BARALABA SOUTH PROJECT

Air Quality and Greenhouse Gas Assessment

Baralaba South Pty Ltd

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Report
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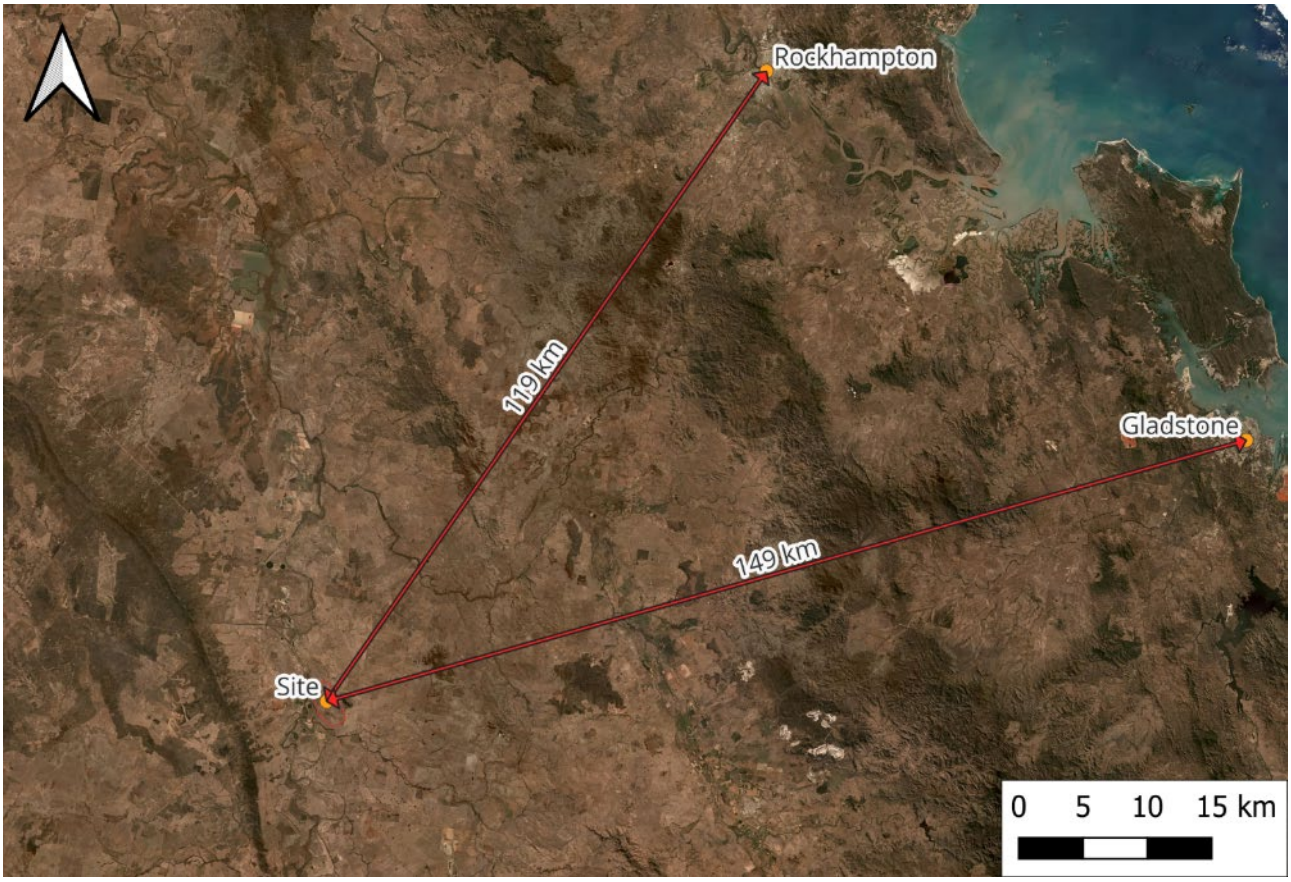
1. INTRODUCTION

1.1 Overview

Trinity Consultants Australia was commissioned by Baralaba South Pty Ltd to provide air quality consultancy services for the proposed Baralaba South Project (BSP). The proponent for the Project is Baralaba South Pty Ltd (ACN 603 037 065) (formerly Mount Ramsay Coal Company Pty Ltd and Wonbindi TLO Holdings Pty Limited). The proponent is a privately owned Australian metallurgical coal company; and a wholly owned subsidiary of Baralaba Coal Pty Ltd (Baralaba Coal Company). Baralaba Coal Pty Ltd is majority owned by the AMCI Group.

The proposed location is approximately 120 kilometres inland from Rockhampton and 150 kilometres from Gladstone as shown in **Figure 1.1**.

Figure 1.1: Location of the Baralaba South Project



This report presents an assessment of the air quality impacts and greenhouse gas emissions associated with the proposed coal mine. It is to form an appendix to the Environmental Impact Statement (EIS) for consideration by Queensland Department of Environment and Science (DES).

1.2 Scope

This report is based on the following tasks to achieve the requirements of Section 8.5 of the Terms of Reference for the BSP:

- Review the project and the associated potential air emissions.

- Review existing air quality monitoring data applicable to the project site.
- Prepare a greenhouse gas inventory based on current National Greenhouse Accounts Factors, National Greenhouse and Energy Reporting (NGER) guidelines, and the FullCAM vegetation model. Discuss the relative scale and implications of these emissions compared to state and national emissions.
- Develop an emission inventory based on National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 literature for particulates less than 2.5 microns ($PM_{2.5}$), particulates less than 10 microns (PM_{10}), total suspended particles (TSP) and dust deposition.
- Model meteorological conditions using TAPM and Calmet.
- Model the dispersion of expected air pollutants based on proposed activities using Calpuff to estimate levels of the emissions reaching sensitive receptors and develop contours over the modelling domain for the three most severe (worst case) scenarios (which are during operations) during the mine life.
- Analyse the results of meteorological and pollutant dispersion modelling, including cumulative impacts and compare results with the relevant air quality criteria designed to protect human health and wellbeing and dust deposition guidelines designed for amenity purposes.
- Qualitatively assess the impacts during construction and closure of the mine.
- Provide recommendations on control measures and for monitoring and corrective actions.

To aid in the understanding of the terms in this report, a glossary is included in **Appendix A**.

1.3 Terms of Reference

This report addresses Section 8.5 of the Terms of Reference (ToR) for the impact assessment issued by the Department of Environment and Heritage Protection, as summarised in **Table 1.1.**

Table 1.1: Requirements from Section 8.5 of the Terms of Reference

Requirements from the Terms of Reference	Addressed in this Report
Fully describe the characteristics (through an emissions inventory) of the contaminants or materials released when carrying out the activity (point source and fugitive emissions). Provide an estimate of the greenhouse gas (direct) scope 1, (indirect) scope 2 and 3 emissions factors during construction, commissioning, upset conditions, operation and closure in accordance with the Australian Government National Greenhouse Accounts Factors.	**Sections 6.3** to **6.7** – Emissions inventories and modelled source parameters are presented. **Section 11.2** – The annual greenhouse gas emission rate during the mine's operation was estimated. The emissions include clearing during construction, and rehabilitation during closure of the mine. Commissioning emissions will be insubstantial.
Predict the impacts of the releases from the activity on environmental values of the receiving environment using recognised quality assured methods. The description of impacts should take into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts. The impact prediction must: ■ address residual impacts on the environmental values (including appropriate indicators and air quality objectives) of the air receiving environment, with reference to sensitive receptors, using recognised quality assured methods. This should include all relevant values potentially impacted by the activity, under the EP Act, EP Regulation and Environmental Protection (Air) Policy 2008 (EPP (Air)); ■ address the cumulative impact of the release with other known releases of contaminants, materials or wastes associated with existing development (including the existing Baralaba mine and haul road)	**Section 3.1** – Presents the relevant air pollutants for this assessment. **Section 4.1.2** – Discusses other sources that may contribute to cumulative background. The assimilative capacity of the air quality is the difference between the criteria and the background. **Section 7** – Presents the predicted incremental and cumulative impacts at the sensitive receptors. The section also presents contour plots of cumulative impacts for the most critical pollutants (or particle size fractions). The particulate concentrations were assessed against criteria intended to protect human health. The dust deposition guideline is designed for amenity purposes. Hence, compliance with these criteria and guideline provides indication of the human health risk and amenity impacts. The human health risks of air pollutants emitted by the proposed mine are quantified in the EPP (Air). **Section**

Requirements from the Terms of Reference	Addressed in this Report
and possible future development (as described by approved plans and existing project approvals); and ■ quantify the human health risk and amenity impacts associated with emissions from the project for all contaminants whether or not they are covered by the National Environmental Protection (Ambient Air Quality) Measure or the EPP (Air).	**9.2** also addresses potential ingestion of metal from drinking water.
Describe the proposed mitigation measures and how the proposed activity will be consistent with best practice environmental management. Where a government plan is relevant to the activity or site where the activity is proposed, describe the activity's consistency with that plan.	**Sections 10.4** and **11.3** – Mitigation measures are recommended in these sections.
Describe how the achievement of the objectives would be monitored, audited and reported, and how corrective actions would be managed.	**Section 10.5** – Monitoring is recommended including review for future extent of monitoring. **Section 10.5** – Describes how monitoring data can be used for management measures. **Section 10.6** – Describes how objectives will be monitored and reported and corrective actions identified.

1.4 Identification of Existing Sensitive Receptors

The definition of a sensitive place required to be considered by operators of environmentally relevant activities is provided by the Department of Environment and Science (DES, 2023). This definition is a place that could include but is not limited to:

- remnant and regrowth ecosystems of all types
- a protected area under the Nature Conservation Act 1992, the Marine Parks Act 2004 or a World Heritage Area
- all dwelling, residential allotments, mobile home or caravan parks, residential marinas or other residential premises
- a motel, hotel or hostel
- a kindergarten, school, university or other educational institution
- a medical centre or hospital
- a public park or garden
- a place used as a workplace including an office for business or commercial purposes.

