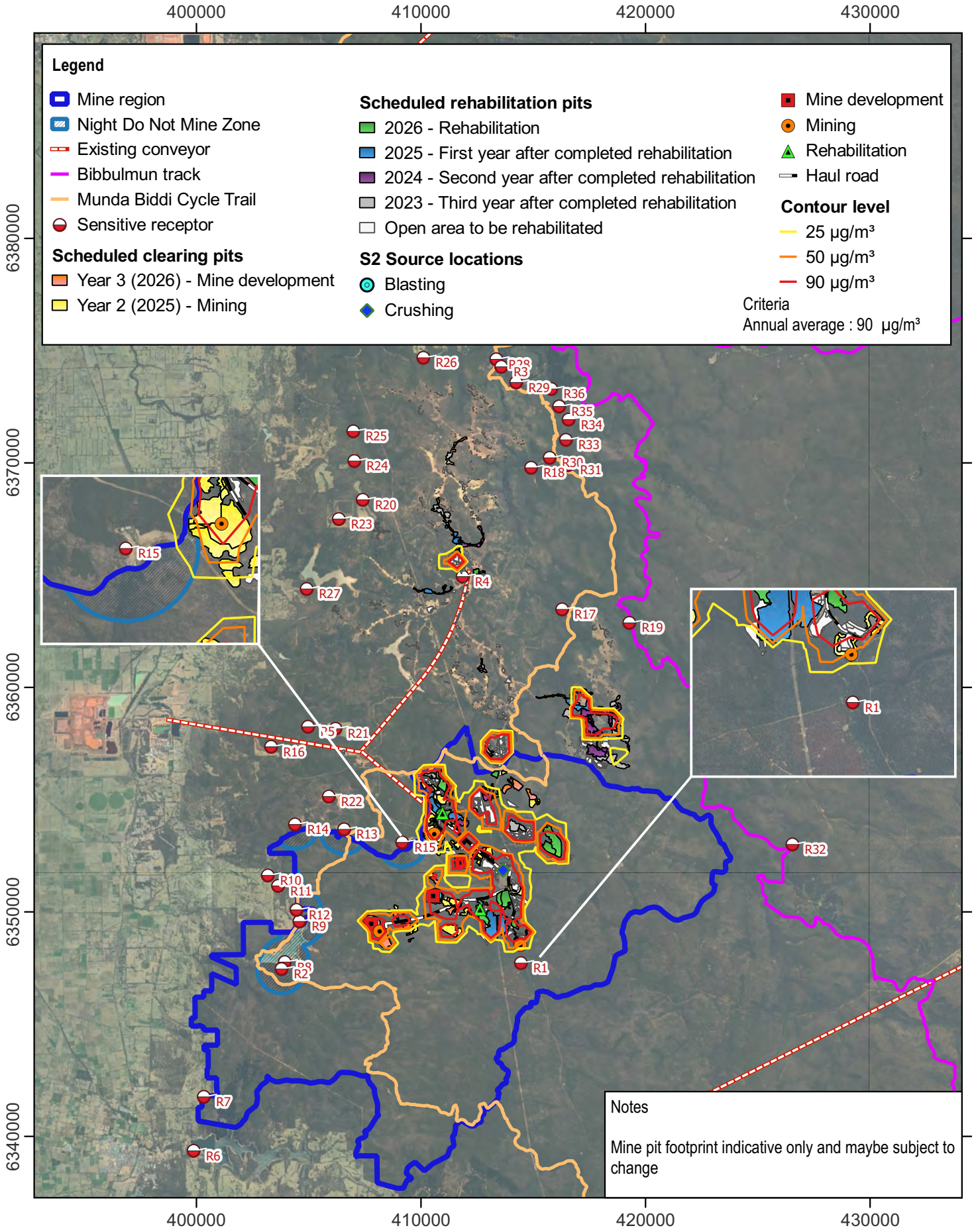
FIGURE 10.9

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average TSP concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

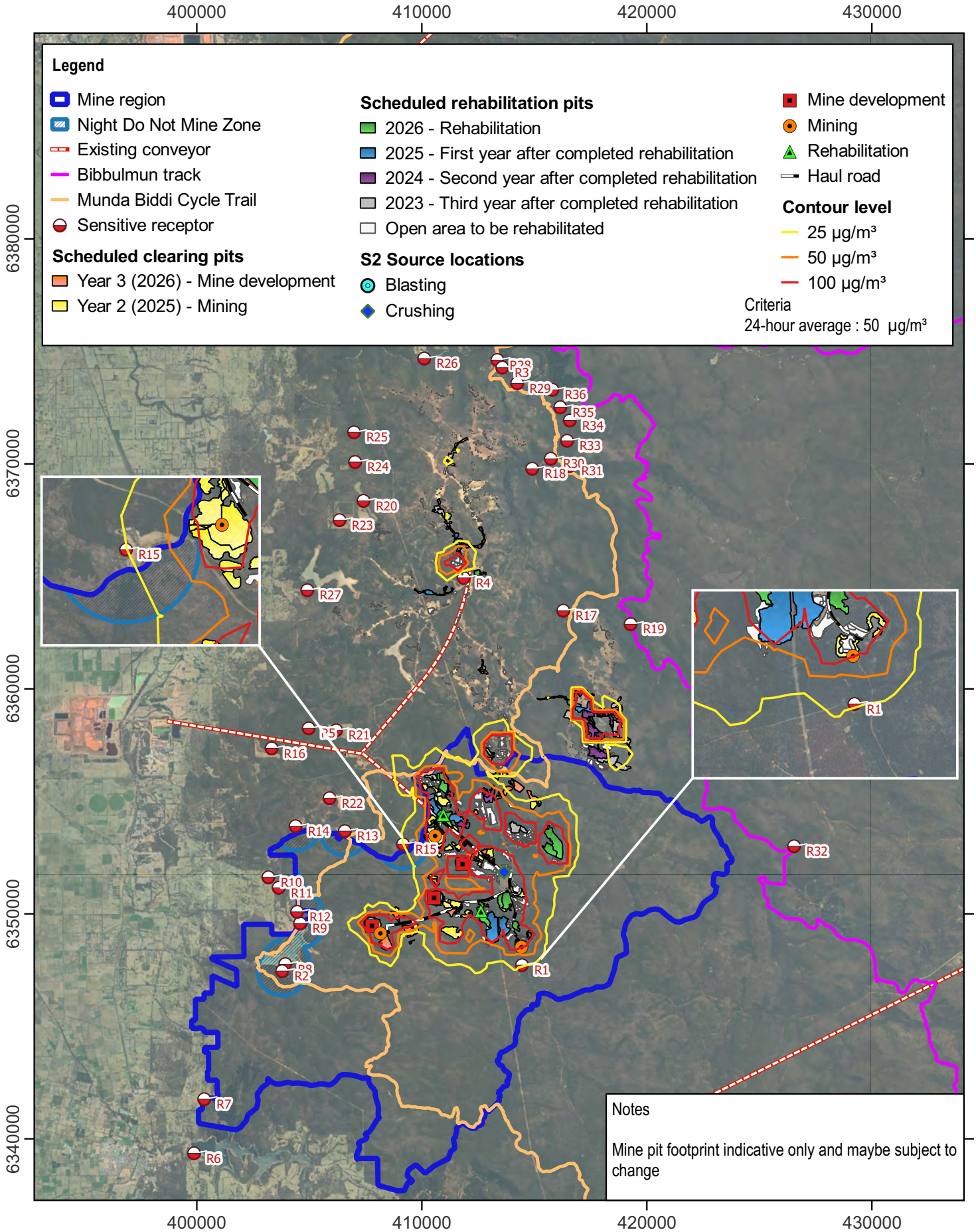
FIGURE 10.10

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM10 concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

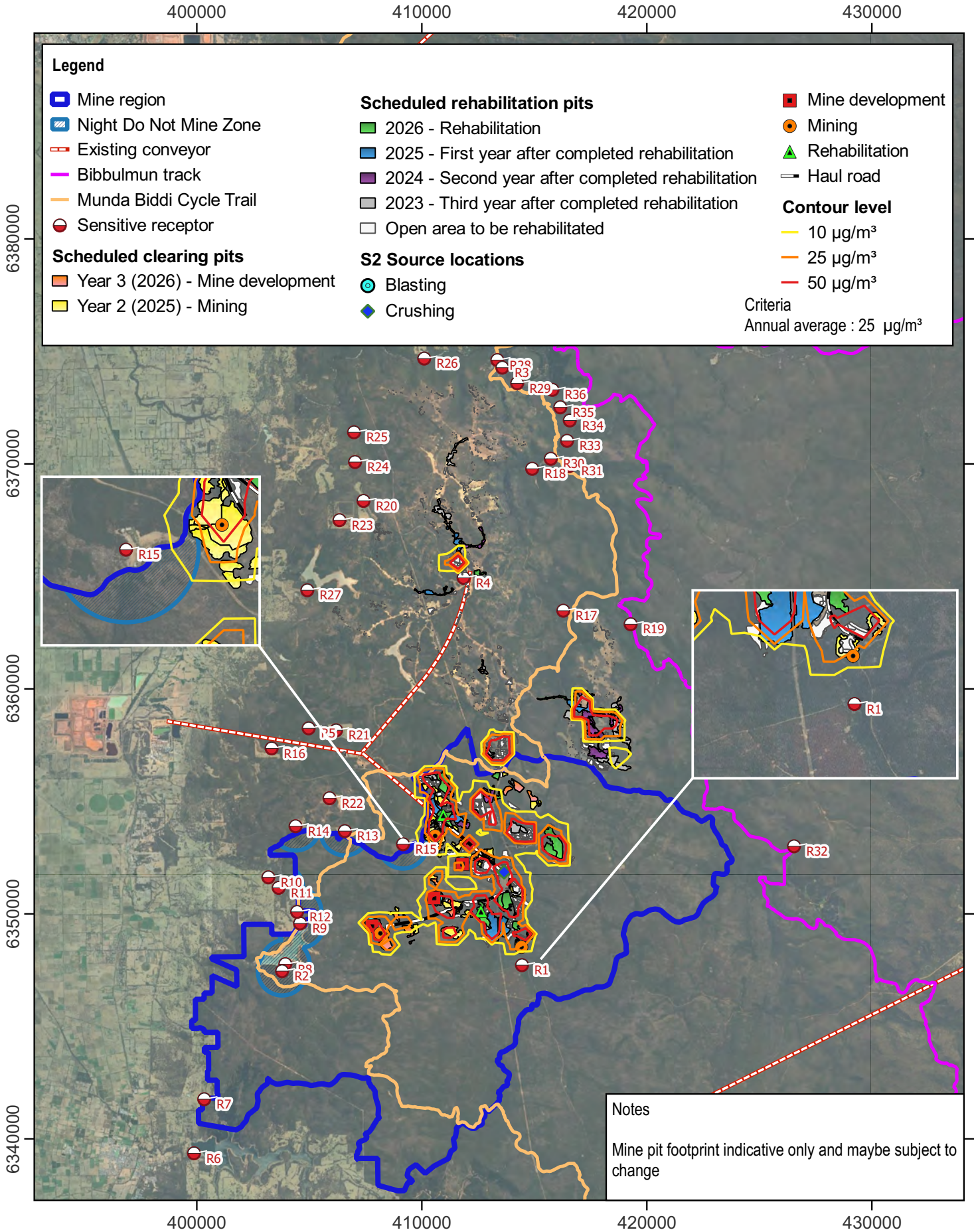
FIGURE 10.11

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average PM10 concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

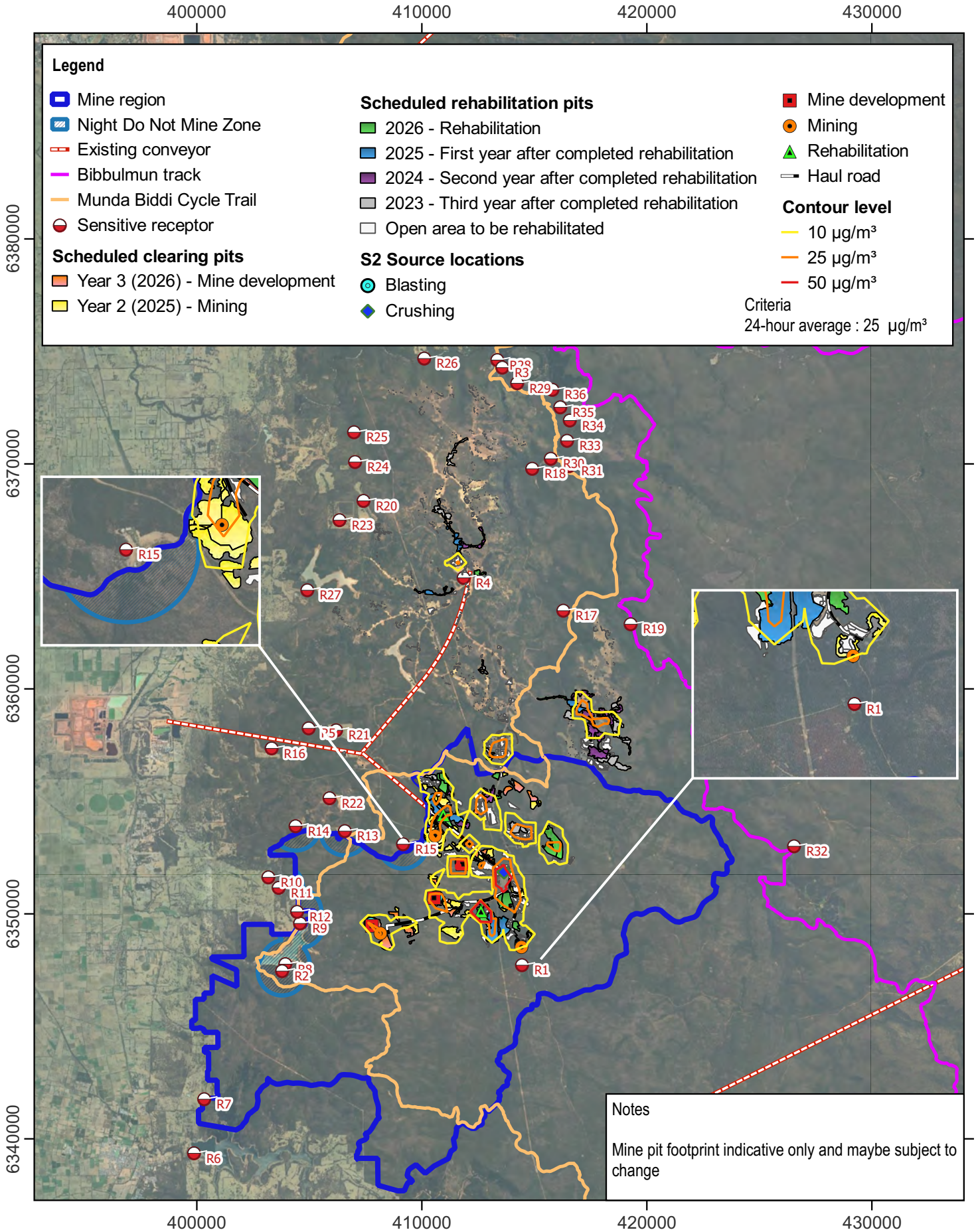
FIGURE 10.12

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM2.5 concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