The nearest dwellings to the BSP and train-load-out (TLO) facility are summarised in **Table 1.2** and **Table 1.3,** including their northing and easting locations, and are shown in **Figure 1.2** and **Figure 1.3**. The receptor locations were selected based on the presence of a dwelling and the distance and direction of the receptor from the site and other receptors. Receptors 1, 2 and 14 are located within the MLA, and therefore, according to the Guideline Model Mining Conditions (MMC) (DES, 2017) are not sensitive receptors. Places that are owned or leased by the holder of the environmental authority (EA) are not sensitive locations. Receptor 9 is on a block of land that underlies the MLA and will require a compensation agreement as part of the Mount Ramsay/McLaughlin's agreement, and consequently, is not a sensitive receptor. Impacts to regional ecosystems are described in **Section 9.3.1**. There are no other types of sensitive receptors in the vicinity.

Table 1.2: List of Dwellings with UTM Coordinates (WGS84 Z55) Near BSP

ID	Property	Name / Address	Real Property Description	Approximate Distance and Direction from Lease Boundary	Easting (m)	Northing (m)
1	'Broadmeadow'	Moura Baralaba Rd	11/FN153	Within the MLA	791210	7312217
2	'Broadmeadow'	Moura Baralaba Rd	11/FN153	Within the MLA	791130	7312026
3	'Mount Ramsay'	Moura Baralaba Rd	26/FN153	Within the MLA	792701	7310779
4	'Belvedere'	Bindaree Harcourt Rd	35/FN141	3.6 km south-west	789817	7306551
5	'Tingle Hill'	Moura Baralaba Rd	141/FN137	3.7 km north	788105	7320494
6	'Alberta Vale'	Alberta Rd, Alberta	5/RP856832	2.9 km north-west	786668	7318708
7	'Riverside'	Alberta Rd, Alberta	3/RP856832	4.9 km north-west	785609	7320451
8	'Lucerne Park'	Baralaba Rannes Rd	110/FN103	4.8 km north-west	786247	7320822
9	'Mount Ramsay'	Moura Baralaba Rd	1/RP801031	900 m north-east	790694	7317563
10	'Murrindindi'	'Remfreys Rd	126/FN148	3.2 km north-east	793686	7318245
11	'Nonda'	Moura Baralaba Rd	102/SP107139	2.9 km north	790328	7319625
12	'Brahmleigh'	Baralaba Rannes Rd	80/SP131479	4.9 km north	790405	7321578
13	'Woodlands'	Remfreys Rd	133/FN143	3.1 km north-east	794051	7317045
14	'Mount Ramsay'	Moura Baralaba Rd	135/FN143	Within the MLA	791300	7314361
15	'Alberta'	Alberta Rd, Alberta	6/KM50	3.5 km west	784262	7314555
16	'Riverland'	Harcourt Baralaba Rd	4/FN514	1.8 km south-west	787625	7310449
17	'Bauhinia Park'	Baralaba Banana Rd	28/FN154	4.1 km southeast	796940	7309124
18	'Airedale'	Baralaba Banana Rd	30/FN154	4.5 km southeast	797418	7309218
19	'Alberta Vale'	Alberta Rd, Alberta	5/RP856832	3.2 km north-west	786010	7318462
20	'Harcourt'	Harcourt Baralaba Rd	12/FN514	2.2 km south-west	788702	7308881
21	'Harcourt'	Harcourt Baralaba Rd	12/FN514	4.6 km south-west	785139	7309128

Figure 1.2: Location of Site for BSP and Dwellings

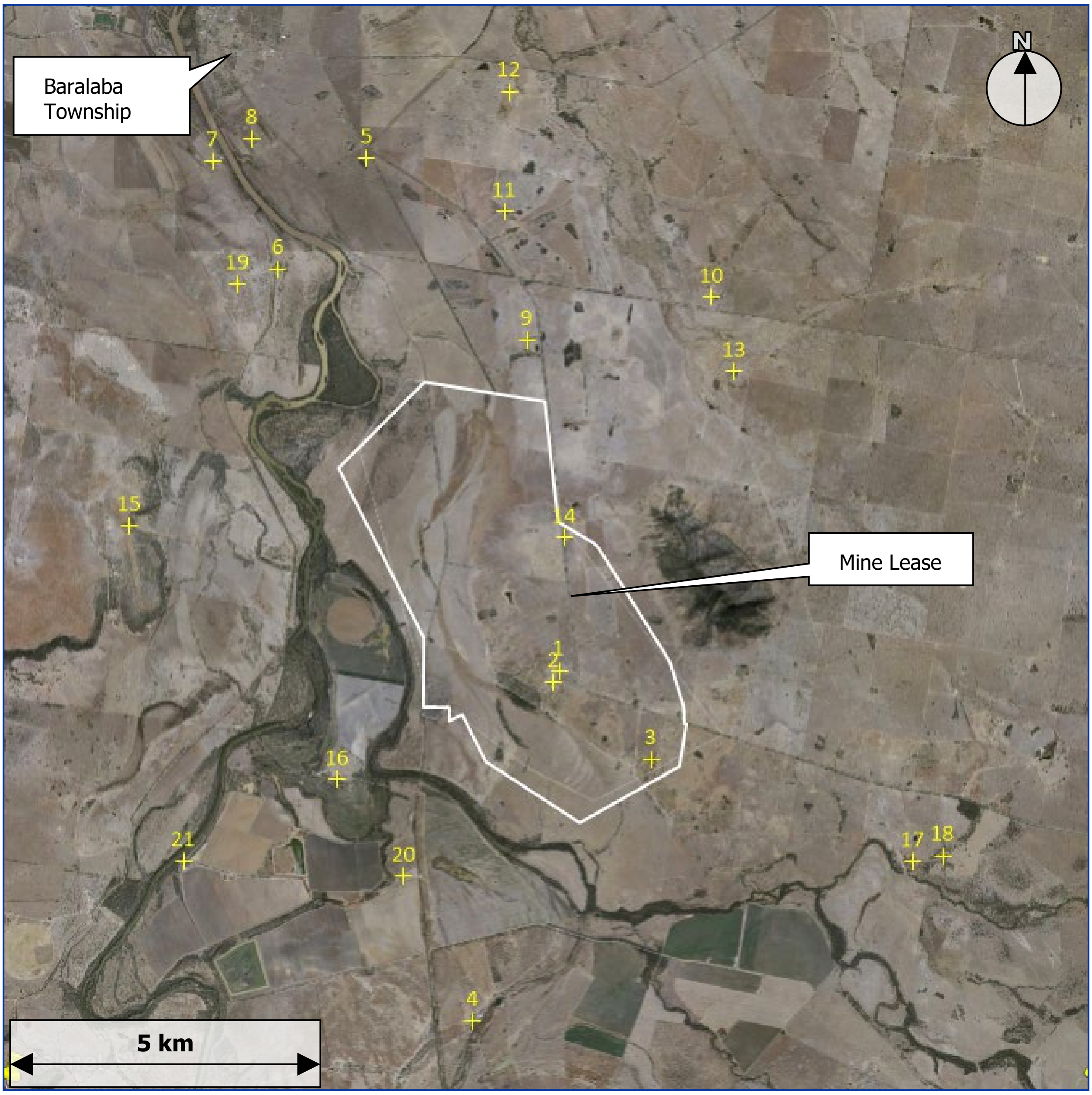


Table 1.3: List of Dwellings with UTM Coordinates (WGS84 Z55) Near the TLO Facility

ID	Property	Name / Address	Real Property Description	Approximate Distance and Direction from Lease Boundary	Easting (m)	Northing (m)
A	'Coal Dust Plains'	17406 Dawson Hwy, Banana	1/RP613366	6 km north-east	809856	7285912
B	'Pasadena' (potentially multiple dwellings)	17526 Dawson Hwy, Banana	27/FN187	4.5 km north-east	808265	7285512
C	Workers Camp	17356 Dawson Hwy, Banana	1/RP909511	3 km north-east	807361	7284186

ID	Property	Name / Address	Real Property Description	Approximate Distance and Direction from Lease Boundary	Easting (m)	Northing (m)
D	Dawson Mine Infrastructure	Theodore Moura Rd, Kianga	6/SP101809	3 km north-east	807660	7283409
E	'Tremere'	Gibihi Rd, Kianga	7/FN464	6 km east-southeast	810865	7278824
F	'Billabong'	3884 Theodore Moura Rd, Kianga	22/RP911707	3 km south	804731	7277360
G	Centre of Moura Township	3 McArthur St, Moura	17/M86313	3.6 km south-west	800919	7278907
H	'Olney Park'	241 Moura Baralaba Rd, Moura	1/SP118855	2.6 km north	804437	7285144
I	'Olney Park'	Moura Baralaba Rd, Moura	1/RP616586	2.6 km north	804839	7285174
J	'Kilmuir'	370 Moura Baralaba Rd, Moura	40/FN508	4 km north	804175	7286594
K	'Glenvale'	Moura Baralaba Rd, Moura	13/FN399	4.5 km north	803725	7286871
L	'Undi'	90 Moura Bindaree Rd, Moura	7/SP118855	2 km west	801617	7281958
M	'Ridgedale'	4002 Theodore Moura Rd, Kianga	2/SP252890	1 km south-west	803346	7280070
N	-	18230 Dawson Hwy, Moura	34/FN499	800 m west	802917	7281405
O	'Ridgedale'	4002 Theodore Moura Rd, Kianga	2/SP252890	1.6 km south-west	802884	7279730
P	Workers Camp	184 Dawson Hwy, Moura	1/SP188953	2 km south-west	801967	7280114
Q	Eastern Boundary of Moura Township	9 Gillespie St, Moura	106/M8699	2.8 km south-west	801500	7279476

Figure 1.3: Location of TLO Facility and Dwellings

2. PROPOSED DEVELOPMENT

2.1 Overview

The BSP represents a greenfield metallurgical coal mine development opportunity, located approximately 8 kilometres (km) south of Baralaba and 120 km inland from Rockhampton in the lower Bowen Basin region of Central Queensland. The Project objective is to develop an open-cut, metallurgical coal resource for export of a low-volatile pulverised coal injection (PCI) product to the steel production industry. Approximately 49 million tonnes (Mt) of run-of-min (ROM) coal is estimated to be mined in the indicative mine schedule to produce approximately 36 Mt of product coal over the life of the Project.

The Project would produce up to 2.5 Mtpa of ROM coal. The identified resource area supports a mine with an operational life of approximately 23 years under optimal mining conditions.

The mining activity is proposed to be undertaken within Mining Lease Application (MLA) 700057, which covers a total area of 2,214 ha. Overburden and interburden will be disposed of both in-pit and out-of-pit spoils dumps located on site and contiguous with the pit excavation. A conventional Coal Handling and Preparation Plant (CHPP) would be constructed at the BSP for coal washing. Dry disposal of reject material is proposed within the spoil. Process wastewater will be recovered for recycling through the plant. Other associated infrastructure would include offices, crib rooms, warehouse, workshops, wash down bay, refuelling facility, ETLs and communication facilities.