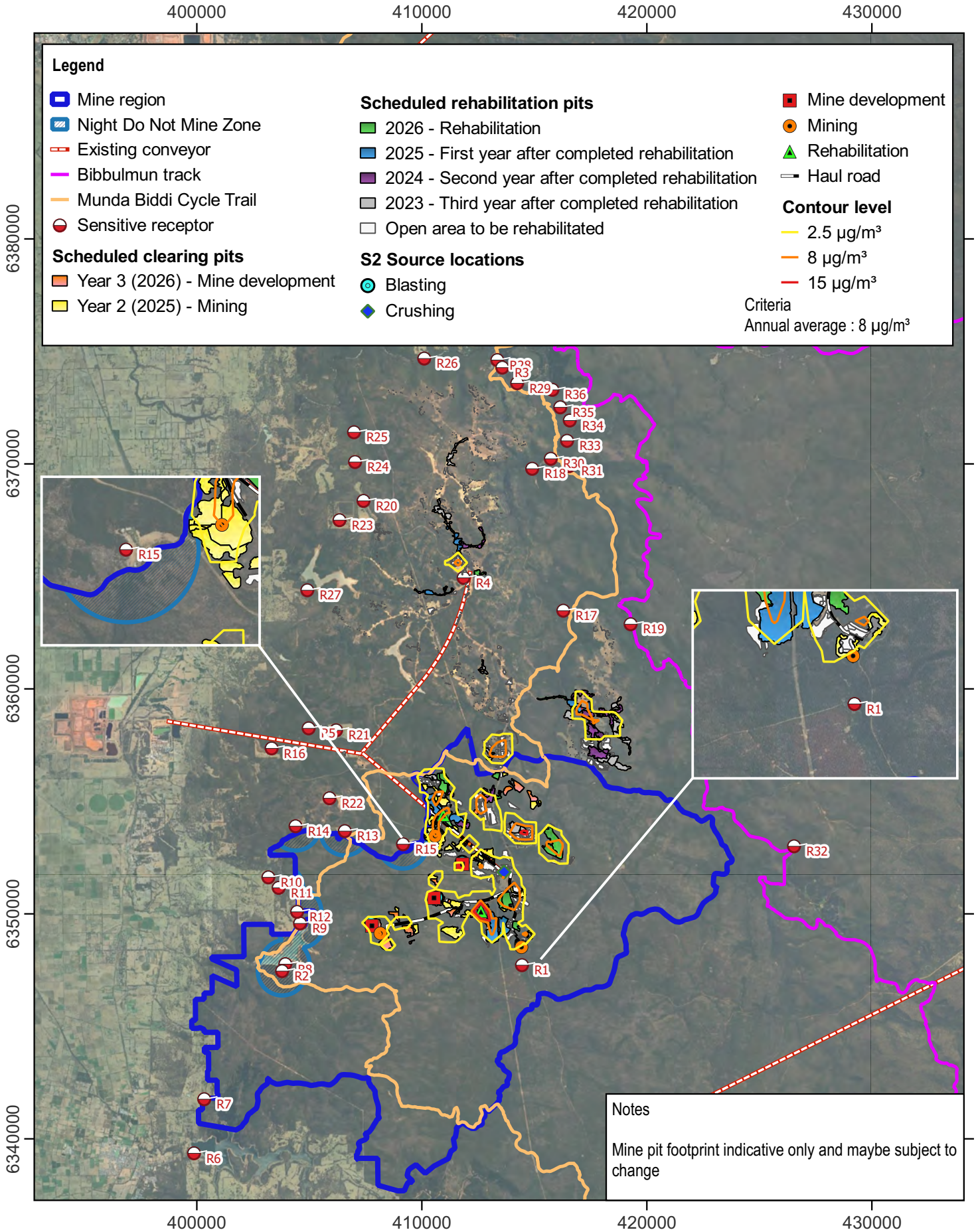
FIGURE 10.13

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average PM2.5 concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

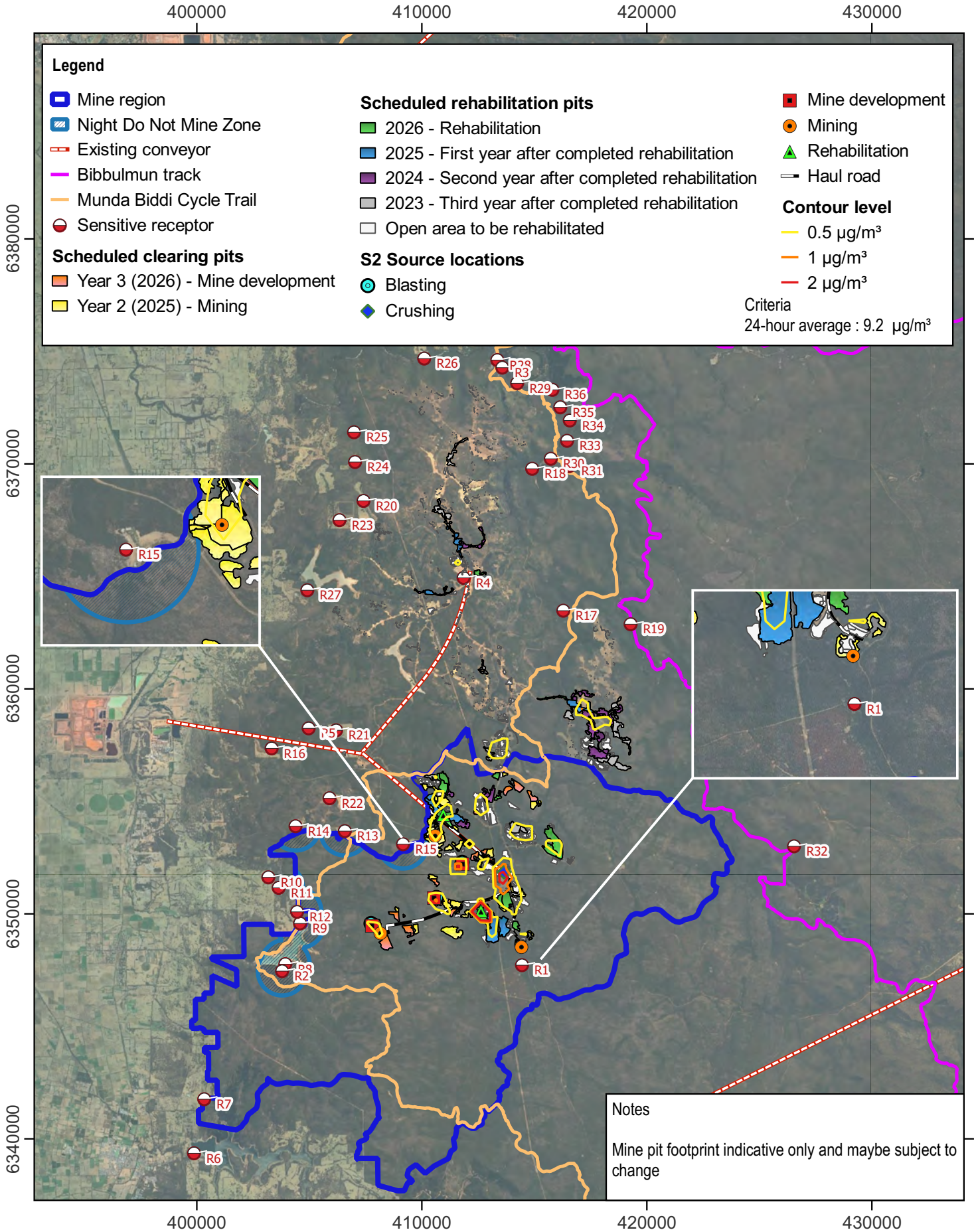
FIGURE 10.14

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Laregro Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average RCS concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

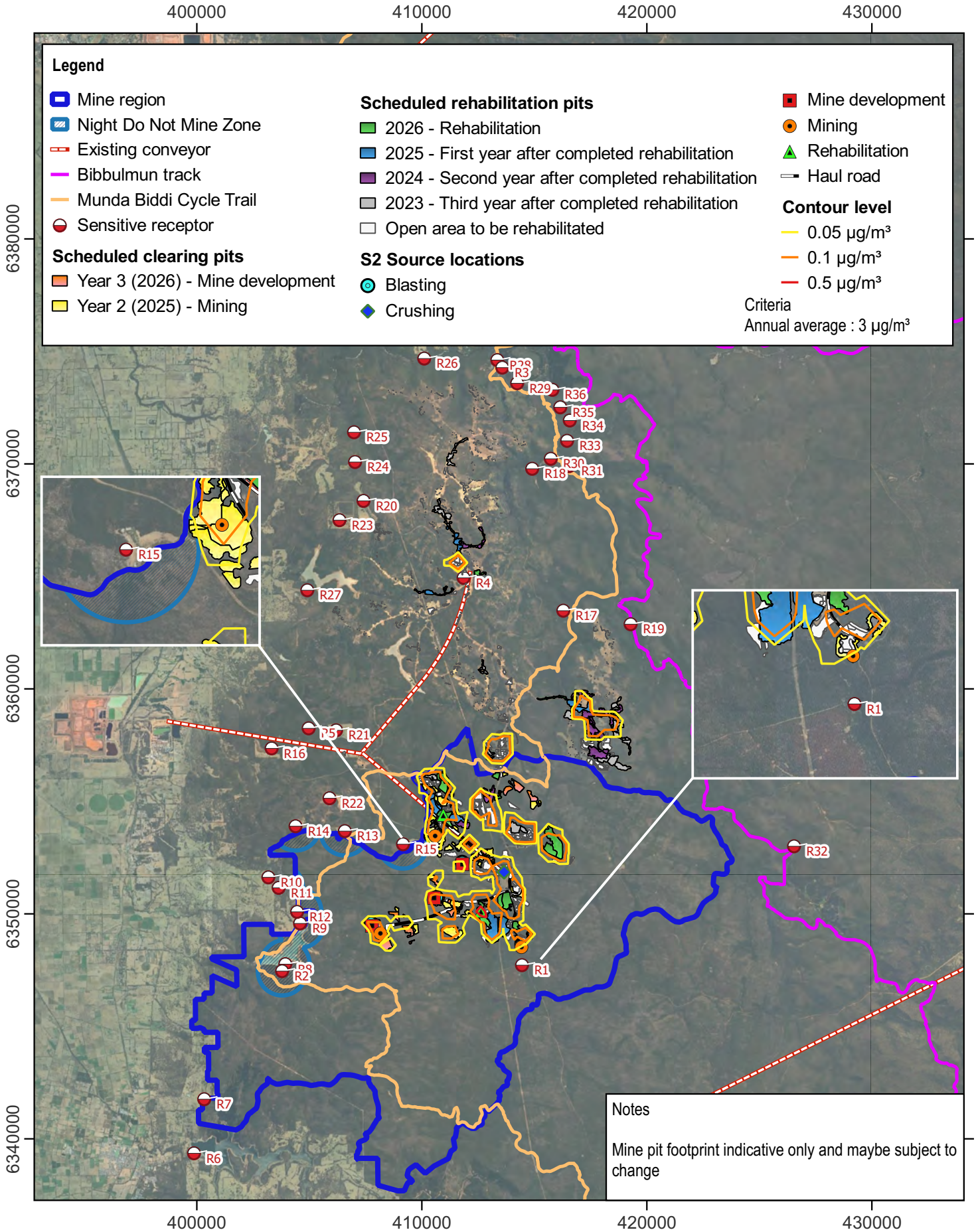
FIGURE 10.15

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregro.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average RCS concentration Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

FIGURE 10.16

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

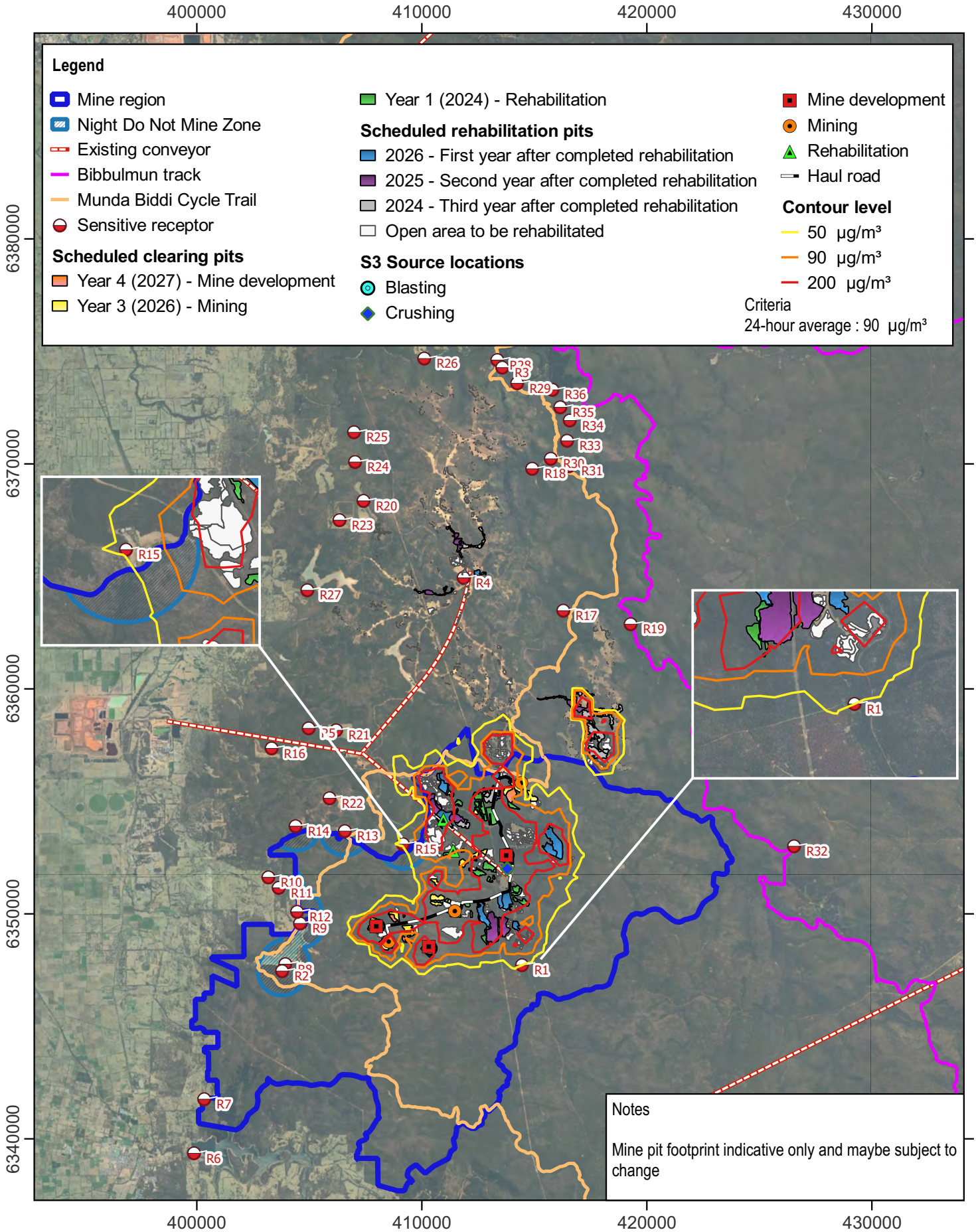
10.1.3 Scenario 3

Predicted incremental and cumulative dust concentrations for Scenario 3, which is modelled as Year 4 of mining operations, are provided in Table 10.3. Predicted incremental concentrations for TSP, PM_{10}, $PM_{2.5}$ and RCS were in compliance with the assessment criteria for all receptors. The contour plots for predicted incremental 24-hour and annual averages of TSP, PM_{10}, $PM_{2.5}$ and RCS ground level concentrations are provided in Figure 10.17 to Figure 10.24.