Coal would be transported via road trains along the existing Baralaba North Mine haul route, approximately 40 km by public road south to the existing train load-out (TLO) facility east of Moura. Product coal would then be transported by rail to the Port of Gladstone for export to international markets.

Project development requires realignment of a 4.5 km section of the Moura Baralaba Road from within the ML application area. The preferred route for the Banana Shire Council road is directly east of the MLA boundary, selected to minimise impacts to landholders, road users and the environment.

All land disturbed by mining activities will be rehabilitated to achieve post-mining land use. Rehabilitation will occur progressively during the mine life as land becomes available. Queensland's Mined Land Rehabilitation Policy and associated legislative amendments were adopted in the design of all phases of the BSP.

The project also involves constructing an 8 km long electricity transmission line (ETL) within a 20 m wide easement to connect the project with the Baralaba Substation, located about 6 km east-south-east of Baralaba. Two ETL alignment options are being evaluated, and the final alignment choice will depend on the assessment outcomes from the Environmental Impact Statement (EIS).

2.2 Open-cut Mine Methodology

The mine plan is based on conventional truck and excavator terrace mining operations. Once the first spoil batters have been fully developed, rehabilitation will be undertaken progressively.

The open-cut operations are described as follows:

- Topsoil will be removed and hauled to the topsoil stockpile area.
- Drilling and blasting will be undertaken.
- Excavators will load trucks with overburden, which will then be hauled initially to overburden dumps and once the terraces are established, back into the pit.
- Dozers will push out overburden dumps, and once established, the in pit dumps.
- Excavators will load the exposed coal into haul trucks to be transported from the pits to the run-of-mine (ROM) pad.
- Haul trucks will unload ROM coal at the ROM pad.

- The ROM coal will be processed in the coal handling and preparation plant (CHPP). The product coal will be stockpiled and trucked off lease to a TLO to the east of Moura. The CHPP rejects will be dried and returned to the pit/dump for disposal in spoil.
- The CHPP will operate 24 hours per day throughout the year.
- The life of the mine is estimated to be 23 years of mining at maximum mining rates, after 24 months of construction, and followed by final closure works after mining has ceased.

2.3 Plant and Production Quantities

Mining will be carried out sequentially from the central part of the site, progressing towards the south over the life of the mine. Estimated material handling quantities over the life of the mine, excluding construction and closure, are provided in **Table 2.1**.

Table 2.1: Material Handling Quantities Over Life of Mine

Year	Overburden (bank cubic metres – bcm)	Coal from mine to wash plant – ROM coal (t)	Dump Disturbance Area (m^2)	Pit Disturbance Area (m^2)	Product Coal (t)	Reject (t)
1	29,917,134	1,251,073	1,245,945	965,593	947,374	329,444
2	36,470,360	2,141,756	1,100,963	454,658	1,578,896	605,767
3	37,146,816	2,030,053	0	588,757	1,469,714	600,280
4	35,182,411	2,100,000	355,674	810,346	1,548,821	593,269
5	37,018,878	2,200,000	193,886	0	1,608,699	635,019
6	36,725,699	2,300,000	485,747	342,394	1,694,116	651,923
7	26,950,122	2,400,000	0	14,854	1,769,800	678,296
8	26,894,981	2,500,000	0	0	1,789,793	758,846
9	26,880,500	2,500,000	0	449,829	1,806,014	743,065
10	27,095,057	2,317,103	186,917	30,788	1,666,441	695,949
11	27,048,859	2,250,000	481,936	312,407	1,662,594	632,588
12	27,061,516	2,250,000	0	81,812	1,618,978	675,019
13	27,071,849	2,250,000	0	45,942	1,620,640	673,402
14	27,150,196	2,189,267	0	424,308	1,595,225	637,394
15	26,948,916	2,416,509	0	0	1,750,293	713,781
16	26,877,465	2,500,000	0	0	1,833,437	716,388
17	26,877,027	2,500,000	0	295,556	1,848,062	702,160
18	27,179,947	2,182,084	0	0	1,613,811	612,130
19	27,178,118	2,100,000	0	0	1,528,349	613,185
20	27,229,113	2,019,095	0	48,780	1,489,877	569,707
21	24,557,634	2,142,522	0	0	1,579,192	606,245
22	15,258,017	1,309,976	0	0	942,255	393,327
23	5,662,948	750,948	0	0	563,484	202,777

The maximum annual Run of Mine (ROM) coal is 2.5 Mt in multiple years. Maximum product coal is 1.85 Mt while the rest is rejects. Rejects will be hauled from the processing plant to be buried under the spoil dumps or in-pit dumps for disposal. The amount of rejects (up to 0.8 Mt) will be variable over the years and depend on the seams being mined and ash content, among other variables. The maximum overburden removal is 37 Mbcm in years 3, 5 and 6.

The typical topsoil thickness is 0.3 metres.

The following moisture contents of materials were provided by Baralaba Coal:

- insitu coal– 3%
- ROM coal – 5.4%
- product coal – 8%
- reject – 10-15% (conservatively modelled as 10%)

The following silt contents of materials were used based on data from similar sites:

- overburden – 4%
- ROM coal – 2.8%
- product coal – 1%

The density of materials as provided by Baralaba Coal are:

- topsoil – 2.2 tonnes/bcm
- overburden – 2.3 tonnes/bcm

Table 2.2 presents a list of the quantity of major mobile equipment operating to achieve the project goals over the life of the project. This includes equipment on maintenance at any specific time. As a result, the actual number of equipment units in operation at any given time may be lower than the figures presented in **Table 2.2**. After year 19, substantially less equipment is required for rehabilitation.

Table 2.2: Major Mobile Equipment List

Year	Excavators / Loading Units		Haul Trucks		Dozers in Dumps	Dozers in Pit	Grader
Model	**PC4000**	**PC5500**	**830E**	**930E**	**D10**	**D11**	**24**
1	3	2	16	23	2	4	4
2	3	2	17	14	3	6	4
3	3	2	21	18	3	6	4
4	3	2	21	20	3	5	4
5	3	2	22	19	3	6	4
6	3	2	22	20	3	6	4
7	3	1	18	8	3	5	4
8	3	1	17	7	3	5	4
9	3	1	21	10	3	5	4
10	3	1	22	10	3	5	4
11	3	1	23	11	3	5	4
12	3	1	16	7	3	5	4
13	3	1	16	7	3	5	4
14	3	1	20	10	3	5	4
15	3	1	24	10	3	5	4
16	3	1	25	11	3	5	4
17	3	1	19	8	3	5	4
18	3	1	22	11	3	5	4

Year	Excavators / Loading Units		Haul Trucks		Dozers in Dumps	Dozers in Pit	Grader
19	3	1	18	8	3	5	4
20	3	1	20	9	3	5	4
21	3	1	22	12	2	4	4
22	1	1	6	8	2	3	4
23	3	1	4	4	1	1	4

2.4 Choice of Modelling Scenarios for Operation of Mine

Emissions from mines are mainly dependent on the movement of materials and wind speeds. On a mine site, the relevant upset conditions would be lack of water for use by watering trucks and sprays. If that occurs, operations would be adjusted accordingly to reduce dust emissions.

The major determinants of air quality impacts over the life of the BSP are the quantity of materials handled and the location of emission sources relative to sensitive receptors. Estimated material handling quantities over the life of the mine are provided in **Table 2.1**. The location of activities throughout the mine life are shown in the available stage plans illustrated in **Figure 2.1** to **Figure 2.7**.

Three representative scenarios were chosen where source locations and production rates were anticipated to have the worst-case impacts on the nearest sensitive receptors to the BSP. Emission sources are expected to be closest to receptors 6, 13, and 19 during Year 1 of the operational phase. As the mining activities advance to the site's southern section, the emission sources get closer to receptors 16 and 20. Receptor locations are presented in **Figure 1.2**

The chosen three mine scenarios are as follows:

- Scenario 1: Year 1 is when waste is dumped closest to receptors 6, 13 and 19. See **Figure 2.1**.
- Scenario 2: Year 3 is when waste quantities, truck and dozer operating hours are high, and activities are still close to receptors 6, 13 and 19. See **Figure 2.2**.
- Scenario 3: Year 11 is when the truck hours are highest for the years when activities are close to receptor 16. See **Figure 2.4**.

Figure 2.1: Year 1 Mine Site Layout Plan

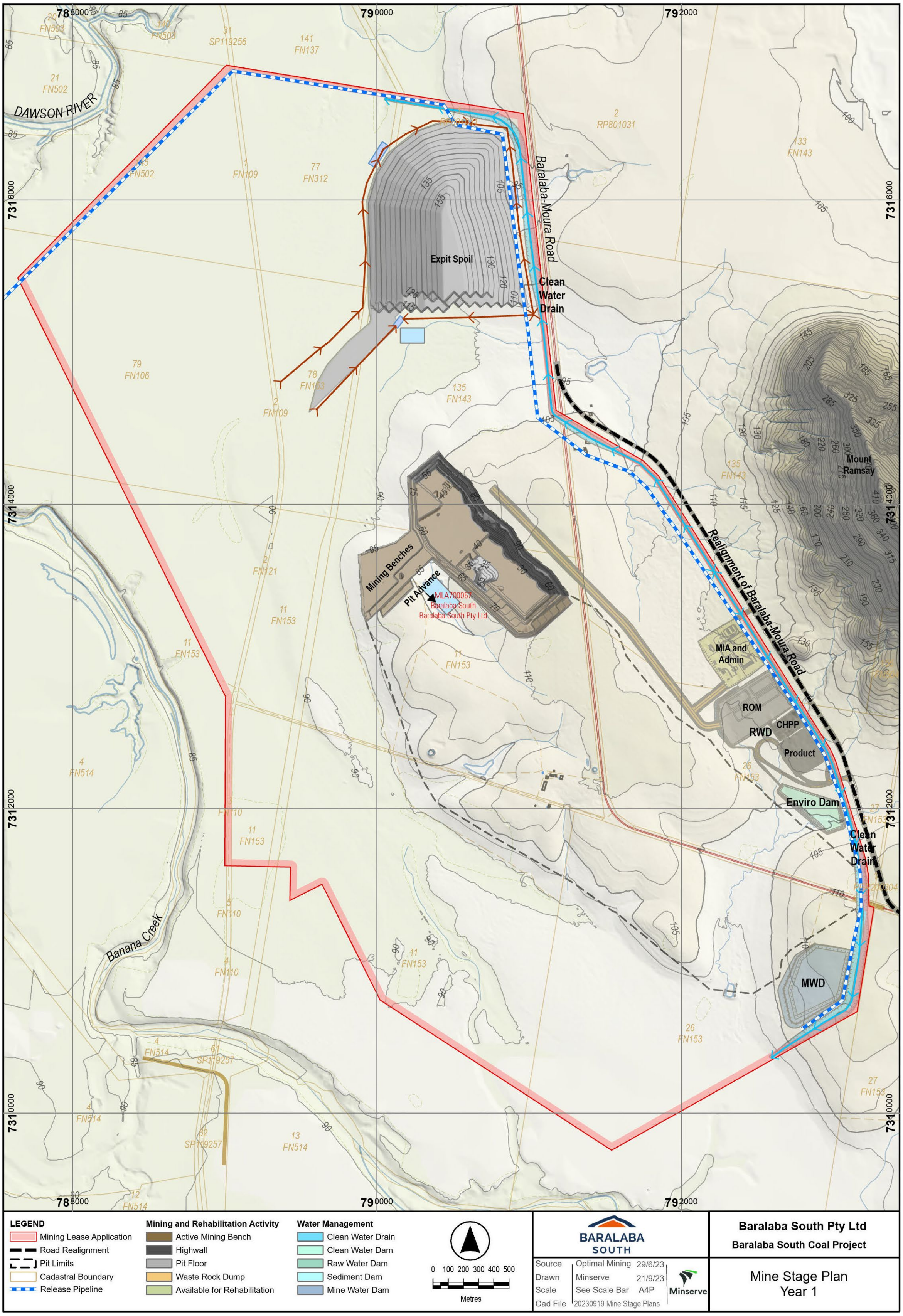


Figure 2.2: Year 3 Mine Site Layout Plan

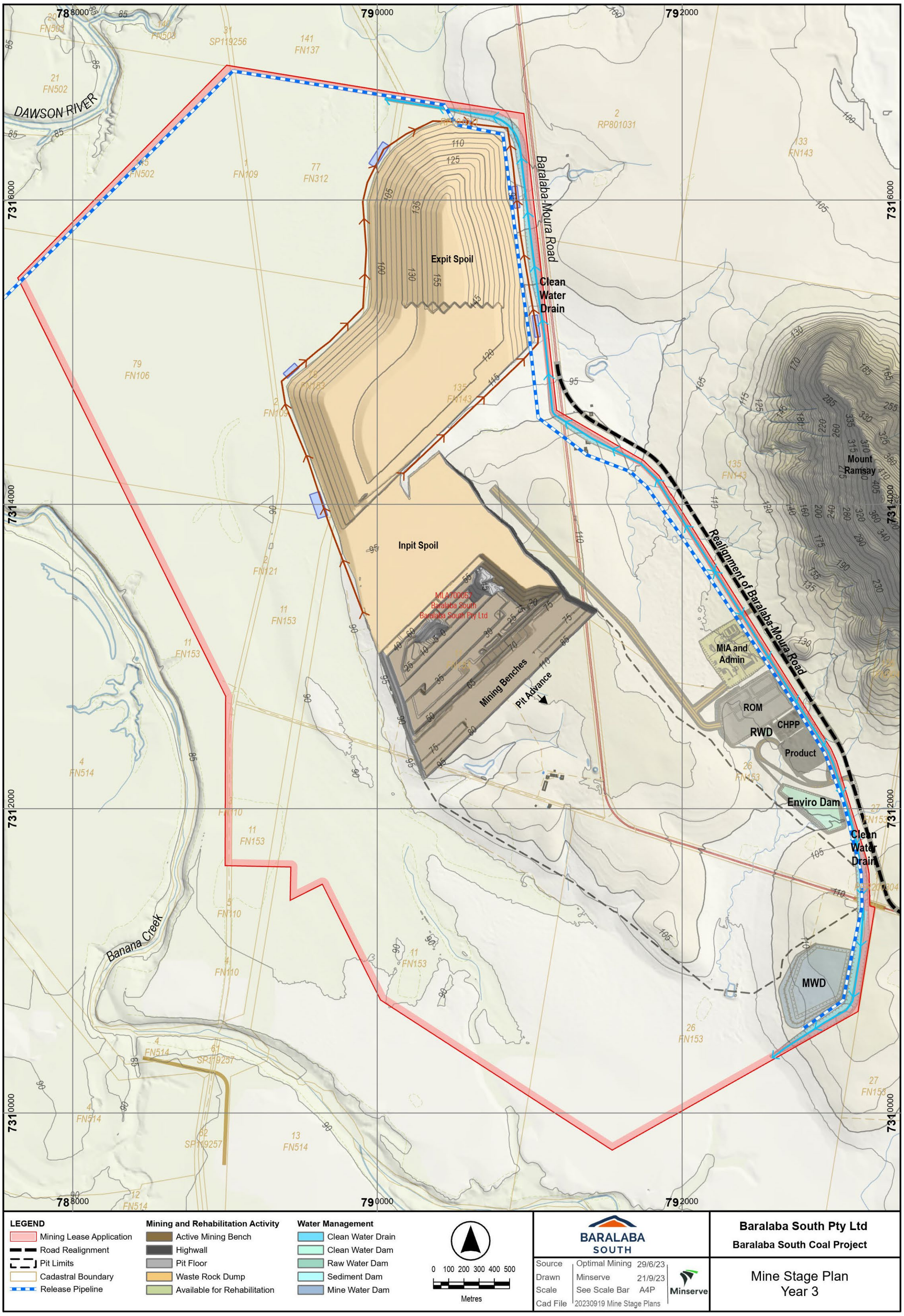


Figure 2.3: Year 6 Mine Site Layout Plan

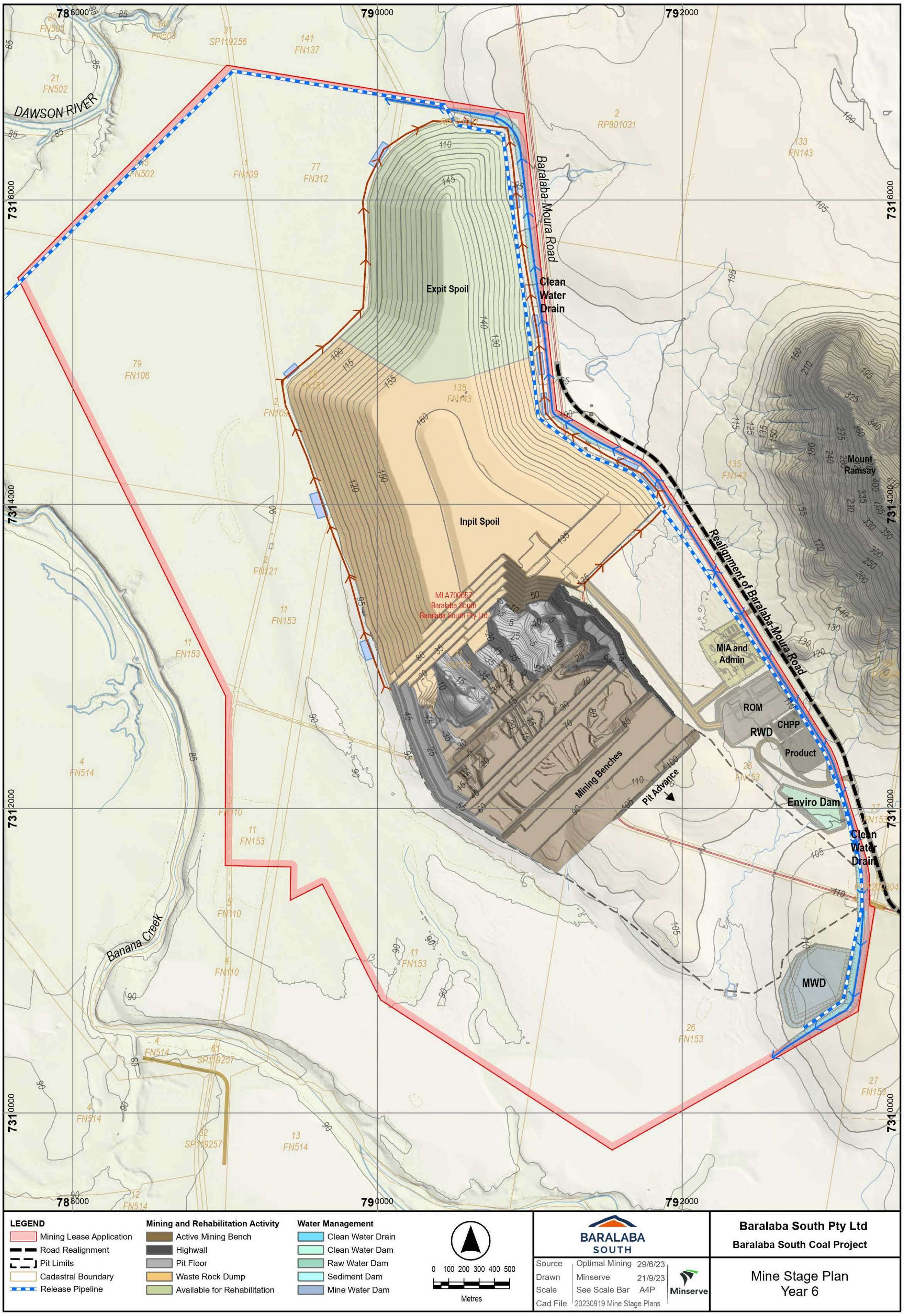


Figure 2.4: Year 11 Mine Site Layout Plan

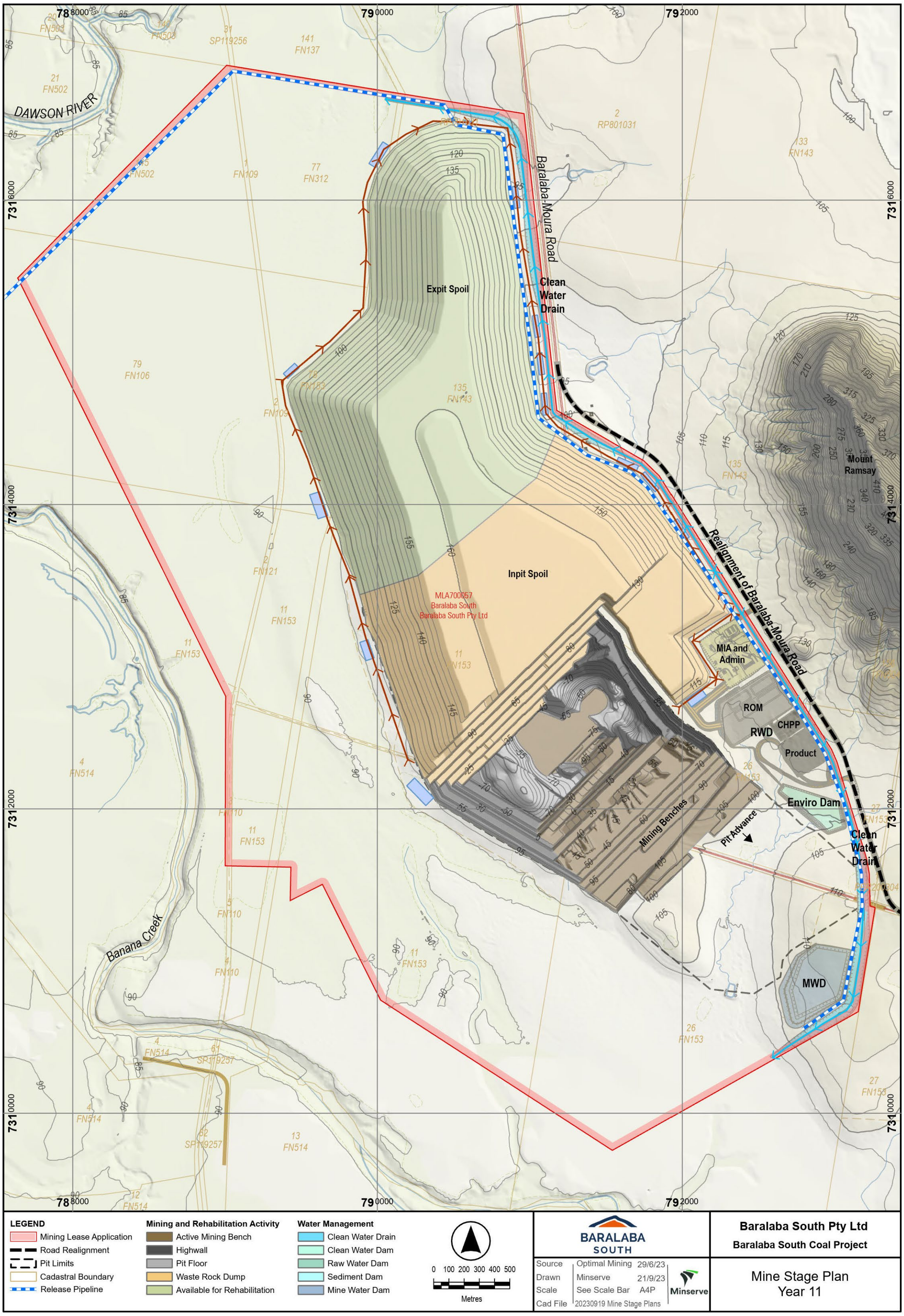


Figure 2.5: Year 14 Mine Site Layout Plan

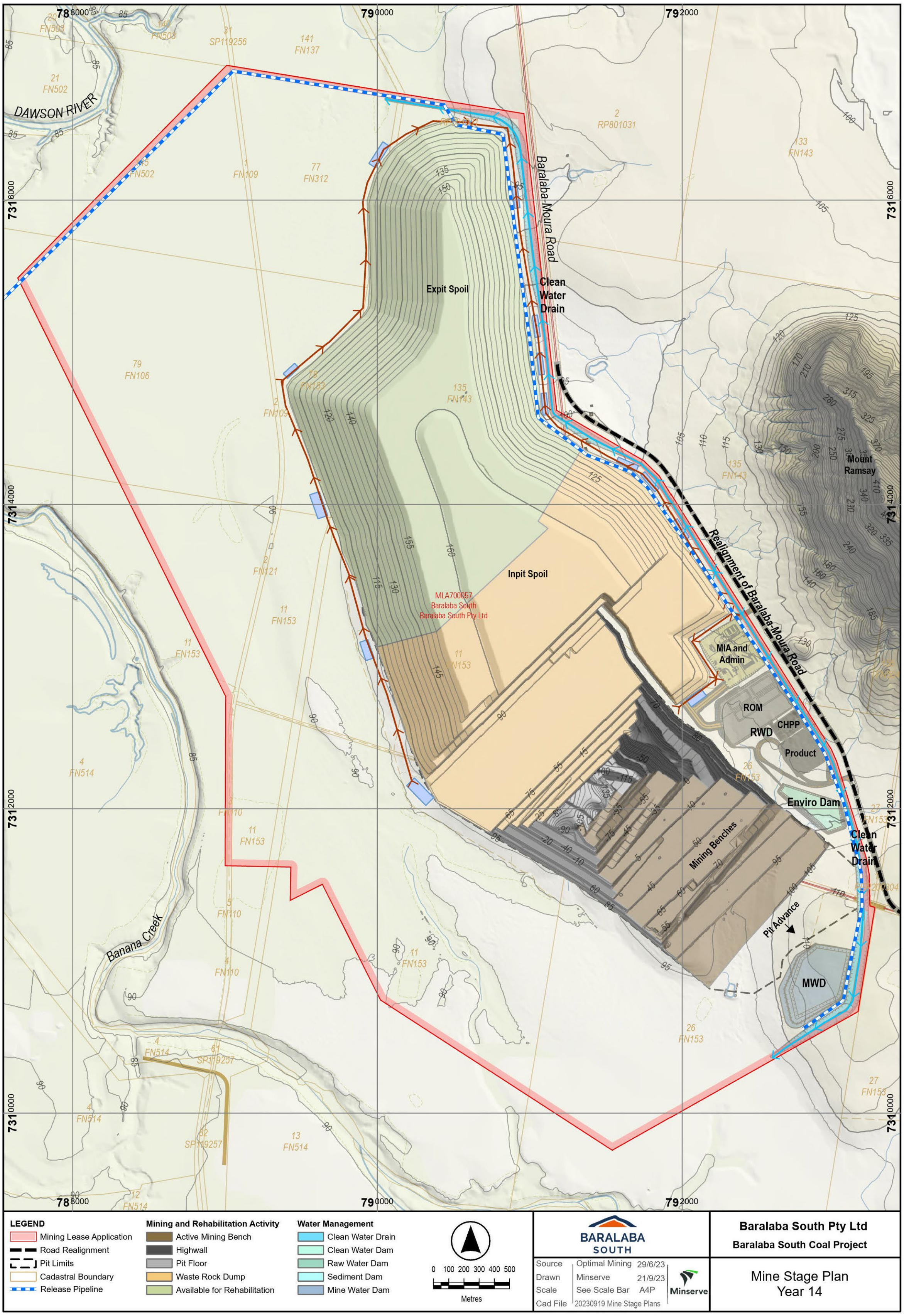


Figure 2.6: Year 19 Mine Site Layout Plan

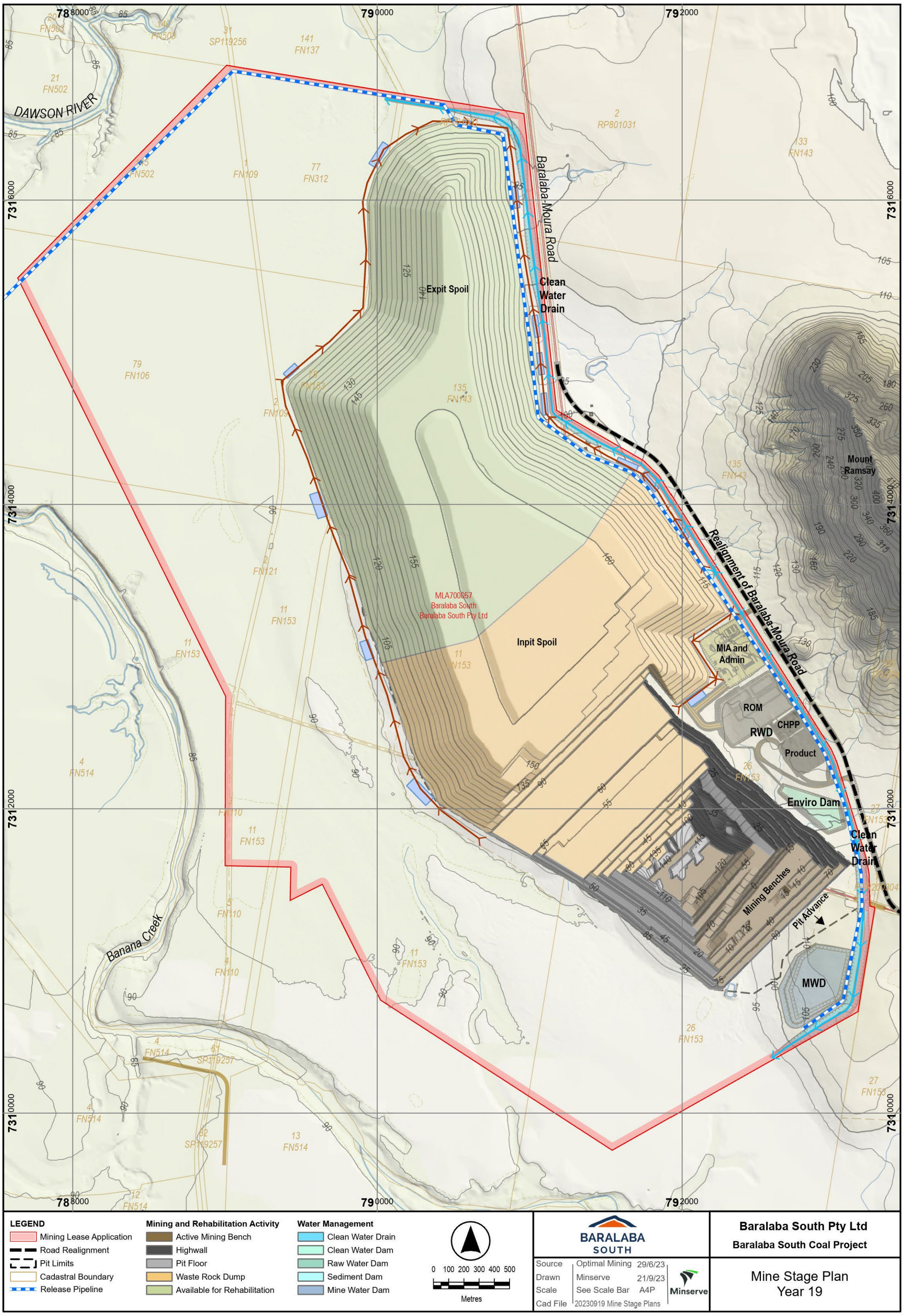
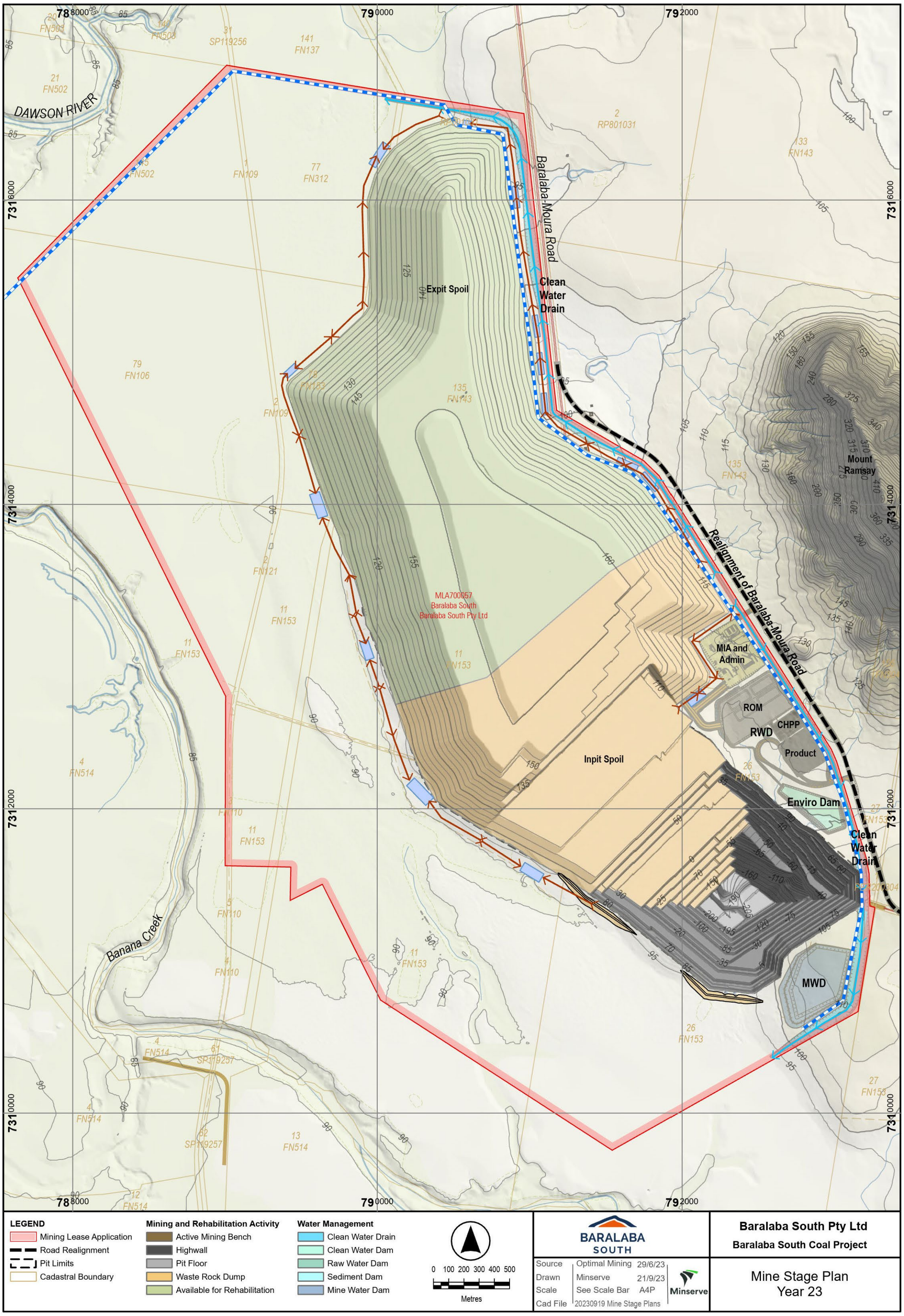


Figure 2.7: Year 23 Mine Site Layout Plan



2.5 Drilling and Blasting

The proposed development includes drilling and blasting, as defined in **Table 2.3**. The explosive to be used comprise 70/30, 50/50 and 40/60 blend products, where the blend refers to the emulsion ratio vs. ANFO. This is modelled as per the Baralaba North mine and its current explosives use.

Table 2.3: Blasting Data

Parameter	Year 1	Year 3	Year 11
Drill hole diameter (mm)	229	229	229
Number of blasts (per year)	150	186	135
Average blast area (m2)	13,333	13,333	13,333
Number of holes (per blast)	274	274	274
AEL330 - 30% ANFO (tonnes)	5,474,676	6,797,669	4,949,797
AEL350 - 50% ANFO (tonnes)	912,446	1,132,945	824,966
AEL360 - 60% ANFO (tonnes)	2,737,338	3,398,834	2,474,898
Annual explosive consumption (tonnes)	9,124,459	11,329,448	8,249,661

2.6 Construction

The construction of the necessary infrastructure to commence mining is expected to take approximately 24 months.

The on-site infrastructure that will be constructed includes:

- diversion of the section of road within the mining lease immediately east and construction of the proposed intersection to access the site.
- light vehicle access roads
- heavy vehicle haul roads
- communications infrastructure (i.e. towers, cabling)
- bunds
- coal handling and preparation plant (CHPP)
- fines recovery system
- mine infrastructure areas
- sediment dams
- water infrastructure (e.g. dams, diversion drains)
- ROM transfer pads
- coal stockpiling and blending facility
- topsoil stockpiles
- equipment laydown areas
- offices and administration facilities
- ablutions and crib room facilities
- sewage treatment facilities
- fuel and oil storage facilities
- high voltage transmission lines/poles and reticulation.

The off-site infrastructure that will be constructed are: the realignment of sections of the Moura-Baralaba Road, that are currently within the mining lease boundary; the upgrade of the existing electrical power transmission line from Baralaba substation to site. The impacts of these will be relatively minor.