Table 10.3 Predicted dust concentrations for Scenario 3

Receptor	Predicted incremental air quality concentration (µg/m3) Scenario 3							
Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**RCS**	
Averaging period	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
Assessment criteria	**90**	**90**	**50**	**25**	**25**	**8**	**10**	**3**
R01	50.1	3.6	23.0	1.6	2.3	0.2	0.1	3.54×10^{-3}
R02	4.1	0.3	1.7	0.1	0.2	0.02	3.82×10^{-3}	3.16×10^{-4}
R03	1.1	0.1	0.4	0.03	0.04	0.00	9.47×10^{-4}	5.81×10^{-5}
R04	8.1	0.4	3.3	0.2	0.3	0.1	0.01	4.12×10^{-4}
R05	5.4	0.4	2.3	0.2	0.2	0.02	0.01	3.65×10^{-4}
R06	0.6	0.0	0.2	0.02	0.02	0.00	5.11×10^{-4}	3.59×10^{-5}
R07	1.2	0.1	0.5	0.02	0.1	0.00	1.15×10^{-3}	5.29×10^{-5}
R08	5.2	0.4	2.2	0.2	0.2	0.02	4.86×10^{-3}	3.47×10^{-4}
R09	6.9	0.5	2.8	0.2	0.3	0.02	0.01	4.71×10^{-4}
R10	1.8	0.2	0.7	0.1	0.1	0.01	1.58×10^{-3}	2.16×10^{-4}
R11	1.9	0.3	0.8	0.1	0.1	0.01	1.74×10^{-3}	2.70×10^{-4}
R12	6.6	0.5	2.6	0.2	0.3	0.02	0.01	4.87×10^{-4}
R13	10.3	1.1	4.1	0.5	0.4	0.1	0.01	1.03×10^{-3}
R14	4.9	0.5	1.9	0.2	0.2	0.02	4.25×10^{-3}	4.64×10^{-4}
R15	54.3	6.1	22.3	2.7	2.2	0.3	0.05	0.01
R16	1.9	0.2	0.8	0.1	0.1	0.01	1.81×10^{-3}	2.37×10^{-4}
R17	5.3	0.5	2.2	0.2	0.2	0.02	4.77×10^{-3}	4.59×10^{-4}
R18	2.7	0.1	1.2	0.1	0.1	0.01	2.63×10^{-3}	1.31×10^{-4}
R19	5.0	0.4	2.0	0.2	0.2	0.02	4.36×10^{-3}	3.56×10^{-4}
R20	2.2	0.1	0.9	0.1	0.1	0.01	2.03×10^{-3}	1.31×10^{-4}
R21	7.1	0.5	3.1	0.2	0.3	0.02	0.01	4.99×10^{-4}
R22	5.3	0.8	2.3	0.3	0.2	0.04	0.01	7.60×10^{-4}
R23	2.4	0.1	1.0	0.1	0.1	0.01	2.28×10^{-3}	1.36×10^{-4}
R24	1.5	0.1	0.6	0.04	0.1	0.01	1.38×10^{-3}	9.17×10^{-5}
R25	1.1	0.1	0.4	0.03	0.04	0.00	9.50×10^{-4}	6.73×10^{-5}
R26	0.9	0.0	0.4	0.02	0.04	0.00	8.07×10^{-4}	3.92×10^{-5}
R27	1.8	0.2	0.7	0.1	0.1	0.01	1.60×10^{-3}	1.56×10^{-4}
R28	1.0	0.1	0.4	0.02	0.04	0.00	8.42×10^{-4}	5.24×10^{-5}
R29	1.3	0.1	0.5	0.03	0.1	0.00	1.20×10^{-3}	6.79×10^{-5}
R30	2.7	0.1	1.2	0.1	0.1	0.01	2.58×10^{-3}	1.23×10^{-4}

Receptor	Predicted incremental air quality concentration (µg/m3) Scenario 3							
Pollutant	**TSP**		**PM_{10}**		**$PM_{2.5}$**		**RCS**	
Averaging period	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**	**24-hour**	**Annual**
Assessment criteria	**90**	**90**	**50**	**25**	**25**	**8**	**10**	**3**
R31	2.5	0.1	1.0	0.1	0.1	0.01	2.21×10^{-3}	1.32×10^{-4}
R32	1.9	0.2	0.7	0.1	0.1	0.01	1.62×10^{-3}	1.64×10^{-4}
R33	2.2	0.1	0.9	0.05	0.1	0.01	1.95×10^{-3}	1.09×10^{-4}
R34	2.2	0.1	0.9	0.05	0.1	0.01	1.94×10^{-3}	1.01×10^{-4}
R35	2.1	0.1	0.9	0.04	0.1	0.01	1.95×10^{-3}	9.11×10^{-5}
R36	2.1	0.1	0.9	0.04	0.1	4.70×10^{-3}	2.01×10^{-3}	8.31×10^{-5}



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average TSP concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

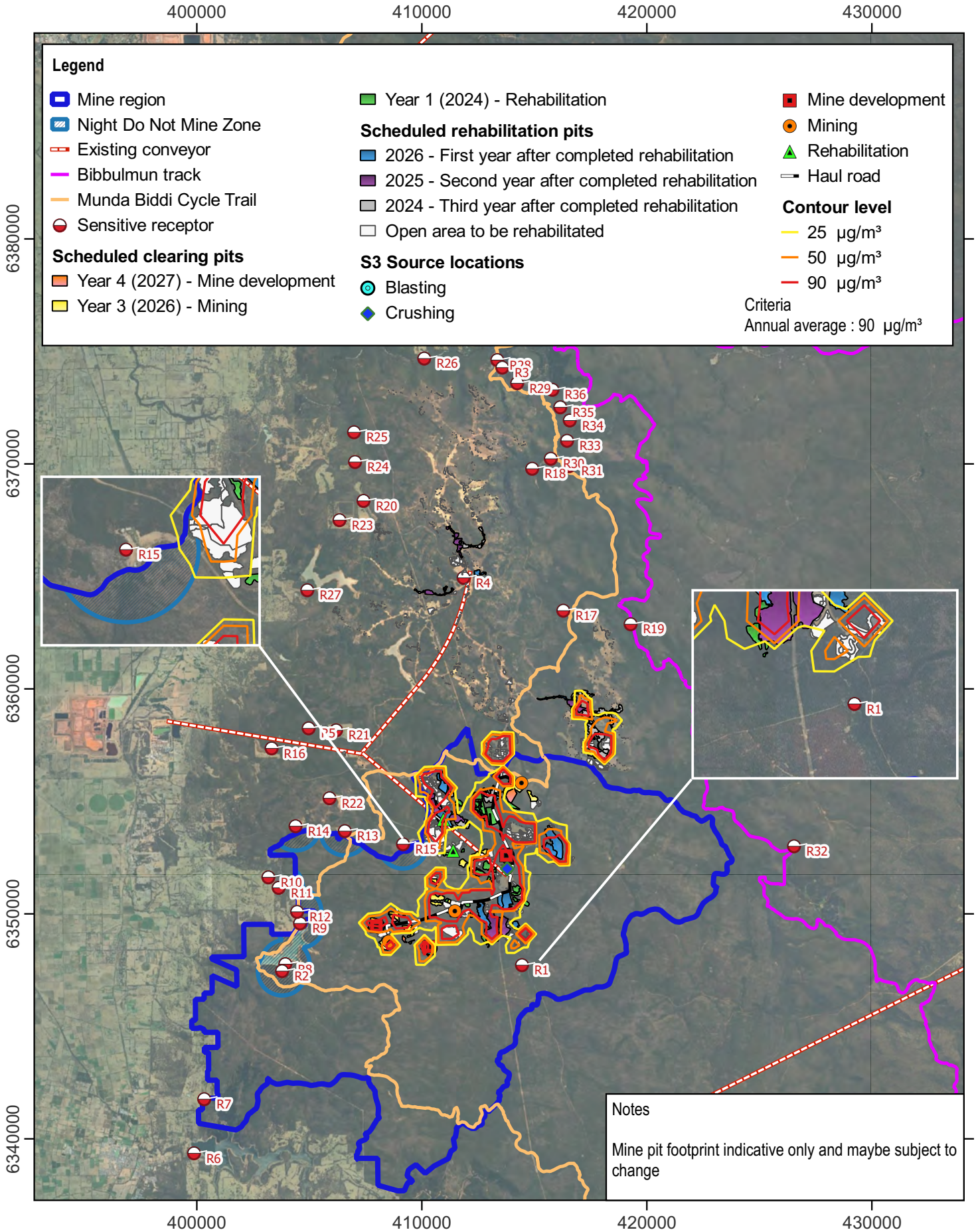
FIGURE 10.17

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average TSP concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

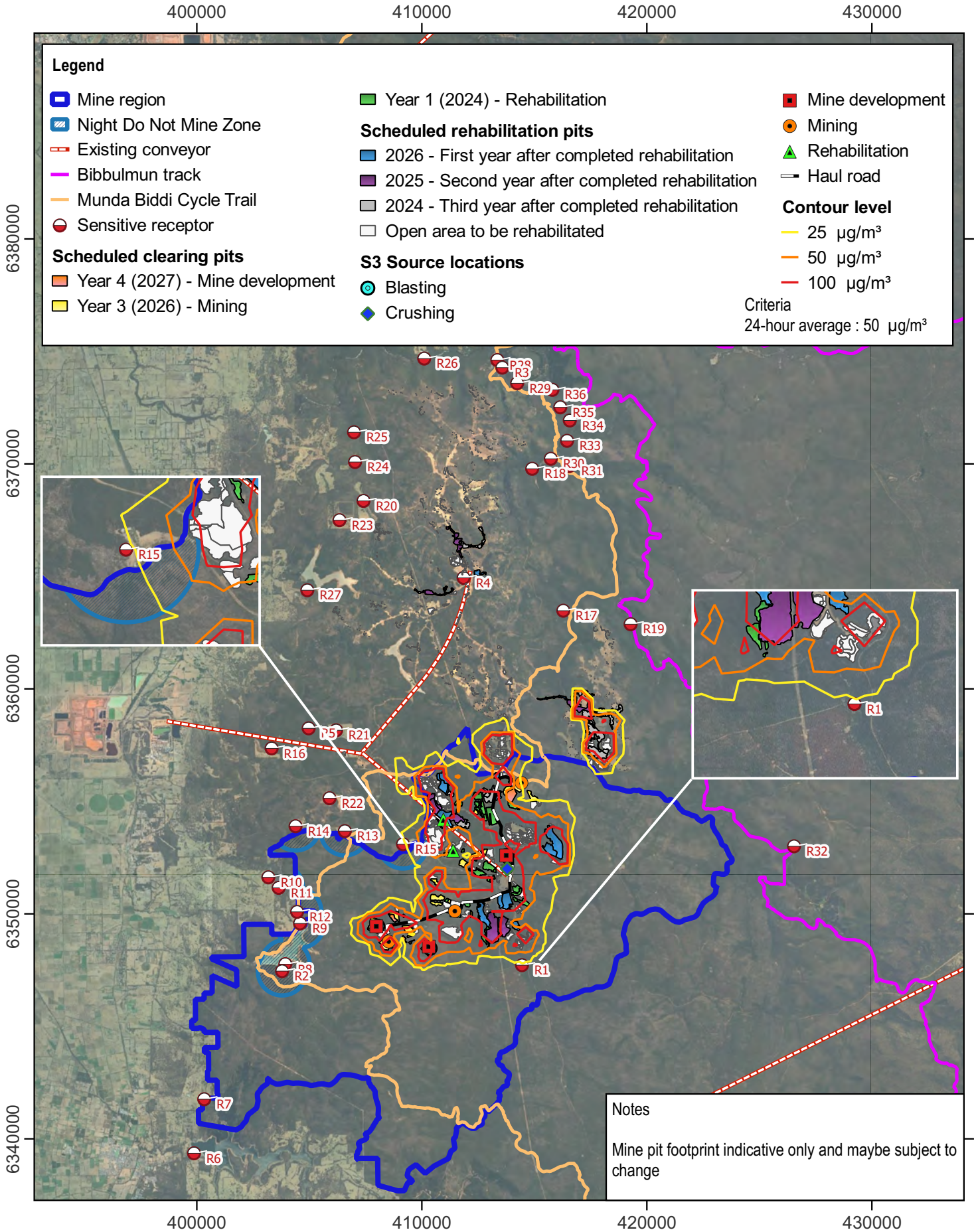
FIGURE 10.18

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM10 concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

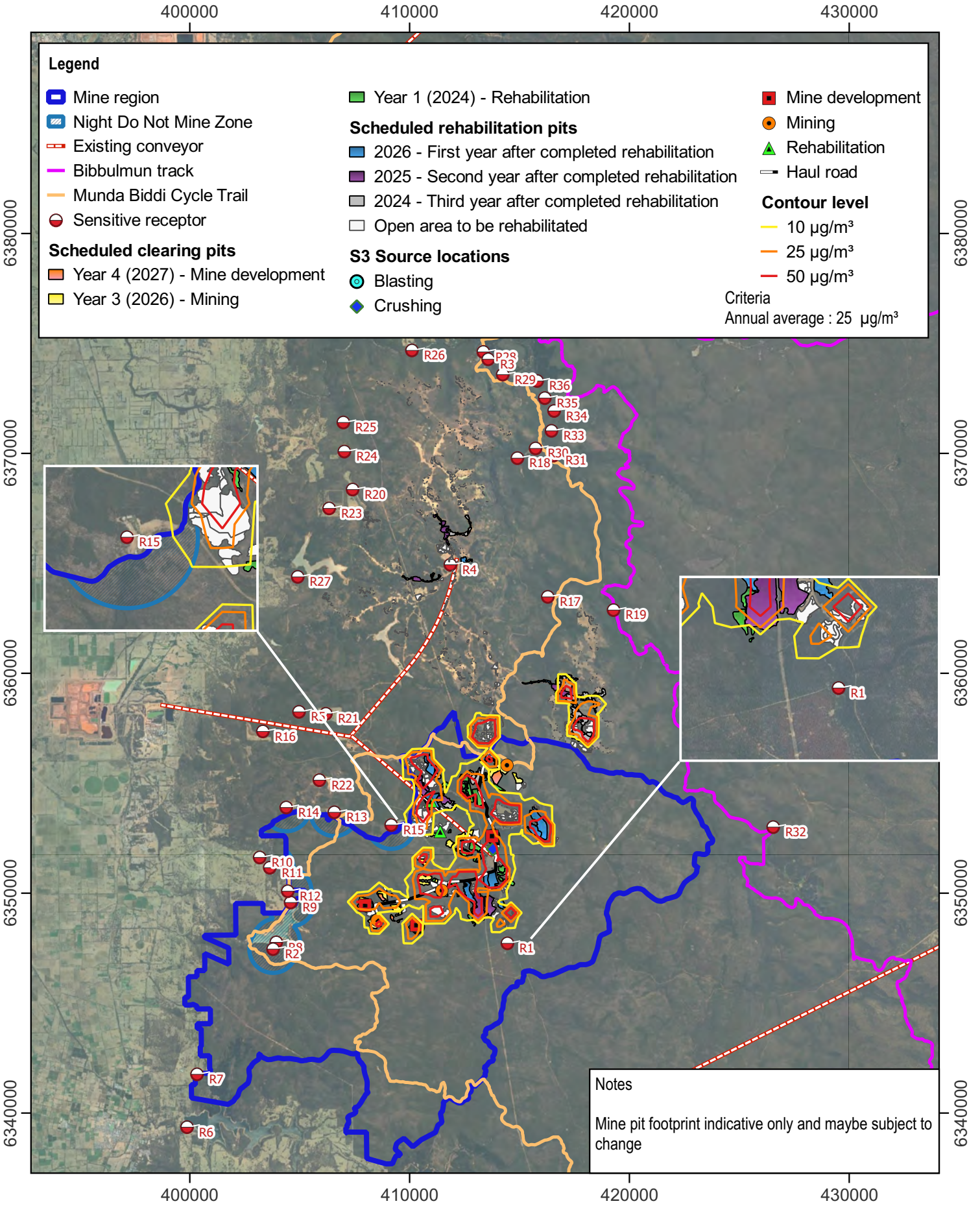
FIGURE 10.19

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Laregro Mine Region
Air Quality Impact Assessment

Predicted annual average PM10 concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

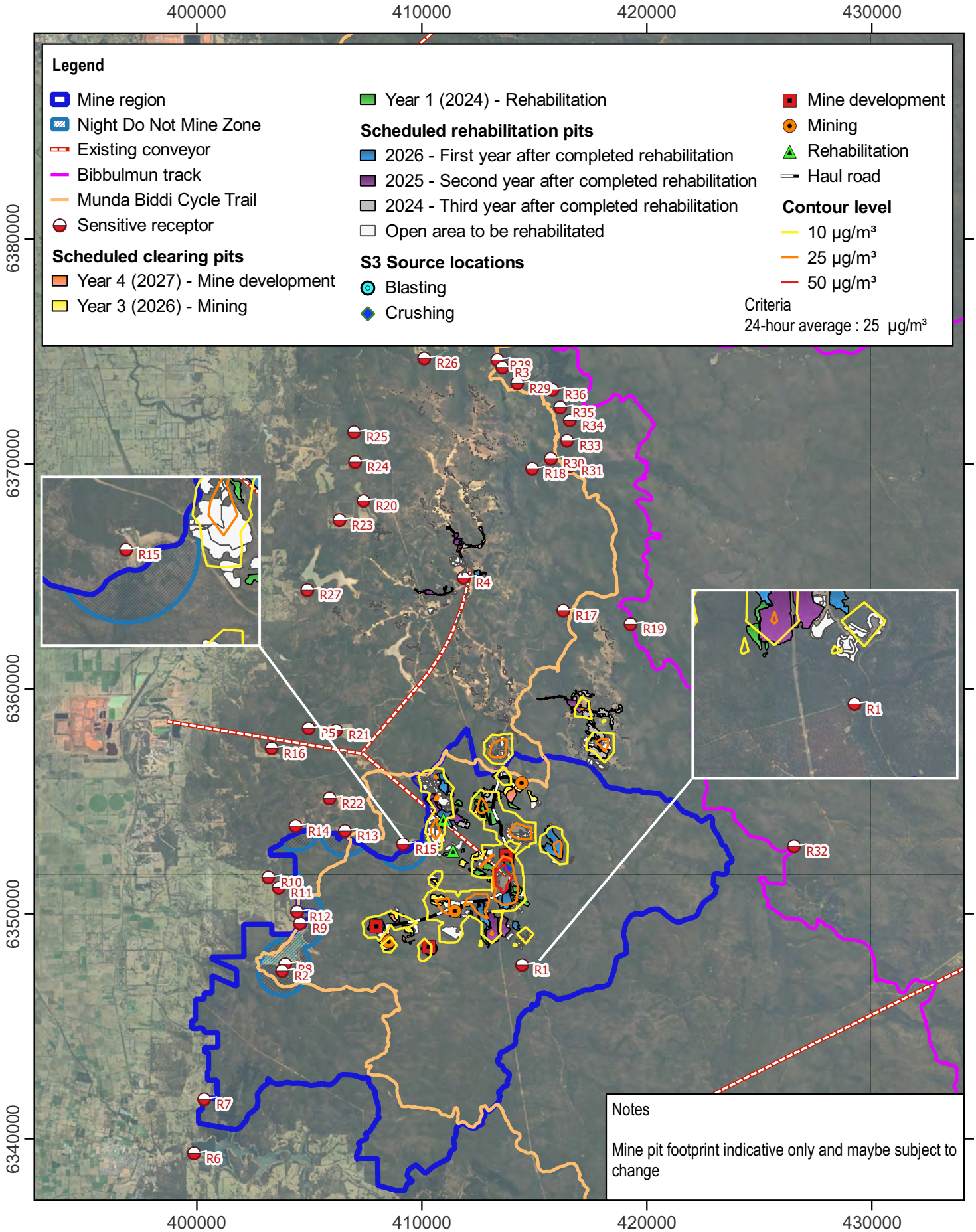
FIGURE 10.20

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregro.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average PM2.5 concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

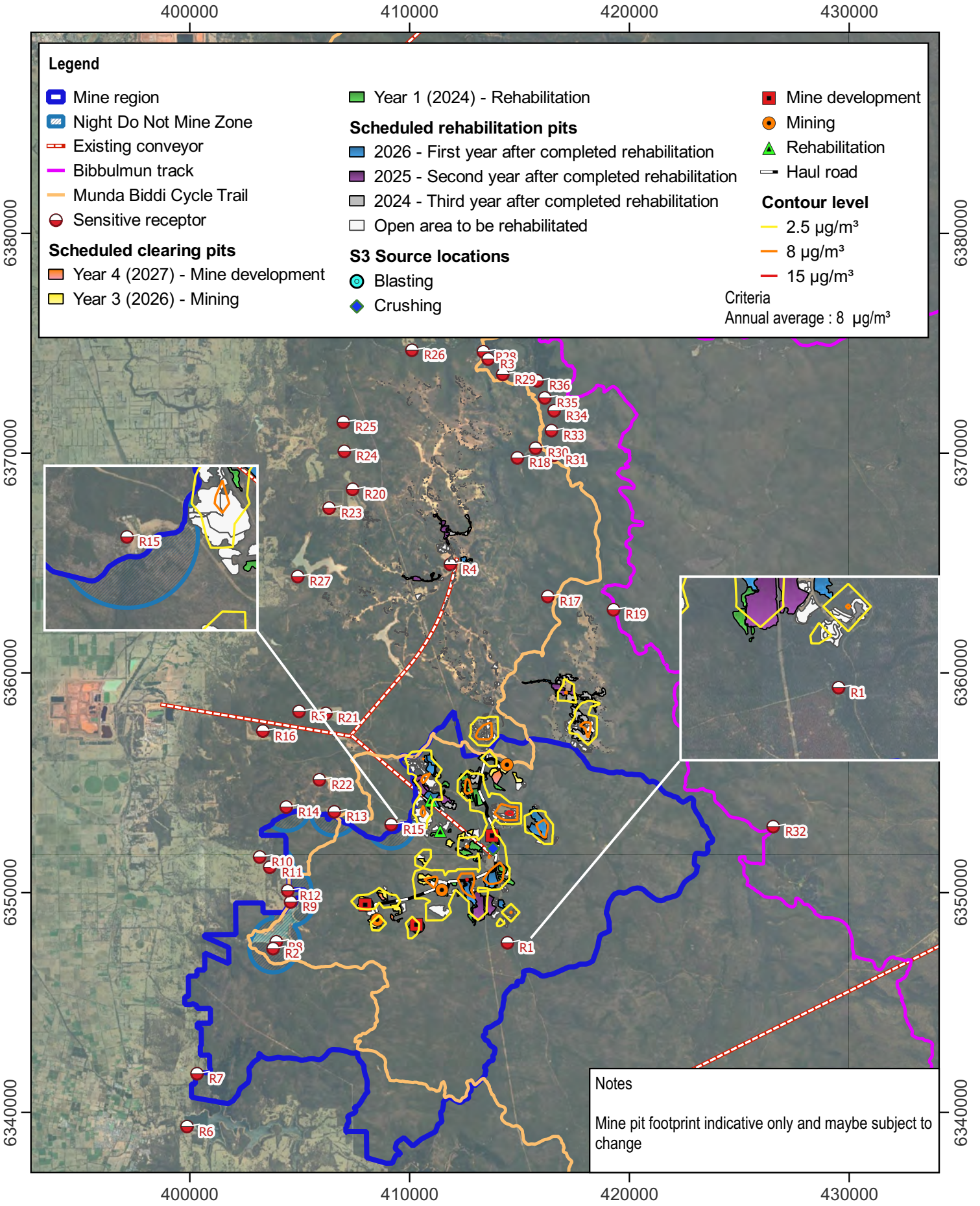
FIGURE 10.21

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average PM2.5 concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

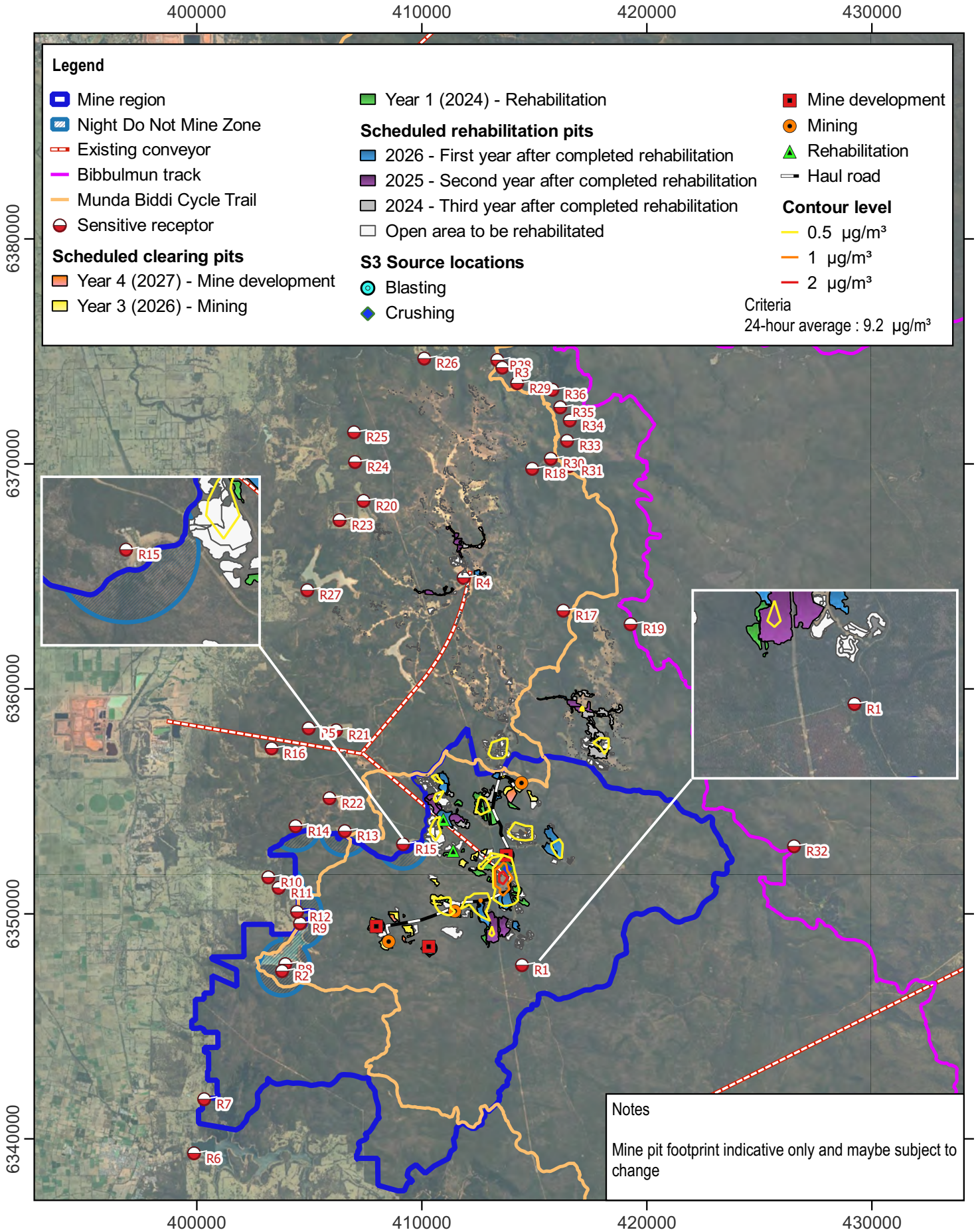
FIGURE 10.22

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregо.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted maximum 24-hour average RCS concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

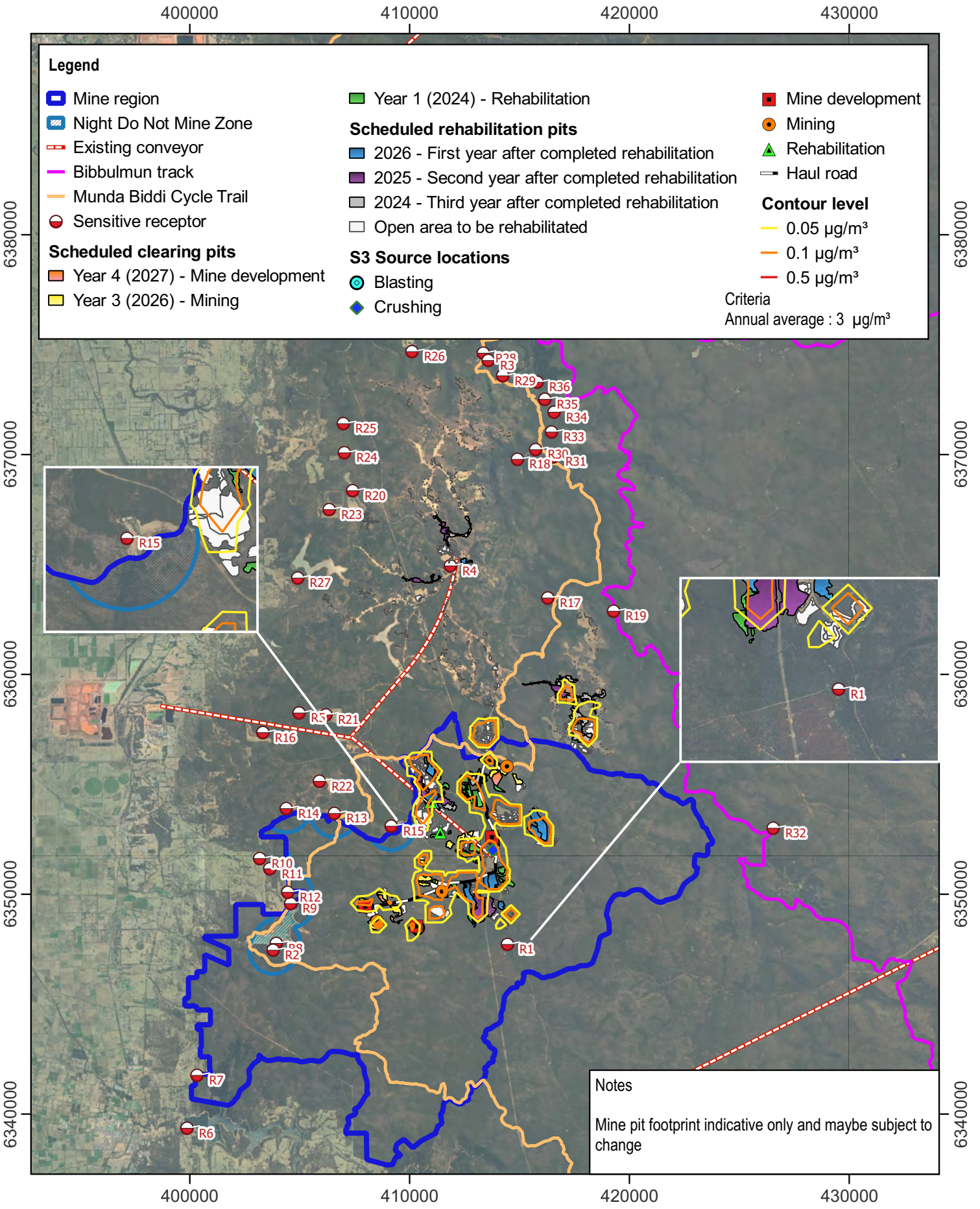
FIGURE 10.23

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average RCS concentration Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

FIGURE 10.24

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregо.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

10.2 Predicted dust deposition

Predicted dust deposition rates are provided in Table 10.4. Compliance with the maximum increase dust deposition criteria (2 g/m^2/month) was predicted at all receptors for all scenarios.

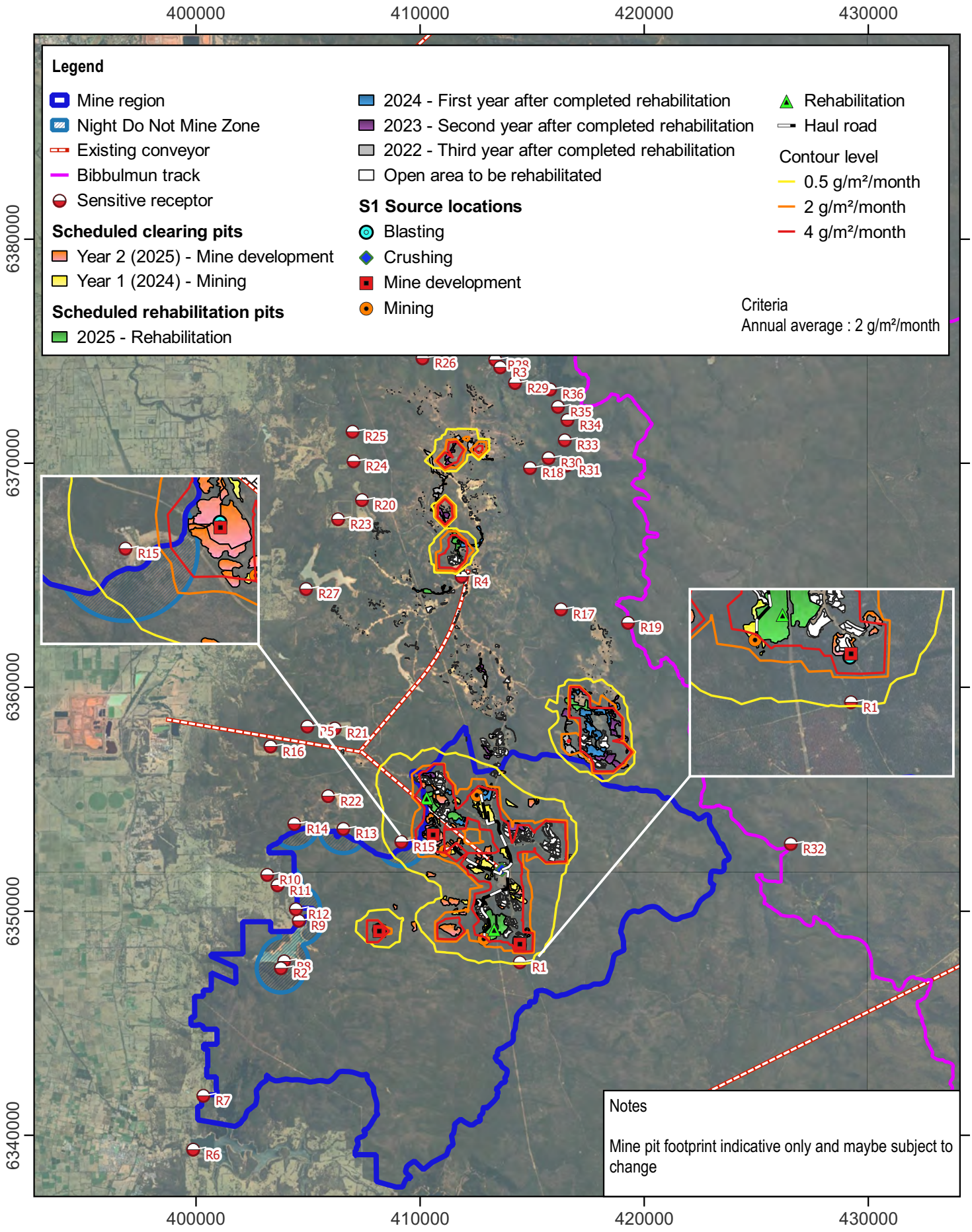
No cumulative assessment of dust deposition was undertaken as background data was not available. However, in consideration of potential cumulative dust deposition impacts, a review of the identified background air quality sources discussed in Section 5.4 was undertaken, and it was considered unlikely that any of these sources would significantly contribute to dust deposition within the local airshed.