The emissions from the construction phase will include dust emissions from clearing of land and material handling and minor gaseous combustion emissions from mobile equipment. The emissions due to the construction activities are expected to be of a similar nature, albeit minor in comparison to the mining operations emissions. The activities will also be short-lived. The construction activities closest to sensitive receptors will be the construction of the bund at the southwest boundary of the mine and the realignment of the Moura-Baralaba Road. The air quality impacts due to the construction of the bund are likely to be less than those during the year 11 operation of the mine when the pit and active dump are close to this area; therefore, this impact is negated.

The only receptor that has the potential to be impacted by the realignment of the Moura-Baralaba Road is receptor 14, shown in **Figure 1.2,** located at 3890 Moura Baralaba Road within MLA 700057. Baralaba Coal Company Pty Ltd must agree compensation and reach an agreement with this receptor before the mining lease may be granted. Where appropriate and where requested by the landholder, such agreement will involve the relocation of the receptor before construction commences.

2.7 Rehabilitation and Closure of Mine

Closure of the BSP will include decommissioning of the facilities on-site. As with the construction activities, emissions will be of similar nature to the construction activities and are likely minimal in comparison to mining operations and will be short-lived. During this decommissioning phase, the emissions from mining and processing will have ceased, and the closure of the BSP will also involve rehabilitation works. This will include revegetation of exposed areas, substantially reducing emissions. Therefore, emissions from these closure sources were not modelled in this assessment.

2.8 Off-site Product Haul Route

Product coal from the mine will be hauled south along public roads to the TLO facility on the Dawson Highway, where coal from the existing Baralaba North mine is currently transported.

Based on the information provided by Baralaba Coal Company Pty Ltd:

- Haul trucks will be covered.
- The full length of the haul route will have a sealed bitumen surface.
- The length of the one-way haul route is approximately 40 kilometres.
- The maximum annual quantity of product coal transported from the BSP will be 1.8 MT/year. Based on ABB Quads with 105 tonne payload, this corresponds to 17,143 trips per year or approximately 47 trips per day from the BSP.
- The nearest dwelling is approximately 100 metres from the haul route. This has been verified by Trinity using Google Earth aerial photography.

Based on the above information, the dust emissions from these additional covered haul trucks over sealed roads will be insubstantial and the likelihood of impacts at sensitive receptors 100 metres or more from the route is negligible. Therefore, modelling of the dust emissions was not warranted.