Contour plots of predicted incremental annual average dust deposition for each scenario are provided in Figure 10.25, Figure 10.26 and Figure 10.27.

Table 10.4 Predicted dust deposition per scenario (annual average, g/m^2/month)

Receptor	Predicted dust deposition per scenario (g/m^2/month)		
	Scenario 1	Scenario 2	Scenario 3
R01	0.6	0.3	0.3
R02	0.04	0.1	0.1
R03	0.01	4.44×10^{-3}	3.59×10^{-3}
R04	0.1	0.2	0.02
R05	0.1	0.1	0.1
R06	3.61×10^{-3}	3.55×10^{-3}	3.28×10^{-3}
R07	0.01	0.01	0.01
R08	0.03	0.04	0.04
R09	0.1	0.1	0.1
R10	0.04	0.1	0.04
R11	0.05	0.1	0.1
R12	0.1	0.1	0.1
R13	0.2	0.2	0.2
R14	0.1	0.1	0.1
R15	0.8	0.9	0.8
R16	0.1	0.1	0.1
R17	0.05	0.03	0.03
R18	0.02	0.01	0.01
R19	0.03	0.02	0.02
R20	0.02	0.02	0.01
R21	0.1	0.1	0.1
R22	0.2	0.2	0.1
R23	0.02	0.01	0.01
R24	0.02	0.01	0.01
R25	0.02	0.01	0.01
R26	0.01	3.65×10^{-3}	2.98×10^{-3}
R27	0.02	0.02	0.02
R28	0.01	3.97×10^{-3}	3.26×10^{-3}
R29	0.01	0.01	4.15×10^{-3}
R30	0.02	0.01	0.01

Receptor	Predicted dust deposition per scenario (g/m^2/month)		
	Scenario 1	Scenario 2	Scenario 3
R31	0.01	0.01	0.01
R32	0.02	0.02	0.02
R33	0.01	0.01	0.01
R34	0.01	0.01	0.01
R35	0.01	0.01	4.94×10^{-3}
R36	0.01	0.01	4.33×10^{-3}



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average dust deposition Scenario 1

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

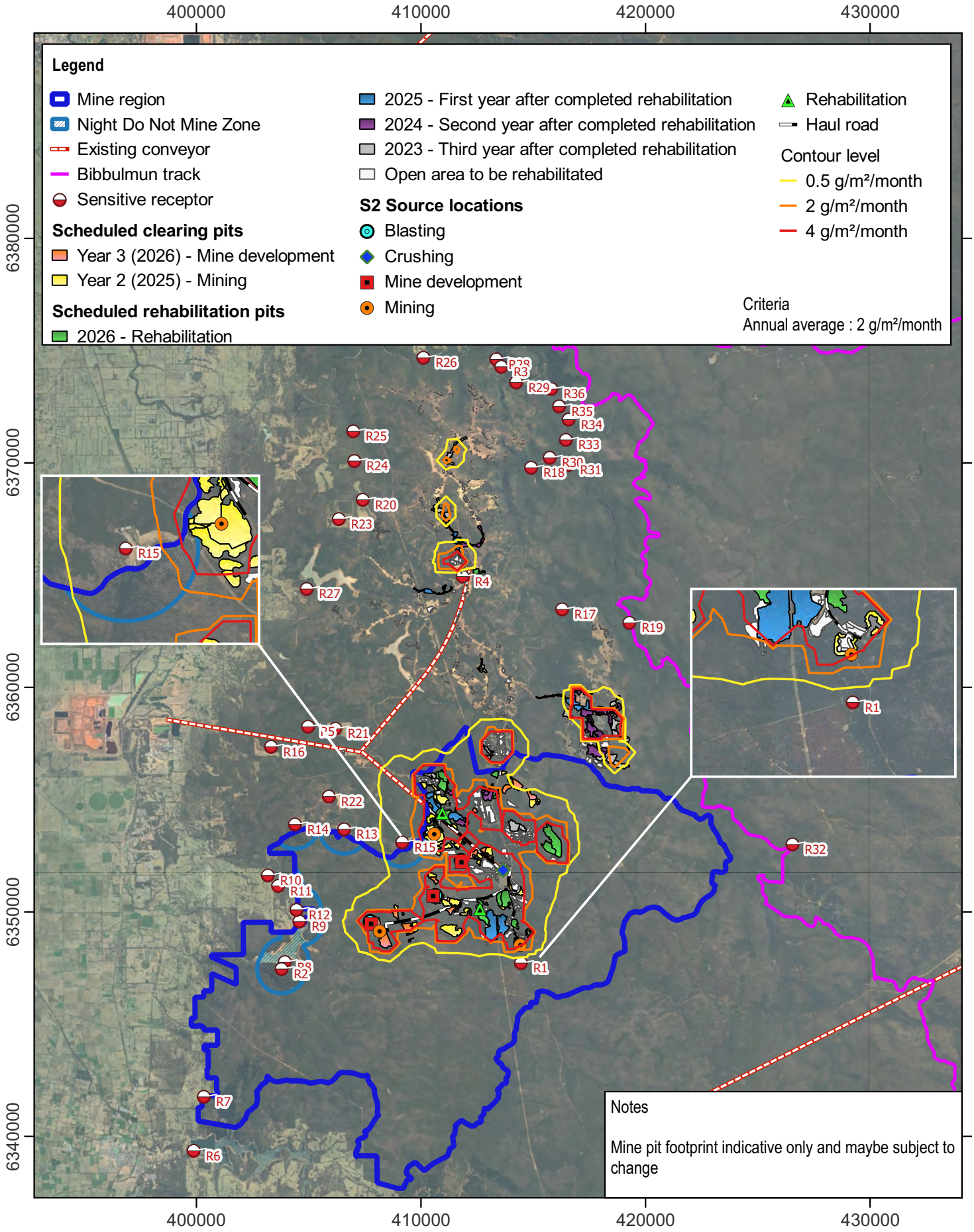
FIGURE 10.1

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average dust deposition Scenario 2

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

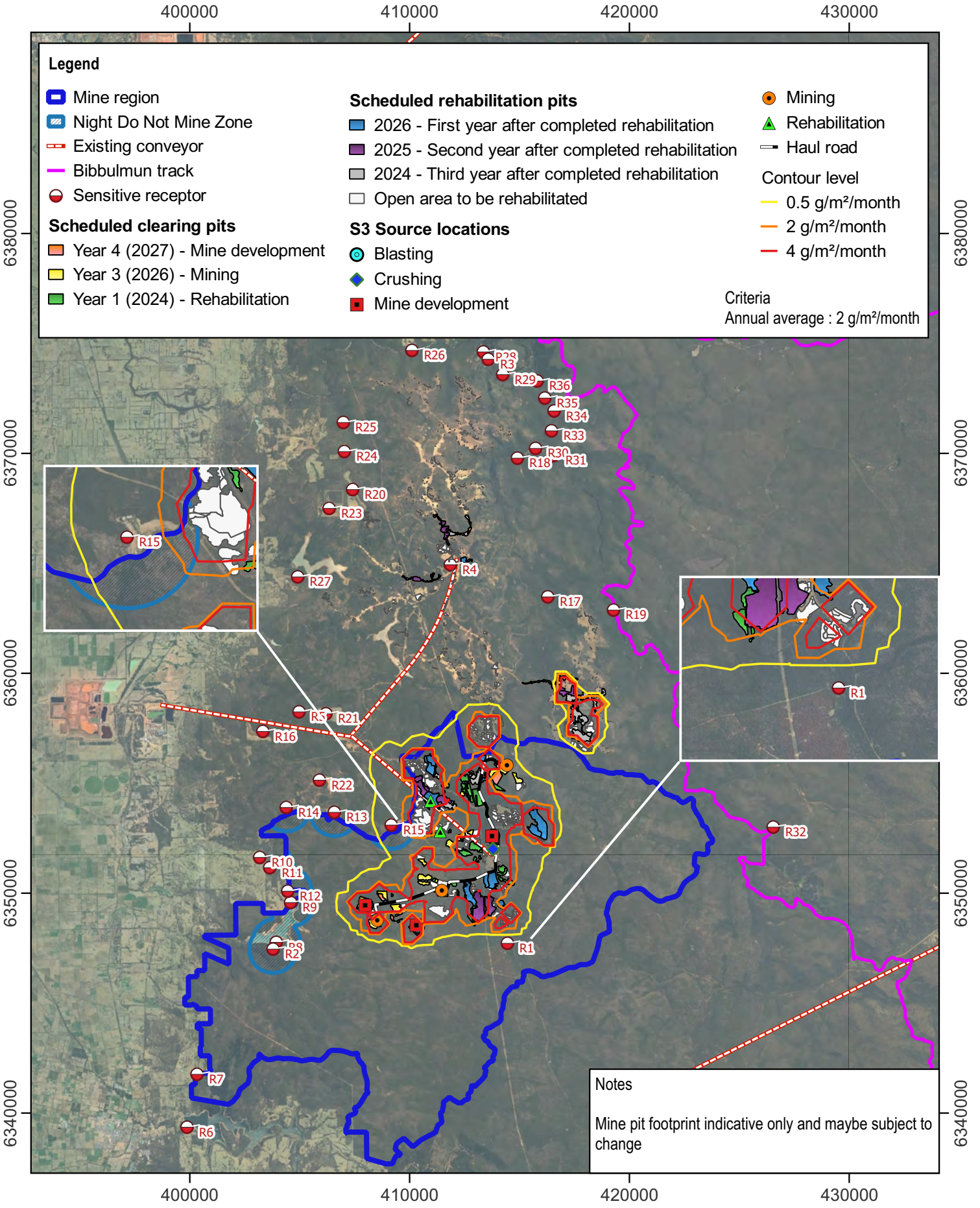
FIGURE 10.26

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Larego.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.



Paper Size ISO A4

0 1 2 3 4 km

Map Projection: Transverse Mercator
Horizontal Datum: AGD84
Grid: AGD84 / AMG zone 50

N

GHD

Alcoa of Australia Limited
Larego Mine Region
Air Quality Impact Assessment

Predicted annual average dust deposition Scenario 3

Project No. **12632796**
Revision No. **A**
Date. **08/10/2024**

FIGURE 10.27

Document Path: \\ghdnet\ghd\AU\Melbourne\Projects\61\12632796\03_GIS\Maps\Working\Air quality\12632796_Air_Quality_Laregо.qgz
Print Date: 08/10/2024

Data Source:Google Earth Imagery 2024; Alcoa: mine boundary, conveyor, clearing pits, rehabilitation pits; GHD: source locations,night do not mine zone, air quality contours.

Created By: npaul

©2024. While GHD has taken care to ensure the accuracy of this product, GHD and DATA CUSTODIAN(S), make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and DATA CUSTODIAN(S) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

10.3 Modelling results summary

Worst case dust impacts were predicted at receptors located within close proximity of Larego Mine Region. Incremental exceedance of 24-hour TSP assessment criteria was predicted at R01 in Scenario 1. The exceedance occurred only once during the modelled period. This is likely due to placement of mine development, mining and rehabilitation source in the worst case location relative to R01 and the presence of more open area contributing to unmitigated emissions from southern pits in Scenario 1. However, it is understood that plant and equipment would operate at worst case locations for a limited duration and would be relocated when mining activities have been completed in that area. It is also understood that public access to R01 is closed by DBCA and R01 is only open for ad hoc day visits. Hence potential for exceedance to occur during the day visits is very low. As observed from the contour plots, no exceedances are predicted to occur along Bibbulmun track which is located further to the east of Larego Mine Region.

No incremental exceedances of 24-hour and annual PM_{10}, $PM_{2.5}$ and RCS criteria were predicted, and no exceedances of annual TSP criteria were predicted.

11. Management and mitigation measures

11.1 Construction dust management

Prior to construction, a Dust Management Plan (DMP) will be developed to assist with managing dust. The DMP may address issues associated with construction dust, such as:

– Vehicular movement on unsealed roads
– Clearing of vegetation
– Earthmoving activities
– Drilling and blasting
– Dust lift off from cleared areas and stockpiles

Based on potential issues associated with construction dust emissions, management measures in the DMP may consider

– A construction footprint that is minimal as possible
– Area and duration of exposed surfaces to be minimised
– Adoption of dust suppression techniques for unsealed roads, stockpiles and exposed surfaces
– Removal of waste materials, within construction area, that generate dust
– Maintenance of machinery, vehicles and equipment
– Induction and education packages to increase awareness of dust generation and control measures
– Audits and corrective actions
– Defined routes to be used

11.2 Operational dust management

The following dust mitigation measures were assumed in this assessment:

– Operational works to be limited to the hours defined by the development area zones outlined in Section 7.6.
– Level 2 watering provided on unsealed haul routes and unsealed roads, based on the environmental conditions.

Before operation commences, a review of operational procedures is recommended to identify any additional dust mitigation measures to be included.

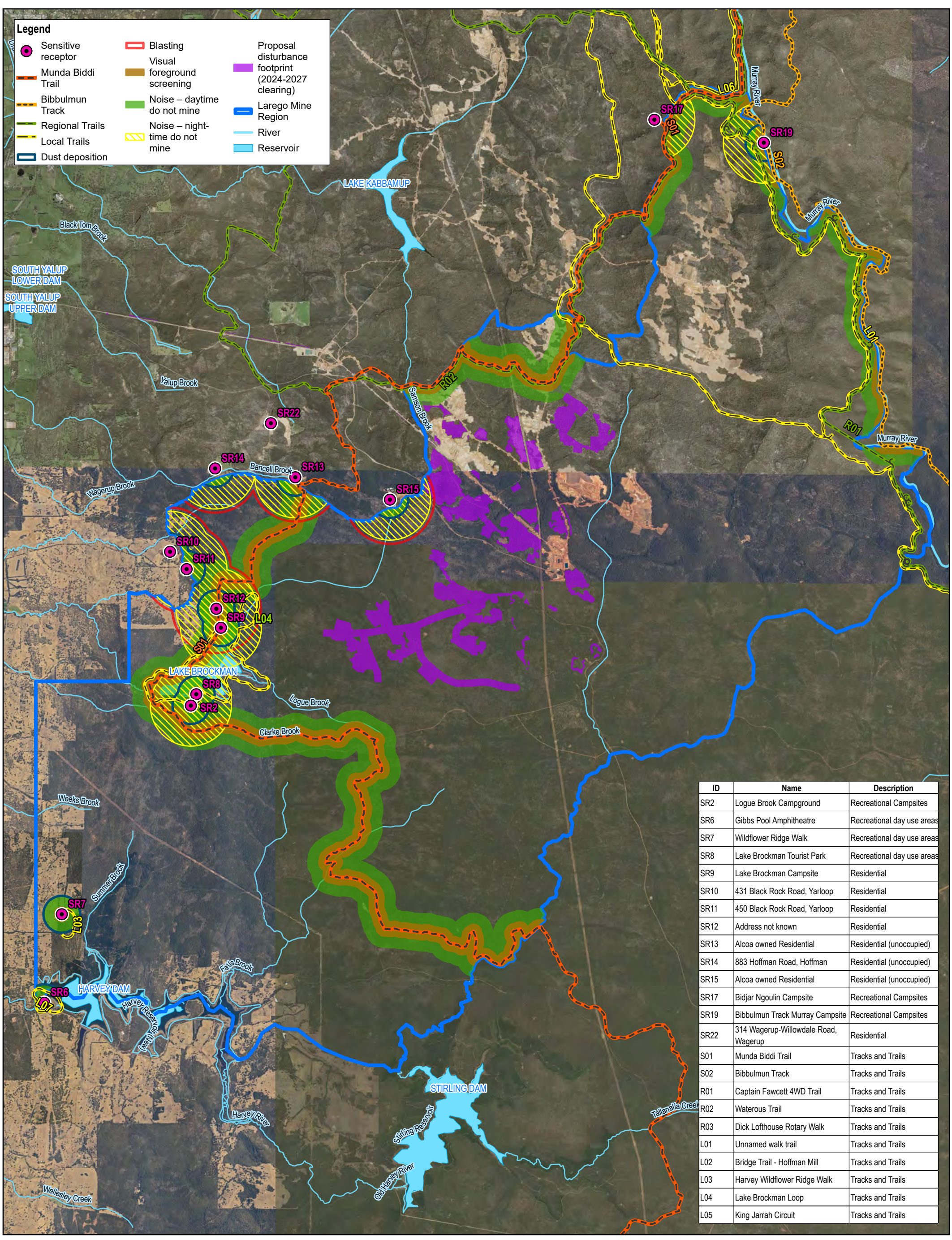
11.3 Mining sensitivity zones

GHD has proposed a Mining Sensitivity Zone (MSZ) based on amenity assessments conducted by GHD, including this AQIA report in addition to relevant guidelines and regulations. The MSZ defines the area/s where the application of the mitigation hierarchy to avoid or minimise impacts on social surroundings are recommended to be implemented.

For dust deposition the recommended buffer distance and criteria to be incorporated in the MSZ, applicable to residential properties, recreational campsites and recreational day use areas is:

- 500 m to comply with 2g/m^2/30 days (above background levels)

The MSZ components are mapped for Larego in Figure 11.1 and the consolidated MSZ (created by aggregating the MSZ components) is mapped for Larego in Figure 11.2. A separate MSZ is mapped for the daytime and night-time to indicate where the MSZ criteria differ temporally and spatially across the mine region.



ID	Name	Description
SR2	Logue Brook Campground	Recreational Campsites
SR6	Gibbs Pool Amphitheatre	Recreational day use areas
SR7	Wildflower Ridge Walk	Recreational day use areas
SR8	Lake Brockman Tourist Park	Recreational day use areas
SR9	Lake Brockman Campsite	Residential
SR10	431 Black Rock Road, Yarloop	Residential
SR11	450 Black Rock Road, Yarloop	Residential
SR12	Address not known	Residential
SR13	Alcoa owned Residential	Residential (unoccupied)
SR14	883 Hoffman Road, Hoffman	Residential (unoccupied)
SR15	Alcoa owned Residential	Residential (unoccupied)
SR17	Bidjar Ngoulin Campsite	Recreational Campsites
SR19	Bibbulmun Track Murray Campsite	Recreational Campsites
SR22	314 Wagerup-Willowdale Road, Wagerup	Residential
S01	Munda Biddi Trail	Tracks and Trails
S02	Bibbulmun Track	Tracks and Trails
R01	Captain Fawcett 4WD Trail	Tracks and Trails
R02	Waterous Trail	Tracks and Trails
R03	Dick Lofthouse Rotary Walk	Tracks and Trails
L01	Unnamed walk trail	Tracks and Trails
L02	Bridge Trail - Hoffman Mill	Tracks and Trails
L03	Harvey Wildflower Ridge Walk	Tracks and Trails
L04	Lake Brockman Loop	Tracks and Trails
L05	King Jarrah Circuit	Tracks and Trails

Paper Size ISO A3

0 0.8 1.6 2.4 3.2

Kilometers

N

Map Projection: Mercator Auxiliary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxiliary Sphere

Alcoa Australia Limited
Alcoa Huntly Mine, Myara Region and Willowdale Mine, Larego Region
Mining Sensitivity Zone

MSZ components – Larego

Project No. **12632796**
Revision No. **0**
Date **06/02/2025**

FIGURE 11.1

\\ghdnet\ghd\AU\Perth\Projects\61\12632796\03_GIS\Maps\Working\12632796_MAZ_figures.aprx - 12632796_Fig6_Larego_MAZ_Components_RevD
Print date: 06 Feb 2025 - 15:20

Data source: WANow: Landgate / SLIP. Created by: cbataller

Legend

- Town/Locality
- Sensitive receptor
- Munda Biddi Trail
- Bibbulmun Track
- Regional Trails
- Local Trails
- MSZ - Daytime
- MSZ - Nighttime
- Larego Mine Region
- Proposal disturbance footprint (2024-2027 clearing)
- River
- Reservoir

WAROONA
LAKE NAVARINO
LAKE MOYANUP
LAKE KABBAMUP
LAKE BROCKMAN
HARVEY DAM
STIRLING DAM
SOUTH YALUP UPPER DAM
SOUTH YALUP LOWER DAM
BALLINGALL
Waroona Drain
Samson South Drain
Black Tom Brook
Yalup Brook
Bancell Brook
Wagerup Brook
Logue Brook
Clarke Brook
Weeks Brook
Summer Brook
Falls Brook
Harvey Reservoir (New)
Wellesley Creek
Wokalup Creek
Samson Brook
Yarragil Brook
Murray River
Harvey River
Stirling Reservoir
Tallanall
SR2
SR6
SR7
SR8
SR9
SR10
SR11
SR12
SR13
SR14
SR15
SR17
SR19
SR22
S01
S02
L01
L03
L04
L06
L07
R01
R02

ID	Name	Description
SR2	Logue Brook Campground	Recreational Campsites
SR6	Gibbs Pool Amphitheatre	Recreational day use areas
SR7	Wildflower Ridge Walk	Recreational day use areas
SR8	Lake Brockman Tourist Park	Recreational day use areas
SR9	Lake Brockman Campsite	Residential
SR10	431 Black Rock Road, Yarloop	Residential
SR11	450 Black Rock Road, Yarloop	Residential
SR12	Address not known	Residential
SR13	Alcoa owned Residential	Residential (unoccupied)
SR14	883 Hoffman Road, Hoffman	Residential (unoccupied)
SR15	Alcoa owned Residential	Residential (unoccupied)
SR17	Bidjar Ngoulin Campsite	Recreational Campsites
SR19	Bibbulmun Track Murray Campsite	Recreational Campsites
SR22	314 Wagerup-Willowdale Road, Wagerup	Residential
S01	Munda Biddi Trail	Tracks and Trails
S02	Bibbulmun Track	Tracks and Trails
R01	Captain Fawcett 4WD Trail	Tracks and Trails
R02	Waterous Trail	Tracks and Trails
R03	Dick Lofthouse Rotary Walk	Tracks and Trails
L01	Unnamed walk trail	Tracks and Trails
L02	Bridge Trail - Hoffman Mill	Tracks and Trails
L03	Harvey Wildflower Ridge Walk	Tracks and Trails
L04	Lake Brockman Loop	Tracks and Trails
L05	King Jarrah Circuit	Tracks and Trails

Paper Size ISO A3

0 1.5 3

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

Alcoa Australia Limited
Alcoa Huntly Mine, Myara Region and Willowdale Mine, Larego Region
Mining Sensitivity Zone

Consolidated MSZ – Larego

Project No. **12632796**
Revision No. **0**
Date **06/02/2025**

FIGURE 11.2

\\ghdnet\ghd\AU\Perth\Projects\61\12632796\03_GIS\Maps\Working\12632796_MAZ_figures.aprx - 12632796_Fig8_Larego_MSZConsolodated_revD
Print date: 06 Feb 2025 - 16:17

Data source: WANow: Landgate / SLIP. Created by: cbataller

12. Conclusion

Particulate emissions (dust considered as TSP, PM_{10}, $PM_{2.5}$ and RCS) were identified as having the most significant risk of an adverse impact to air quality. The assessment was conducted in accordance with recognised and approved modelling and emissions estimation techniques. The assessment investigated the impacts of dust emissions arising from proposed mining operations within Larego Mine Region under the MMP 2023 - 2027.

Air quality dispersion modelling was undertaken to predict potential worst case air quality impacts from particulates due to operation of the Proposal. The averaging period for each particulate fraction or speciation was chosen to align with appropriate assessment criteria specific for the pollutant. The assessment demonstrates predicted ground level concentrations of incremental 24-hour and annually averaged TSP, PM_{10}, $PM_{2.5}$, and RCS were below the relevant criteria at all receptors except for one exceedance of incremental 24-hour TSP at R01 for Scenario 1. R01 is only open for ad hoc day visits and public access is closed by DBCA. Hence the likelihood of an exceedance occurring on the same day as the ad hoc visit is very low. It is also understood that the plant and equipment would operate at worst case locations for a limited duration and would be relocated when mining activities have been completed in that area. Potential exceedance at this receptor may be controlled by planning operations such that mining, rehabilitation and mine development equipment are not active concurrently in the southern pits adjacent to R01.

Potential exceedances could also be controlled by operational planning (reducing operational activity rates) and targeted source mitigation via measures such as dust suppression watering at mining pits located in close proximity to the receptors.

Small quantities of other pollutants such as NO_x, CO and SO_2 were assessed qualitatively. With implementation of standard construction management and operational controls these emissions are not expected to result in significant adverse air quality impacts to sensitive receptors of the environment.

13. References

Australian Government. (2012). *National Pollutant Inventory - Emission estimation technique manual for mining (version 3.1).* Department of Sustainability, Environment, Water, Population and Communities.

Air Assessments. (2008). *Evaluation of Residue Dust Emissions Pinjarra and Kwinana Refineries.*

Australian Bureau of Agricultural and Resource Economics and Sciences. (2021). *Catchment Scale Land Use Mapping for Western Australia*. Retrieved from data.gov.au: https://data.gov.au/dataset/ds-dga-d897e165-46a3-4f3b-a2f2-b348ac06ddfe/details?q=

Barclay, J., & Scire, J. (2011). *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia.* Atmospheric Studies Group TRC Environmental Corporation.

BoM. (2023, April 13). *Climate classification maps*. Retrieved from Bureau of Meteorology: http://www.bom.gov.au/climate/maps/averages/climate-classification/?maptype=tmp_zones

BoM. (2024). Retrieved from Climate Data Online: https://reg.bom.gov.au/climate/data/index.shtml?bookmark=200

Bureau of Meteorology. (2023). *2023*. Retrieved from Climate Data Online: http://www.bom.gov.au/climate/data/

DEC. (2011). *A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and Other Related Activities .* Department of Environment and Conservation.

Department of Environment. (2006). *Air Quality Modelling Guidance Notes.* Perth.

DWER. (2019). *Guideline: Air emissions.* Department of Water and Environmental Regulation, Government of Western Australia.

DWER. (2021). *Guideline: Dust emissions.* Department of Water and Environmental Regulation, Government of Western Australia.

EPA NSW. (2022). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.* NSW Environment Protection Authority.

EPA Vic. (2007). *1191: Protocol for Environmental Management: Mining and extractive industries.* Environment Protection Authority Victoria.

EPA WA. (1999). Environmental Protection (Kwinana) (Atmospheric Waste) Policy (1999). Environmental Protection Authority Western Australia.

EPA WA. (2005). *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986): Separation Distances Between Industrial and Sensitive Land Uses.* Environmental Protection Authority of Western Australia.

EPA WA. (2020). *Environmental Factor Guideline: Air Quality.* Environmental Protection Authority Western Australia.

GHD. (2021a). *Alcoa Huntly Expansion Environmental Approval Respirable Crystalline Silica Ambient Air Monitoring Results.* Report prepared for Alcoa of Australia Limited.

GHD. (2021b). *Pinjarra Alumina Refinery Revised Proposal Air Quality Impact Assessment for Huntly Mine - Myara North.*

GHD. (2021c). *Air Quality Modelling for 2021 HEalth Risk Assessment - Pinjarra Alumnina Refinery Revised Proposal.* REport prepared for Aloca of Australia Limited.

NEPC. (2021). *National Environment Protection (Ambient Air Quality) Measure*. Retrieved Feb 2, 2023, from National Environment Protection Council: https://www.nepc.gov.au/nepms/ambient-air-quality#toc_1

US EPA. (2000). *Meteorological Monitoring Guidance for Regulatory Modeling Applications.* United States Environmental Protection Agency.

Appendices

Appendix A

Detailed emission inventory

Emission factors were calculated in accordance with the National Pollutant Inventory (NPI) *Emission Estimation Technique (EET) Manual for Mining* (NPI, 2012).

The use of site-specific emission factors was prioritised where sufficient data was available. However, if the necessary site-specific data was not available, then the default values were adopted.

A-1-1 Excavators/shovels/front end loaders

Emission factors for use of excavators/shovels/front end loaders (on overburden) were given by:

$$EF_{TSP(kg/t)} = k_{TSP} \times 0.0016 \times \frac{\left(\frac{U_{(m/s)}}{2.2}\right)^{1.3}}{\left(\frac{M_{(\%)}}{2}\right)^{1.4}}$$

$$EF_{PM_{10}(kg/t)} = k_{PM_{10}} \times 0.0016 \times \frac{\left(\frac{U_{(m/s)}}{2.2}\right)^{1.3}}{\left(\frac{M_{(\%)}}{2}\right)^{1.4}}$$

Where:

$EF_{TSP(kg/t)}$ = emission factor for TSP (kg/t)

$EF_{PM_{10}(kg/t)}$ = emission factor for PM_{10} (kg/t)

k_{TSP} = 0.74 for particles less than 30 micrometres aerodynamic diameter

$k_{PM_{10}}$ = 0.35 for particles less than 10 micrometres aerodynamic diameter

$U_{(m/s)}$ = mean wind speed (m/s)

$M_{(\%)}$ = moisture content (%)

The following site-specific parameters were adopted:

$U_{(m/s)}$ = 4 m/s as the average wind speed at the Site predicted by CALMET

$M_{(\%)}$ = 8% as advised by Alcoa

A-1-2 Wheel generated dust from unpaved roads

Emission factors for wheel generated dust from unpaved roads were given by:

$$EF_{(kg/VKT)} = \frac{0.4536}{1.6093} \times k \times \left(\frac{s_{(\%)}}{12}\right)^{a} \times \left(\frac{W_{(t)}}{3}\right)^{b}$$

Where:

k_{TSP} = 4.9 for TSP

$k_{PM_{10}}$ = 1.5 for PM_{10}

$s_{(\%)}$ = silt content of material (%)

$W_{(t)}$ = vehicle mass (t)

a_{TSP} = 0.7 (empirical constant)

$a_{PM_{10}}$ = 0.9 (empirical constant)

b = 0.45 (empirical constant)

The following site-specific parameters were adopted:

$s_{(\%)}$ = 10% as advised by Alcoa

$W_{(t)}$ = 222.2 t calculated as the average of a empty and loaded haul mine truck

A-1-3 Dozer on material other than coal

Emission factors for use of dozers on material other than coal were given by:

$$EF_{TSP(kg/hr)} = 2.6 \times \frac{{s_{(\%)}}^{1.2}}{{M_{(\%)}}^{1.3}}$$

$$EF_{PM_{10}(kg/hr)} = 0.34 \times \frac{{s_{(\%)}}^{1.5}}{{M_{(\%)}}^{1.4}}$$

Where:

$s_{(\%)}$ = silt content of material (%)

$M_{(\%)}$ = moisture content of overburden in (%)

The following site-specific parameters were adopted:

$s_{(\%)}$ = 10% as advised by Alcoa

$M_{(\%)}$ = 8% as advised by Alcoa

A-1-4 Miscellaneous transfer points (including conveying)

In accordance with NPI guidance, emission factors for miscellaneous transfer points (including conveying) were given by same emission factor as excavators/shovels/front end loaders per point of transfer (refer A-1-1).

A-2 Emissions inventory

A detailed emissions inventory containing all assumptions is provided in the tables below.