2.9 The TLO Facility

No construction of significance is required at the TLO to accommodate the additional coal from the BSP. The operational information for the facility relevant to the assessment of air quality impacts is nominated as follows:

- The haul road for coal in-loading to the facility will be sealed for the entirety of the route. Unsealed bypass lanes are located at two locations around the haul road. Emissions from vehicles travelling on these bypass roads are not expected to be significant and have not been considered.
- The truck receival station takes product coal from the haul trucks by direct tipping into a receival hopper. The perimeter of the receival hopper will be fitted with water sprays to control dust emissions during unloading.
- The coal from the receival hopper is transported via a conveyor system to the stockpile.
- Coal is transferred onto the stockpile using a variable height radial stacker. The drop height from the stacker has the potential to range from 1.8 metres to 20 metres high. It is understood that the general minimum drop height during operation will be 6.8 metres (stockpile height of 5.0 metres).
- The total stockpile, including dozer pushout, is 147.3 metres wide (east-west) and 117.9 metres long (north-south), resulting in a total area of 17,367 m^2. Particulate emissions from the stockpile are controlled with six perimeter water sprays.
- Two pairs of coal valves underneath the stockpile allow the coal to drop into a reclaim tunnel to be transferred by a conveyor to discharge into the train load-out bin.
- In addition to the water sprays at the receival hopper and stockpile, water will also be applied via sprays:
  - at the head chute of the truck receival feeder
  - in the transfer chute between the link conveyor and stacker (while coal is falling)
  - halfway along the stacker (prior to drop)
  - across the reclaim conveyor after each pair of coal valves
  - at the exit of the reclaim tunnel.
- Train wagons will be veneered following coal loading.
- A maximum of 2.5 MT/year of coal will be transported to the TLO facility. This includes 1.6 Mt from Baralaba North Mine and 0.9 Mt from the BSP. There will be 6 train trips per week.
- Haul truck capacity is 105 tonnes per truck (a total of four trailers for each truck), with an average of 65 truck deliveries per day (combined deliveries from Baralaba North Mine and BSP).
- Coal would be washed prior to transporting to the TLO facility. The washed coal from Baralaba would have the following properties:
  - silt content: 1%
  - moisture content: 8%
- TLO push dozers will operate on average 5.4 hours per day.