Table A.1 Detailed emissions inventory for Scenario 1

Activity/location	Source (use of plant or activity)	Emission factor source	Quantity of plant	Activity rate	Units	Emissions factors (EF) (No control applied)				EF units	Emissions control	Emissions control reduction factor	Emission rates (g/s)				Assumptions
						TSP	PM10	PM2.5	RCS				TSP	PM10	PM2.5	RCS	
Mine pit development	Blasting	NPI EETM for Mining V3.1 (2012) - (Blasting)	3	1.00	blasts/hour	13.4	7	0.7	0.02	kg/blast/hour	No control		11.2	5.8	0.6	0.0	One blast occurs at each blast rig location from 12:00 - 13:00 during pit operational hours
	Drilling	NPI EETM for Mining V3.1 (2012) - (Drilling)	2	1.00	holes/hour	0.6	0.3	0.03	6.82×10^{-4}	kg/hole/hour	No control		0.3	0.2	0.02	3.79×10^{-4}	Alcoa propose to drill 33 small holes of 0.127 m diameter to a depth of 1.8 m per hour
	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	169.53	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.20×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.0	0.01	1.13×10^{-3}	2.49×10^{-5}	Excavators handle 2.9 Mtpa of material during mine development activities
	Loader	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	339.1	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.02	0.01	1.13×10^{-3}	2.49×10^{-5}	Loaders handle 2.9 Mtpa of material during mine development activities
	Scraper	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	3	113.0	t/hour	2.90×10^{-2}	7.30×10^{-3}	7.3×10^{-4}	1.61×10^{-5}	kg/t/hour	No control		2.7	0.69	6.88×10^{-2}	1.51×10^{-3}	Scrapers handle 2.9 Mtpa of material through mine development activities
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	7	1.0	hour/hour	2.76	0.58	5.8×10^{-2}	1.29×10^{-3}	kg/hour/hour	No control		5.4	1.1	0.11	2.50×10^{-3}	Each dozer operates continuously over pit operational hours
	Loading scraper in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		169.5	t/hour	4.00×10^{-4}	1.70×10^{-4}	1.7×10^{-5}	3.74×10^{-7}	kg/t/hour	No control		0.1	0.0	0.00	5.28×10^{-5}	2.9 Mtpa of material is loaded into scrapers for transport into rehabilitation area
Mining	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	3	397.7	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.1	0.0	3.99×10^{-3}	8.77×10^{-5}	Excavators handle 100% of extracted material (10,451,835 tpa)
	Loading truck in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		398	t/hour	4.00×10^{-4}	1.70×10^{-4}	1.7×10^{-5}	3.74×10^{-7}	kg/t/hour	No control		0.1	0.1	0.01	1.24×10^{-4}	100% of the extracted material is loaded into haulage trucks (10,451,835 tpa)
Mine pit rehabilitation	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	69	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.01	0.00	4.62×10^{-4}	1.02×10^{-5}	Excavators handle 1,211,015 tpa of material during mine rehabilitation activities.
	Loader	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	138	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.01	0.00	4.62×10^{-4}	1.02×10^{-5}	Loaders handle 1,211,015 tpa of material during mine rehabilitation activities.
	Scraper	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	2	69	t/hour	2.90×10^{-2}	7.30×10^{-3}	7.3×10^{-4}	1.61×10^{-5}	kg/t/hour	No control		1.1	0.3	0.0	6.17×10^{-4}	Scrapers handle 1,211,015 tpa of material during mine rehabilitation activities.
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	4	1	hour/hour	2.8	0.6	5.8×10^{-2}	1.29×10^{-3}	kg/hour/hour	No control		3.1	0.6	0.1	1.43×10^{-3}	Each dozer operates continuously over pit operational hours.
	Soil return	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		69	t/hour	0.01	4.30×10^{-3}	4.3×10^{-4}	9.46×10^{-6}	kg/t/hour	No control		0.5	0.2	0.0	3.63×10^{-4}	1,211,015 tpa of soil is returned during mine rehabilitation activities.
Haul Roads	Trucks - 190T	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)		45	VKT/hour	8.8	2.6	0.3	5.72×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	27.3	8.1	8.05E-01	1.77×10^{-2}	Haulage truck have an average payload capacity of 204 t

	Graders	NPI EETM for Mining V3.1 (2012) - (Graders)	2	10.0	km/hour	0.2	0.1	8.50×10^{-3}	1.87×10^{-4}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	0.1	0.1	5.90×10^{-3}	1.30×10^{-4}	Each grader operates constantly (24 hours per day, 7 days per week) at 10 km/h
	Low loader fleet	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)	2	20.0	km/hour	2.7	0.8	0.1	1.75×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	3.7	1.1	0.1	2.43×10^{-3}	Each float operates constantly (24 hours per day, 7 days per week) at 20 km/h
Material processing	Truck dumping into crusher	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		1193	t/hour	0.01	4.30×10^{-3}	4.30×10^{-4}	9.46×10^{-6}	kg/t/hour	No control		4.0	1.4	0.1	3.14×10^{-3}	All material is processed through crusher. Activity rate calculated as the maximum possible rate that would only occur during day periods (single excavator rate multiplied by number of excavators).
	Screening	NPI EETM for Mining V3.1 (2012) - (Screening (controlled) (AP42))		1193.1	t/hour	0.01	3.70×10^{-3}	3.70×10^{-4}	8.14×10^{-6}	kg/t/hour	No control		3.6	1.2	0.1	2.70×10^{-3}	All material is crushed.
	Crushing/sizing	NPI EETM for Mining V3.1 (2012) - (Primary Crushing (Low M))		1193.1	t/hour	0.2	0.02	2.00×10^{-3}	4.40×10^{-5}	kg/t/hour	hooding with fabric filters		11.3	1.1	0.1	2.48×10^{-3}	All material is screened.
	Conveyor	NPI EETM for Mining V3.1 (2012) - (Conveyor transfer point (AP42))		1193	t/hour	1.50×10^{-3}	5.50×10^{-4}	5.50×10^{-5}	1.21×10^{-6}	kg/t/hour	No control		0.5	0.2	0.02	4.01×10^{-4}	All material is transferred via conveyor.
Wind Erosion	Wind erosion (Exposed area in mine development pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		283	ha	0.4	0.20	0.02	4.40×10^{-4}	kg/ha/hour	No control		31.4	15.7	1.6	0.0	All mine development pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in mining pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		173	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		19.2	9.6	1.0	0.02	All mining pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in rehabilitation pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		202	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		22.4	11.2	1.1	0.0	All pits undergoing rehabilitation are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 1 year after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		195	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	primary rehabilitation	0.3	15.2	7.6	0.8	0.02	Mine pit rehabilitation is completed. However all mine pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 2 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		182	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	secondary rehabilitation	0.6	8.1	4.0	0.4	0.01	Mine pit rehabilitation is completed and dust emissions occur although some vegetation is established
	Wind erosion (Exposed area in pits 3 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		124	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	revegetation	0.9	1.4	0.7	0.1	1.52×10^{-3}	Mine pit rehabilitation is completed and dust emissions occur, although significantly reduced by established vegetation
	Wind erosion (Exposed area in pits yet to be rehabilitated)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		568	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		63.1	31.5	3.2	6.94×10^{-2}	All open pits to be rehabilitated are exposed and would contribute to wind blown dust

Table A.2 Detailed emissions inventory for Scenario 2

Activity/location	Source (use of plant or activity)	Emission factor source	Quantity of plant	Activity rate	Units	Emissions factors (EF) (No control applied)				EF units	Emissions control	Emissions control reduction factor	Emission rates (g/s)				Assumptions
						TSP	PM10	PM2.5	RCS				TSP	PM10	PM2.5	RCS	
Mine pit development	Blasting	NPI EETM for Mining V3.1 (2012) - (Blasting)	3	1.00	blasts/hour	13.4	7	0.7	0.02	kg/blast/hour	No control		11.2	5.8	0.6	0.0	One blast occurs at each blast rig location from 12:00 - 13:00 during pit operational hours
	Drilling	NPI EETM for Mining V3.1 (2012) - (Drilling)	2	1.00	holes/hour	0.6	0.3	0.03	6.82×10^{-4}	kg/hole/hour	No control		0.3	0.2	0.02	3.79×10^{-4}	Alcoa propose to drill 33 small holes of 0.127 m diameter to a depth of 1.8 m per hour
	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	101.10	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.20×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.0	0.01	6.76×10^{-4}	1.49×10^{-5}	Excavators handle 1.8 Mtpa of material during mine development activities
	Loader	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	202.2	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.01	0.01	6.76×10^{-4}	1.49×10^{-5}	Loaders handle 1.8 Mtpa of material during mine development activities
	Scraper	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	3	67.4	t/hour	2.90×10^{-2}	7.30×10^{-3}	7.3×10^{-4}	1.61×10^{-5}	kg/t/hour	No control		1.6	0.41	4.10×10^{-2}	9.02×10^{-4}	Scrapers handle 1.8 Mtpa of material through mine development activities
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	7	1.0	hour/hour	2.76	0.58	5.8×10^{-2}	1.29×10^{-3}	kg/hour/hour	No control		5.4	1.1	0.11	2.50×10^{-3}	Each dozer operates continuously over pit operational hours
	Loading scraper in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		101.1	t/hour	4.00×10^{-4}	1.70×10^{-4}	1.7×10^{-5}	3.74×10^{-7}	kg/t/hour	No control		0.0	0.0	0.00	3.15×10^{-5}	1.8 Mtpa of material is loaded into scrapers for transport into rehabilitation area
Mining	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	3	397.3	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.1	0.0	3.98×10^{-3}	8.76×10^{-5}	Excavators handle 100% of extracted material (10,440,323 tpa)
	Loading truck in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		397	t/hour	4.00×10^{-4}	1.70×10^{-4}	1.7×10^{-5}	3.74×10^{-7}	kg/t/hour	No control		0.1	0.1	0.01	1.24×10^{-4}	100% of the extracted material is loaded into haulage trucks (10,440,323 tpa)
Mine pit rehabilitation	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	80	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.01	0.01	5.38×10^{-4}	1.18×10^{-5}	Excavators handle 1,408,921 tpa of material during mine rehabilitation activities.
	Loader	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	161	t/hour	2.54×10^{-4}	1.20×10^{-4}	1.2×10^{-5}	2.65×10^{-7}	kg/t/hour	No control		0.01	0.01	5.38×10^{-4}	1.18×10^{-5}	Loaders handle 1,408,921 tpa of material during mine rehabilitation activities.
	Scraper	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	2	80	t/hour	2.90×10^{-2}	7.30×10^{-3}	7.3×10^{-4}	1.61×10^{-5}	kg/t/hour	No control		1.3	0.3	0.0	7.18×10^{-4}	Scrapers handle 1,408,921 tpa of material during mine rehabilitation activities.
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	4	1	hour/hour	2.8	0.6	5.8×10^{-2}	1.29×10^{-3}	kg/hour/hour	No control		3.1	0.6	0.1	1.43×10^{-3}	Each dozer operates continuously over pit operational hours.
	Soil return	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		80	t/hour	0.01	4.30×10^{-3}	4.3×10^{-4}	9.46×10^{-6}	kg/t/hour	No control		0.5	0.2	0.0	4.23×10^{-4}	1,408,921 tpa of soil is returned during mine rehabilitation activities.
Haul Roads	Trucks - 190T	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)		63	VKT/hour	8.8	2.6	0.3	5.72×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	38.4	11.3	1.13	2.49×10^{-2}	Haulage truck have an average payload capacity of 204 t

	Graders	NPI EETM for Mining V3.1 (2012) - (Graders)	2	10.0	km/hour	0.2	0.1	8.50×10^{-3}	1.87×10^{-4}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	0.1	0.1	5.90×10^{-3}	1.30×10^{-4}	Each grader operates constantly (24 hours per day, 7 days per week) at 10 km/h
	Low loader fleet	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)	2	20.0	km/hour	2.7	0.8	0.1	1.75×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	3.7	1.1	0.1	2.43×10^{-3}	Each float operates constantly (24 hours per day, 7 days per week) at 20 km/h
Material processing	Truck dumping into crusher	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		1192	t/hour	0.01	4.30×10^{-3}	4.30×10^{-4}	9.46×10^{-6}	kg/t/hour	No control		4.0	1.4	0.1	3.13×10^{-3}	All material is processed through crusher. Activity rate calculated as the maximum possible rate that would only occur during day periods (single excavator rate multiplied by number of excavators).
	Screening	NPI EETM for Mining V3.1 (2012) - (Screening (controlled) (AP42))		1191.8	t/hour	0.01	3.70×10^{-3}	3.70×10^{-4}	8.14×10^{-6}	kg/t/hour	No control		3.6	1.2	0.1	2.69×10^{-3}	All material is crushed.
	Crushing/sizing	NPI EETM for Mining V3.1 (2012) - (Primary Crushing (Low M))		1191.8	t/hour	0.2	0.02	2.00×10^{-3}	4.40×10^{-5}	kg/t/hour	hooding with fabric filters		11.3	1.1	0.1	2.48×10^{-3}	All material is screened.
	Conveyor	NPI EETM for Mining V3.1 (2012) - (Conveyor transfer point (AP42))		1192	t/hour	1.50×10^{-3}	5.50×10^{-4}	5.50×10^{-5}	1.21×10^{-6}	kg/t/hour	No control		0.5	0.2	0.02	4.01×10^{-4}	All material is transferred via conveyor.
Wind Erosion	Wind erosion (Exposed area in mine development pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		169	ha	0.4	0.20	0.02	4.40×10^{-4}	kg/ha/hour	No control		18.7	9.4	0.9	0.0	All mine development pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in mining pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		283	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		31.4	15.7	1.6	0.03	All mining pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in rehabilitation pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		235	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		26.1	13.0	1.3	0.0	All pits undergoing rehabilitation are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 1 year after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		202	ha	0.40	2.00E-01	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	primary rehabilitation	0.3	15.7	7.8	0.8	0.02	Mine pit rehabilitation is completed. However all mine pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 2 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		195	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	secondary rehabilitation	0.6	8.7	4.3	0.4	0.01	Mine pit rehabilitation is completed and dust emissions occur although some vegetation is established
	Wind erosion (Exposed area in pits 3 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		182	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	revegetation	0.9	2.0	1.0	0.1	2.22×10^{-3}	Mine pit rehabilitation is completed and dust emissions occur, although significantly reduced by established vegetation
	Wind erosion (Exposed area in pits yet to be rehabilitated)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		542	ha	0.40	0.20	2.00×10^{-2}	4.40×10^{-4}	kg/ha/hour	No control		60.2	30.1	3.0	6.62×10^{-2}	All open pits to be rehabilitated are exposed and would contribute to wind blown dust

Table A.3 Detailed emissions inventory for Scenario 3

Activity/location	Source (use of plant or activity)	Emission factor source	Quantity of plant	Activity rate	Units	Emissions factors (EF) (No control applied)				EF units	Emissions control	Emissions control reduction factor	Emission rates (g/s)				Assumptions
						TSP	PM10	PM2.5	RCS				TSP	PM10	PM2.5	RCS	
Mine pit development	Blasting	NPI EETM for Mining V3.1 (2012) - (Blasting)	3	1	blasts/hour	107.90	55.91	5.59	0.12	kg/blast/hour	No control		89.92	46.59	4.66	0.10	One blast occurs at each blast rig location from 12:00 - 13:00 during pit operational hours
	Drilling	NPI EETM for Mining V3.1 (2012) - (Drilling)	3	1	holes/hour	0.59	0.31	0.03	6.8210^{-4}	kg/hole/hour	No control		0.49	0.26	0.03	5.6810^{-4}	Alcoa propose to drill 33 small holes of 0.127 m diameter to a depth of 1.8 m per hour
	Excavator PC3000/575	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	139	t/hour	3.7010^{-4}	1.7510^{-4}	1.7510^{-5}	3.8510^{-7}	kg/t/hour	No control		0.03	0.01	1.35×10^{-3}	2.9710^{-5}	Excavators handle 2.4 Mtpa of material during mine development activities
	Loaders - CAT 992/993	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	278	t/hour	3.7010^{-4}	1.7510^{-4}	1.7510^{-5}	3.8510^{-7}	kg/t/hour	No control		0.03	0.01	1.35×10^{-3}	2.9710^{-5}	Loaders handle 2.4 Mtpa of material during mine development activities
	Scraper - 637D	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	5	56	t/hour	2.9010^{-2}	7.30×10^{-3}	7.3010^{-4}	1.6110^{-5}	kg/t/hour	No control		2.24	0.56	0.06	1.24×10^{-3}	Scrapers handle 2.4 Mtpa of material through mine development activities
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	8	1	hour/hour	2.76	0.5850	0.06	1.29×10^{-3}	kg/hour/hour	No control		6.13	1.30	0.13	2.86×10^{-3}	Each dozer operates continuously over pit operational hours
	Loading scraper in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		139	t/hour	4.0010^{-4}	1.7010^{-4}	1.7010^{-5}	3.7410^{-7}	kg/t/hour	No control		0.06	0.03	2.62×10^{-3}	5.7710^{-5}	2.4 Mtpa of material is loaded into scrapers for transport into rehabilitation area
Mining	Excavator PC3000/575	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	6	331.3	t/hour	3.7010^{-4}	1.7510^{-4}	1.7510^{-5}	3.8510^{-7}	kg/t/hour	No control		0.20	0.10	9.66×10^{-3}	2.1210^{-4}	Excavators handle 100% of extracted material (17,4121678 tpa)
	Loading truck in pit	NPI EETM for Mining V3.1 (2012) - (Loading to trains)		331.3	t/hour	4.0010^{-4}	1.7010^{-4}	1.7010^{-5}	3.7410^{-7}	kg/t/hour	No control		0.15	0.06	6.26×10^{-3}	1.3810^{-4}	100% of the extracted material is loaded into haulage trucks (17,4121678 tpa)
Mine pit rehabilitation	Excavator	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	2	1988	t/hour	1.2010^{-2}	4.30×10^{-3}	4.3010^{-4}	9.46×10^{-6}	kg/t/hour	No control		0.01	0.01	5.8810^{-4}	1.2910^{-5}	Excavators handle 1,060,683 tpa of material during mine rehabilitation activities.
	Loader	NPI EETM for Mining V3.1 (2012) - (Excavators/Shovels/Front-end loaders (on overburden))	1	1988	t/hour	0.01	3.70×10^{-3}	3.7010^{-4}	8.14×10^{-6}	kg/t/hour	No control		0.01	0.01	5.8810^{-4}	1.2910^{-5}	Loaders handle 1,060,683 tpa of material during mine rehabilitation activities.
	Scraper	NPI EETM for Mining V3.1 (2012) - (Scrapers (removing topsoil))	3	1988	t/hour	0.20	0.02	2.00×10^{-3}	4.4010^{-5}	kg/t/hour	No control		0.98	0.25	0.02	5.4010^{-4}	Scrapers handle 1,060,683 tp tpa of material during mine rehabilitation activities.
	Dozer	NPI EETM for Mining V3.1 (2012) - (Bulldozer on material other than coal)	4	1	hour/hour	2.8	0.6	5.8510^{-2}	1.29×10^{-3}	kg/hour/hour	No control		3.07	0.65	0.06	1.43×10^{-3}	Each dozer operates continuously over pit operational hours.
	Soil return	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		1988	t/hour	1.50×10^{-3}	5.5010^{-4}	5.5010^{-5}	1.21×10^{-6}	kg/t/hour	No control		0.61	0.22	0.02	4.7710^{-4}	1,060,683 tpa of soil is returned during mine rehabilitation activities.
Haul Roads	Trucks - 190T	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)		218.1	VKT/hour	8.8	2.6	0.3	5.72×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	133.5	39.4	3.94	0.09	Haulage truck have an average payload capacity of 204 t