3. AIR QUALITY CRITERIA

3.1 Relevant Pollutants

This section identifies the pollutants anticipated from the sources being assessed. Quantitative details of these emissions are provided in **Section 6.6**.

3.1.1 Particulates

The assessment focuses on potential impacts due to particulate matter emissions, the resultant dust deposition and airborne concentrations.

Particulates include the following fractions:

- TSP is the total suspended particulate matter (TSP).
- PM_{10} is the fraction of particulate matter with equivalent aerodynamic diameters of 10 µm or less.
- $PM_{2.5}$ is the fraction of particulate matter with equivalent aerodynamic diameters of 2.5 µm or less.

Health risks associated with suspended particulates are addressed by the criteria in **Section 3.2.2**. Amenity impacts are addressed with the criterion in **Section 3.3**.

3.1.2 Gases

The main air pollutant from mining activities is particulates. Gases are also emitted from combustion engines and blasting. However, in mining operations that apply standard control measures, combustion gases normally have substantially less air quality impact than particulates. Therefore, compliance with particulate criteria generally indicates compliance with criteria for gaseous pollutants. Therefore, this report aims to assess the impact of particulate emissions.

3.2 State Legislative Instruments

3.2.1 State Development Requirements

Table 22.1 of the State Development Assessment Provisions (2022) contains performance and acceptable outcomes for environmentally relevant activities. It requires development to be assessed against the following requirements:

(1) It must be suitably located and designed to avoid or mitigate environmental harm to the air environment.

(2) It must meet the air quality objectives of the Environmental Protection (Air) Policy 2019.

3.2.2 Queensland Environmental Protection Policy

The Environmental Protection (Air) Policy 2019 (EPP(Air)) provides objectives for air quality indicators (pollutants) that address health, the aesthetic environment, ecosystems and agriculture. The objectives relevant to this project and human health and wellbeing have been summarised in **Table 3.1**.

Table 3.1: Air Quality Criteria (EPP Air) for Health and Wellbeing

Air Quality Indicator	Period	Criteria (µg/m^3)
$PM_{2.5}$	1 day	25
	1 year	8
PM_{10}	1 day	50
	1 year	25
TSP	1 year	90

Note that the EPP Air also contains a criterion for visibility reducing particles, but this is a measure of regional air quality and is not relevant to point sources. The impact of visible particles from point sources is addressed by the $PM_{2.5}$ criteria.

3.2.3 National Environmental Protection (Ambient Air Quality) Measure

The EPP(Air) incorporates most of the goals nominated within the National Environmental Protection (Ambient Air Quality) Measure (NEPM). The current NEPM dated May 2021 has new $PM_{2.5}$ standards and goals listed in **Table 3.2.** Apart from the exceptional events defined below, exceedances of the particulate standards are no longer allowed.

Table 3.2: Other Criteria in 2016 NEPM (Ambient Air Quality)

Air Quality Indicator	Period	Criteria (µg/m^3)
$PM_{2.5}$ goals from 2025 onwards	1 day	20
	1 year	7

Notes: For the purpose of reporting compliance against $PM_{2.5}$ 1 day average standards, jurisdictions shall exclude monitoring data that has been determined as being directly associated with an exceptional event (bushfire, jurisdiction authorised hazard reduction burning or continental scale windblown dust that causes exceedance of 1 day average standards).

At the time of this assessment, these new $PM_{2.5}$ NEPM goals for 2025 had not yet been adopted in the EPP (Air) but DES has indicated that they will be adopted in the next amendment. As such, the goals were not adopted for the Project. However, it is noted that the results of this assessment indicate that $PM_{2.5}$ emissions, most commonly associated with fuel combustion, are not likely to present a significant constraint to proposed mine operations.

3.2.4 Department of Environment and Science (DES) Guideline

The Department of Environment and Science (DES) Guideline, version 5.00 (DES 2023) for the Application requirements for activities with impacts to air suggested that a short-term (24-hour average) TSP concentration at the sensitive receptor of greater than 90 µg/m^3 may cause dust nuisance and so has advised the assessment of the short-term (24-hour average) maximum TSP impact to be undertaken and compared against the trigger levels provided in the *Good practice guide for assessing and managing the environmental effects of dust emissions* (N.Z. Ministry for the Environment, 2016) as shown in **Table 3.3**.

The 24-hour average trigger level for a residential area is 60 µg/m^{3,} which is more stringent than the annual average TSP criterion of 90 µg/m3. The N.Z. Ministry for the Environment guide clearly states that these trigger levels are not meant for regulatory compliance purposes but are only applicable to monitoring data and for the purpose of alerting the operators into potentially taking additional dust control measures when triggered. Hence, the current trigger levels are well below those that may impact receptors. Due to this, these trigger levels provide an indication of any need for dust to be addressed in site management plans.

Table 3.3: Suggested 24-Hour Trigger Levels for TSP (N.Z. Ministry for the Environment, 2016)

Sensitivity of Receiving Environment	High	Moderate	Low
Trigger Level (µg/m³)	60	80	100

Notes: 1. In general, all residential areas will be high sensitivity
2. For managing chronic dust only

3.3 Dust Deposition

Whilst there are no quantitative limits specified in the legislation, there are guidelines designed to avoid nuisance caused by dust deposition fallout onto near horizontal surfaces.

The Department of Environment and Science (DES 2023) guideline suggests that a dust deposition limit of 120 mg/m²/day (3.6 g/m²/month), averaged over one month, is frequently used in Queensland. For extractive industries, it is the insoluble component of analysed dust that is used.

It should be noted that these values are a guideline for the level that may cause nuisance at a sensitive place.

3.4 Summary of Relevant Pollutant Concentration Criteria

Table 3.4 presents a summary of the relevant air quality criteria adopted in this assessment.

Table 3.4: Summary of Relevant Air Quality Criteria

Air Quality Indicator	Period	Criteria (µg/m³)
TSP	24 hours	60[1]
	1 year	90
PM_{10}	24 hours	50
	1 year	25
$PM_{2.5}$	24 hours	25
	1 year	8
Dust deposition	1 month	120 mg/m²/day

Notes: 1. For dust management purposes only.

4. EXISTING ENVIRONMENT

4.1 Study Area Description

4.1.1 Overview

The BSP site is located in a rural area surrounded by agricultural land. There are isolated dwellings interspersed around and within the proposed mining lease boundary. The closest town is Baralaba, located approximately 6.5 kilometres northwest of the nearest point of the mining lease boundary. Further north of Baralaba township is the Baralaba North Mine.

The existing TLO facility is also located in a rural area surrounded by agricultural land. There are also isolated dwellings, and the town of Moura is approximately 2.5 kilometres to the southwest. Approximately 3 kilometres to the east are industries, including Queensland Nitrates (QNP) and Dyno Nobel Moura. Approximately 4 kilometres east is the Anglo Coal Dawson Mine. To the southeast and south are networks of coal seam gas extraction wells.

4.1.2 Description of Industrial Emission Sources in the Vicinity

A survey of the surrounding area was conducted using Google Earth on 18 September 2023. No other medium to high impact air emission sources in the vicinity of the BSP were found other than the existing Baralaba North Mine to the north. The impacts from the Baralaba North Mine have been considered in the conservative background concentrations applied in the assessment, as summarised in **Section 4.2.5**. The measured annual average and 70th percentile concentrations in the vicinity of the Baralaba North Mine, as shown in **Section 4.2.2,** are lower than the assumed background concentrations.

Product coal from the mine will be hauled south along public roads to the TLO facility on the Dawson Highway, where coal from the existing Baralaba North Mine is currently transported. The dust emissions from these additional covered haul trucks over sealed roads will be insubstantial and the likelihood of impacts at the sensitive receptors 100 metres or more from the route is negligible.

Industries closest to the TLO facility are identified as the:

- Dawson Mine, approximately 4 kilometres to the east of the TLO facility
- a network of coal seam gas extraction wells to the southeast and south
- the Queensland Nitrate Plant (QNP), which manufactures ammonium nitrate, and Dyno Nobel's explosives facility at Moura are both approximately 3 kilometres east of the TLO facility.

There is also a gas pressure reduction facility next to the industries east of the TLO, which is associated with QNP. However, the latest National Pollution Inventory (NPI) report for this facility is in 2010, and they only reported volatile organic compounds (VOCs).

Among these, the Dawson Mine has the greatest potential to contribute to cumulative dust impacts with the TLO facility at the nearby sensitive receptors. Based on the NPI report, QNP also emits particulates but to a much lower extent. It is unlikely that the contribution of QNP to particulate impacts at sensitive receptors would be discernible. Similarly, the gas extraction wells would have particulate emissions from diesel generators and/or flares but would be indiscernible at the sensitive receptors which are far from the emission sources. Dyno Nobel Moura has not reported particulate emissions in its NPI report; therefore, it has minimal particulate emissions.

4.2 Existing Air Quality

4.2.1 Overview

Based on the rural nature of the regional area, it is expected that the air quality for the study area would be acceptable for the majority of the time, with possible exceptions including dust and particulates. The existing air quality would be influenced by sporadic traffic on unsealed roads and bushfires, controlled burning and dust from agriculture. Localised or short-term degradation of the air quality environment would most likely be due to smoke and dust from fires.