	Graders	NPI EETM for Mining V3.1 (2012) - (Graders)	5	10.00	km/hour	0.2	0.1	0.01	1.8710^{-4}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	0.13	0.06	0.01	1.3010^{-4}	Each grader operates constantly (24 hours per day, 7 days per week) at 10 km/h
	Low loader fleet	NPI EETM for Mining V3.1 (2012) - (Wheel generated dust from unpaved roads at industrial sites)	2	20	km/hour	2.7	0.8	0.08	1.75×10^{-3}	kg/VKT/hour	Level 2 watering (>2L/m^2/h)	0.75	3.75	1.11	0.11	2.43×10^{-3}	Each float operates constantly (24 hours per day, 7 days per week) at 20 km/h
Material processing	Truck dumping into crusher	NPI EETM for Mining V3.1 (2012) - (Trucks (dumping overburden))		1988	t/hour	0.01	4.30×10^{-3}	4.3010^{-4}	9.46×10^{-6}	kg/t/hour	No control		6.6	2.4	0.2	0.01	All material is processed through crusher. Activity rate calculated as the maximum possible rate that would only occur during day periods (single excavator rate multiplied by number of excavators).
	Screening	NPI EETM for Mining V3.1 (2012) - (Screening (controlled) (AP42))		1988	t/hour	0.01	3.70×10^{-3}	3.7010^{-4}	8.14×10^{-6}	kg/t/hour	No control		6.1	2.0	0.2	0.00	All material is crushed.
	crushing/sizing	NPI EETM for Mining V3.1 (2012) - (Primary Crushing (Low M))		1988	t/hour	0.20	0.02	2.00×10^{-3}	4.4010^{-5}	kg/t/hour	hooding with fabric filters		18.8	1.9	0.2	0.00	All material is screened.
	Conveyor	NPI EETM for Mining V3.1 (2012) - (Conveyor transfer point (AP42))		1988	t/hour	1.50×10^{-3}	5.5010^{-4}	5.5010^{-5}	1.21×10^{-6}	kg/t/hour	No control		0.8	0.3	0.03	0.00	All material is transferred via conveyor.
Wind Erosion	Wind erosion (Exposed area in mine development pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		231.83	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	No control		25.76	12.88	1.29	0.03	All mine development pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in mining pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		331.94	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	No control		36.88	18.44	1.84	0.04	All mining pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in rehabilitation pits)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		176.78	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	No control		19.64	9.82	0.98	0.02	All pits undergoing rehabilitation are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 1 year after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		721	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	primary rehabilitation	0.3	56.06	28.03	2.80	0.06	Mine pit rehabilitation is completed. However, all mine pits are exposed and would contribute to wind blown dust
	Wind erosion (Exposed area in pits 2 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		631	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	secondary rehabilitation	0.6	28.02	14.01	1.40	0.03	Mine pit rehabilitation is completed and dust emissions occur although some vegetation is established
	Wind erosion (Exposed area in pits 3 years after rehabilitation)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		500	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	revegetation	0.9	5.56	2.78	0.28	0.01	Mine pit rehabilitation is completed and dust emissions occur, although significantly reduced by established vegetation
	Wind erosion (Exposed area in pits yet to be rehabilitated)	NPI EETM for Mining V3.1 (2012) - (Wind erosion)		2066	ha	0.40	0.20	2.0010^{-2}	4.4010^{-4}	kg/ha/hour	No control		229.54	114.77	11.48	0.25	All open pits to be rehabilitated are exposed and would contribute to wind blown dust

Appendix B

RCS sampling report

10 May 2021

Our ref: 12520591-78658-268

Jocelyn Zimmerman
Environmental Approvals Manager
Alcoa of Australia
181-205 Davy Street
Booragoon WA 6953

Dear Jocelyn,

Alcoa Huntly Expansion Environmental Approval
Respirable Crystalline Silica Ambient Air Monitoring Results

1 Background

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery and extend the Huntly Mine (the Proposal). The Proposal will be assessed by the Environmental Protection Authority (EPA) under Part IV of the WA *Environmental Protection Act 1986* (EP Act), via a Public Environmental Review (PER).

Alcoa has engaged GHD to prepare documentation for the PER. This includes an air quality (dust) assessment of the Huntly Mine component of the Proposal, which involves an extension of mining into the Myara North and Holyoake regions, and increased mine production to support the refinery upgrade and bauxite export. The air quality assessment has been undertaken in accordance with the draft Environmental Scoping Document for the PER. In addition, stakeholder consultation by Alcoa has identified respirable crystalline silica (RCS) as a potential matter of concern. Accordingly, Alcoa has engaged GHD to undertake monitoring of RCS content in particulate matter at the Huntly Mine and incorporate the findings into the air quality assessment.

RCS is a common mineral found in many types of rock, including bauxite. RCS is a hazardous substance, the inhalation of which can lead to silicosis, an incurable lung disease. RCS in the context of ambient air concentrations is contained within the fine fraction of particulate matter less than or equal to 2.5 microns diameter ($PM_{2.5}$). Activities occurring at the Huntly Mine, such as drilling and blasting, and crushing of bauxite, may potentially generate $PM_{2.5}$ that could contain RCS and result in offsite exposure.

This letter report presents the RCS monitoring results at the Huntly Mine and estimates the ratio of RCS to $PM_{2.5}$ in order to convert monitored and modelled $PM_{2.5}$ into ambient and predicted air concentrations of RCS.

1.1 Limitations

This report has been prepared by GHD for Alcoa and may only be used and relied on by Alcoa for the purpose agreed between GHD and Alcoa as set out in this report.

GHD otherwise disclaims responsibility to any person other than Alcoa arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope and limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

1.2 Assumptions

This assessment of RCS assumes:

- All data used from monitoring equipment provided accurate measurements unless otherwise stated.
- This report has been written based on the information on hand as of February 2021.
- The selected monitoring location was reasonably representative of the existing background environment.

2 Purpose of this letter

This letter presents the results of a seven day monitoring programme for RCS, conducted at the Yamba monitoring station west of the existing Huntly Mine operations in the Myara region. Monitoring was conducted to determine the presence of RCS, and to quantify the fraction of RCS/$PM_{2.5}$. The RCS/$PM_{2.5}$ fraction will be used in the Huntly Mine Air Quality Impact Assessment for the Myara North and Holyoake regions.

3 Assessment criteria

There is currently a 24-hour average goal for silica [1] Noting the goal for silica is still a draft value and should only be used as a guideline. In Victoria, the *Protocol for Environmental Management: Mining and Extractive Industries (Mining PEM) 2007*[2] is an incorporated document of the *State Environment Protection Policy (Air Quality Management) 2001*. The Mining PEM sets out the statutory requirements for the management of emissions to the air environment for mining or extractive operations, including RCS (as $PM_{2.5}$).

The criteria are shown in Table 1.

---

[1] Department of Water and Environmental Regulation (2019) Draft Guidelines for Air Emissions

[2] Environmental Protection Authority Victoria. (2007). Protocol for Environmental Management: Mining and Extractive Industries

Table 1 RCS (as a fraction of $PM_{2.5}$) criteria

Pollutant	Averaging period	Maximum concentration (µg/m^3)	Guideline
Silica (as $PM_{2.5}$)	24-hours	10	Draft DWER
RCS (as $PM_{2.5}$)	Annual	3	Mining PEM

4 Methodology

4.1 Existing air quality monitoring

Currently, Yamba monitoring station measures particulate air quality using a combination of a beta attenuation monitors (BAM) to monitor $PM_{2.5}$ and PM_{10} (particulate matter less than 10 µm in aerodynamic equivalent diameter). A tapered element oscillating microbalance (TEOM) monitors total suspended particulates (TSP).

Monitoring data was extracted from the Yamba BAM to determine the 2020 $PM_{2.5}$ annual average concentration.

4.2 High volume air sampler monitoring

The monitoring was undertaken by Ecotech, who are NATA/ISO17025 accredited for operating and maintaining ambient air and continuous emissions monitoring systems.

One high volume air sampler (HiVol) was placed at Alcoa's Yamba monitoring station, operated from mains power. $PM_{2.5}$ samples were captured daily over a seven day period from 15 to 22 February 2021. Samples were not collected on the 16 February 2021, as the sampler was shut down for a period to address a noise complaint at Yamba.

A constant volumetric flow rate was passed through a $PM_{2.5}$ size selective inlet. The $PM_{2.5}$ samples were collected on pre-weighed PVC filters, and changed every 24 hours. Once collected, Ecotech sent the filters to Envirolab Services (refer to Section 4.3) to analyse the RCS content in each sample.

The HiVol location and operations complied with the requirements of Australian Standards *AS 3580.9.14:2013 Determination of Suspended Particulate Matter $PM_{2.5}$ High Volume Sampler with Size Selective Inlet – Gravimetric Method* for the collection of $PM_{2.5}$ samples in ambient air.

4.3 Laboratory analysis

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories analysed the quantity of RCS in the $PM_{2.5}$ samples following gravimetric analysis. Analysis was conducted in accordance with Envirolab Services in-house method of dust direct on filter by x-ray powder diffraction.

The certificates of analysis are provided in Appendix A and the chain of custodies are provided in Appendix B.

4.4 Meteorological monitoring

Alcoa own and operate the Huntly meteorological station, located approximately 1.5 km north-east of the Yamba HiVol. Hourly wind speed and wind direction data for the duration of the monitoring period were provided by Alcoa to assist with the analysis.

The location of the HiVol and Huntly meteorological station, and nearby sensitive receptors are shown in Figure 1.

Figure 1 Site location for Yamba HiVol monitor, Huntly meteorological station and sensitive receptor locations

5 Results

Results from laboratory analysis for 24-hour $PM_{2.5}$ monitoring at Yamba are summarised in Table 2.Table 2 Monitoring results for 24-hour PM2.5 and RCS at Yamba (15 to 22 February 2021)

Table 2 Monitoring results for 24-hour PM2.5 and RCS at Yamba (15 to 22 February 2021)

Date sampled	Finish date	Concentration of RCS (µg/m^3)	$PM_{2.5}$ concentration (µg/m^3)	RCS/PM2.5 Fraction
15/02/2021[1]	16/02/2021	0.91	20.9	4.4%
17/02/2021	18/02/2021	0.16	8.7	1.8%
18/02/2021	19/02/2021	0.2	8.5	2.4%
19/02/2021	20/02/2021	0.13	22.1	0.6%
20/02/2021	21/02/2021	0.3	25.9	1.2%
21/02/2021	22/02/2021	0.41	24.9	1.6%
22/02/2021	23/02/2021	0.76	20.4	3.7%
	7-day average	*0.41*	*18.77*	*2.2%*

[1] Correspondence from Ecotech to GHD reported a noise complaint at Yamba on 16/02/2021. To address the issue, sampling was stopped as per instruction from Alcoa. Consequently, sampling was not completed on 16/02/2021. Samples were collected for all other days noted in column above. It should also be noted there was a discrepancy in dates recorded in the laboratory report with start and finish date being noted as 16/02/2021. This has been updated in the table above based on correspondence with Ecotech.

The average 24-hour RCS concentration over the 7-day monitoring period was 0.41 µg/m^3. The average RCS/$PM_{2.5}$ fraction for the monitoring period was determined to be 2.2%.

Using annual the RCS fraction data from Yamba, the ambient level of RCS can be estimated from this ratio. Table 3 provides summary data collected from 2020 Yamba monitoring, and applies the RCS/$PM_{2.5}$ fraction.

Table 3 Yamba $PM_{2.5}$ monitoring station data (2020) and applied RCS/ $PM_{2.5}$ fraction

Annual average $PM_{2.5}$ concentration	RCS/$PM_{2.5}$ fraction	Estimated annual average RCS concentration
5.04 µg/m^3	2.2%	0.11 µg/m^3

5.1 Meteorology

Meteorological data from the Huntly meteorological monitoring station was supplied by Alcoa. Wind direction during the monitoring period is predominately from the south-east. The wind speed that has the highest velocity is from the south-east, with the south-east being the only quadrant greater than 8 m/s. A smaller proportion of winds blow from the south-west and north-west. The average wind speed during the monitoring period was 4.4 m/s.

A wind rose depicting the direction of winds between 15 and 22 February 2021 is presented in Figure 2.

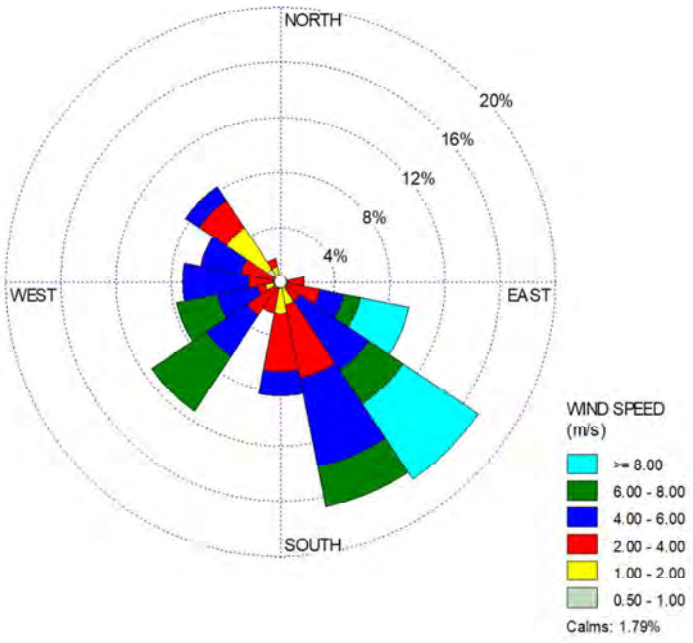


Figure 2 Wind rose for Huntly meteorological station, 15 to 22 February 2021

6 Discussion

The laboratory results for ambient air monitoring over the seven day period indicate that RCS is present at the Huntly Mine, in concentrations ranging from 0.2 µg/m^3 to 0.9 µg/m^3. Results for the period are below the draft DWER 24-hour criteria of 10 µg/m^3.

Estimation of background RCS concentration using measured RCS/$PM_{2.5}$ ratio indicates an annual average background concentration of RCS at Yamba is approximately 0.11 µg/m^3, below the annual 3 µg/m^3 criterion. Potential risk to nearby receptors is assessed as low given the data available.

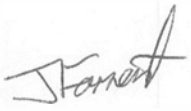
Wind direction was predominately from the south-east. Therefore, this has potential to have captured $PM_{2.5}$ emissions from dust generating activities from the existing Huntly Mine operations in the Myara region, which is located south-east of the monitor. The highest wind speed also was measured from the

south-east quadrant, which brings a higher likelihood from wind erosion fugitive particulate emissions from the mine.

7 Conclusion

In summary, RCS was detected at the Yamba monitoring station, and the RCS/$PM_{2.5}$ fraction of 2.2% will be used for Myara North air quality impact assessment.

Kind regards,



James Forrest
Technical Director – Air Quality and Noise
+61 8 6222 8380

Alyce Sala Tenna
Senior Environmental Scientist
+61 8 6222 8506

ghd.com

The Power of Commitment