Other major regional projects, including the following, have not been modelled as part of this assessment. Still, their contribution to background air quality is discussed in the following sections:

- Operations at the Baralaba North Mine, approximately 12 kilometres to the north. At that distance, there may be some contribution to background air quality at the northern extent of the BSP. However, peak contributions at dwellings south of Baralaba North will occur when northerly wind conditions blow emissions from BSP away from those dwellings. The estimation of background air quality makes some allowance for the presence of Baralaba North by using monitoring data from monitoring stations near industrial sources, as discussed in **Section 4.2.3**.
- The Dawson Mine, held by Anglo Coal (Dawson) Limited, is approximately 25 km southeast of the BSP. ML 5656 extends from the Dawson northern open-cut pit 23 km to the north, close to the southern boundary of the BSP. This portion of the ML represents future mining rights. However, there is no clear project definition or timeline available in the public domain. Operation of the Dawson Mine open-cut mining operations are too far from the BSP to have discernible cumulative impacts. However, Dawson Mine will likely contribute to background air quality at and surrounding the TLO facility. Hence, the background concentrations used to assess the TLO facility have been increased to account for Dawson Mine's contribution.
- The Meridian coal seam gas project is approximately 28 kilometres south of the BSP. Operation of any gas fields, especially at this distance, will not contribute substantially to cumulative impacts.
- The proposed Mungi North gas field extends within 5 kilometres to the south of the BSP. Operation of gas fields has limited particulate emissions and is unlikely to contribute substantially to cumulative impacts. The estimation of background air quality in the following sections makes some allowance for industrial sources in the rural area.
- The contribution of agricultural sources to background air quality would have already been included in the background monitoring concentrations used in this assessment.

Monitoring data from similar locations has been used to represent the existing background air quality. The estimated background concentrations have not been included in the modelling runs but are provided with the results so that the cumulative impact can be compared to the criteria. In the absence of continuous monitoring data, it is recommended (Victoria, 2001) to use the 70th percentile as a background concentration for dispersion modelling.

Department of Science and Environment (DES) operates ambient air monitoring stations. Historical DES data has been obtained from the Queensland Government data website (https://data.qld.gov.au).

4.2.2 Baralaba North PM_{10} Monitoring

PM_{10} concentrations were monitored in the vicinity of the Baralaba North Mine when the mine was in care and maintenance, and during operation. The data collected at each location was less than 75% complete for each year, so the data was not used as background concentrations but is provided here for context. **Table 4.1** presents a summary of the monitoring data in the vicinity of Baralaba North Mine.

The 70th percentile and annual average measured results are relatively low in comparison with predicted modelling results for the Baralaba North Continued Operations Project (Todoroski Air Sciences, 2014). These measured results are typical of rural areas.

Table 4.1: Concentrations Recorded in the Vicinity of Baralaba North Mine from February 2016 to May 2018 to July 2023

Monitor Location	70th Percentile 24-hour Average PM_{10} Concentration (µg/m³)							Maximum 24-hour Average PM_{10} Concentration (µg/m³)							Annual Average PM_{10} Concentration (µg/m³)						
Year	**2016**	**2017**	**2018**	**2020**	**2021**	**2022**	**2023**	**2016**[1]	**2017**	**2018**	**2020**	**2021**	**2022**	**2023**	**2016**	**2017**	**2018**	**2020**	**2021**	**2022**	**2023**
Dwelling 1	12	8	10	-	-	7	10	35	24	28	-	-	33	160[2]	9	7	9	-	-	6	11
Dwelling 2	11	8	6	-	-	-	-	36	24	25	-	-	-	-	9	7	6	-	-	-	-
Dwelling 3	-	-	9	-	4	5	-	-	-	25	-	20	11	-	-	-	8	-	3	4	-
Dwelling 4	10	-	-	-	-	-	-	15	-	-	-	-	-	-	8	-	-	-	-	-	-
Dwelling 5	-	-	-	-	-	14	7	-	-	-	-	-	46	21	-	-	-	-	-	14	6
Dwelling 6	-	-	-	9	5	3	5	-	-	-	44	14	12	37	-	-	-	8	4	2	4
Baralaba Township	6	4	6	-	-	6	8	22	18	6	-	-	62[3]	29	5	3	6	-	-	6	7
Moura Township East (SES)	5	-	-	-	-	-	-	10	-	-	-	-	-	-	4	-	-	-	-	-	-

Notes:

1. The maximum measured concentrations, occurred on 8 December 2016, were not included in the table as the elevated levels during this day were likely due to smoke coming from multiple bushfires including at South Ulam and Byfield affecting Rockhampton, Yeppoon and surrounding areas (QFES, 2016).

2. Maximum concentration occurred on 13 July 2023. Dust concentrations were high likely due to local emission source nearby since other monitoring locations during the same period presented low PM_{10} concentrations.

3. Maximum concentration occurred on 27 August 2022. Dust concentrations were high likely due to local emission source nearby since other monitoring locations during the same period presented low PM_{10} concentrations. During the high dust concentration period, the wind conditions were calm to light winds from the southeast. It is noted that the Baralaba Township is located south of the Baralaba North Mine. Dwelling 1 , located downwind to the west of the mine did not experience high PM_{10} concentrations during the same period.

4.2.3 DES Gladstone Air Quality Monitoring Network

The DES air quality monitoring network in Gladstone is affected by industrial sources in the region. The monitoring station at Fisherman's Landing is located at an industrial facility. It is classified as "peak" according to AS/NZS 3580.1.1, so data at this station is likely to be too high to be used as background for this assessment. The monitoring station at Targinie is classified as "background" as it is relatively far away from pollution sources. So, data from this station would not be representative as "background" for this assessment. The remaining monitoring stations are classified as "neighbourhood" so data from these stations is likely to be more representative of the concentrations experienced at the sensitive receptors in the vicinity of the BSP. **Table 4.2** presents the average air quality monitoring data for the period 2010 – 2022 for all the stations in the Gladstone region classified as "neighbourhood" according to AS/NZS 3580.1.1.

Table 4.2: PM_{10} and $PM_{2.5}$ Concentrations Recorded by DES "Neighbourhood" Stations in the Gladstone Region

Station	Average 70th Percentile 24-hour PM_{10} ($\mu g/m^3$)	Annual Average PM_{10} concentration ($\mu g/m^3$)	Average 70th Percentile 24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Annual Average $PM_{2.5}$ concentration ($\mu g/m^3$)
Auckland Point	19.5	17.9	-	-
Boat Creek	17.0	15.6	5.8	5.5
Boyne Island	14.4	12.8	5.3	4.9
Clinton	16.5	15.0	6.6	6.3
South Gladstone	16.1	14.3	6.0	5.6

Note: Auckland Point station does not measure $PM_{2.5}$ concentrations; hence, it is not included in the table.

As shown, the dust concentrations in the Gladstone area vary slightly with location but are relatively consistent. The data at Boat Creek station was deemed to be the appropriate data to use as it is located in a rural area relatively close to an industrial source, which is representative of the land use in the area of this assessment, whereas the other monitoring stations are located in urban areas. The concentrations at Boat Creek station are also higher than the concentrations measured in the vicinity of the Baralaba North Mine, so using Boat Creek data as background for the assessment is a conservative approach.

Due to the presence of Dawson Mine in the vicinity of the TLO facility, higher background concentrations (Auckland Point) have been used to assess the TLO facility.

Based on a typical ratio of PM_{10} to TSP at Australian mines of 0.39 (ACARP, 1999), the annual average TSP background for the BSP assessment has been estimated as 40.0 $\mu g/m^3$. For the TLO facility assessment, the annual average TSP background has been estimated as 45.9 $\mu g/m^3$.

4.2.4 Dust Deposition

Dust deposition data is available in the BSP area for the period January – May 2021 and is presented in **Table 4.3**.

Table 4.3: Dust Deposition Levels Measured at the BSP in 2021

Month	Dust Deposition (mg/m²/day)
January	16.7
February	13.3
March	46.6
April	36.6
May	86.6
Average	**40.0**
70th Percentile	**44.6**

It has also been noted dust deposition also varies substantially depending on local sources within 1 kilometre of the site. Based on the experience of Trinity over a wide range of projects across Queensland, in rural agricultural or industrial areas, dust deposition levels are typically 50 mg/m²/day. In urban areas they are typically 40 mg/m²/day, and in forested areas they are typically 30 mg/m²/day.

As the vicinity is rural with agricultural activities and considering the average and 70th percentile concentrations measured at the BSP, a dust deposition level of 50 mg/m²/day has been adopted as the background for this study. This level is similar to the adopted dust deposition level of 1.8 g/m²/month (54 mg/m²/day) for the air quality assessment of the Baralaba North Continued Operations Project (Todoroski Air Sciences, 2014).

4.2.5 Summary of Estimated Background Levels

Based on the discussions in the preceding sections, the expected background air quality for key pollutants has been summarised with the estimated concentrations listed in **Table 4.4**. These are well within the criteria contained in **Table 3.4**. It is anticipated that the criteria would only be exceeded during regional events such as bushfires or dust storms.

Table 4.4: Background Air Quality

Air Quality Indicator	Period	BSP Concentration (µg/m³)	TLO Concentration (µg/m³)
TSP	1 year	40.0	45.9
PM_{10}	24-hour	17.0	19.5
	1 year	15.6	17.9
$PM_{2.5}$	24-hour	5.8	6.6
	1 year	5.5	6.3
Dust deposition	1 month	50 mg/m²/day	

5. METEOROLOGICAL MODELLING AND CLIMATE

5.1 Regional Climate

Baralaba is located approximately 115 kilometres inland of Rockhampton. The climate class nominated by the Bureau of Meteorology (2023) for this area is subtropical, with a moderately dry winter.

5.2 Weather Stations

A search of the Bureau of Meteorology's weather station directory revealed that the nearest rain gauge to the BSP is at Belvedere station, located approximately 4.5 km from the MLA boundary. Temperature, rainfall and humidity are available from the Baralaba Post Office station, located approximately 7 km from site and operational until 2013.

The nearest weather station with continuous wind monitoring is the Baralaba North Mine weather station located within the Baralaba North Mine. Data from this station is presented in **Section 5.6.3**.

The absence of a BOM weather station in the immediate vicinity of the project area poses a challenge in assimilating surface data for the subject site. The nearest available weather stations, namely Thangool Airport, Rockhampton Airport, Blackwater Airport and Rolleston Airport BOM stations, are approximately 75 - 130 km away, limiting the applicability of surface data at the subject site. Alternatively, meteorological data from the Balaraba North Coal Mine weather station, located approximately 10 kilometres north-northwest from the BSP's mining lease boundary, were available for assimilation into the model run.

5.3 Existing Temperature, Rain and Humidity

Long-term weather and climate data from the Baralaba Post Office weather station and Belvedere are summarised in **Table 5.1** and **Table 5.2**.

Table 5.1: Climate Statistics for Baralaba Post Office

Month	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°C)	Mean Monthly Rainfall (mm)	Highest Monthly Rainfall (mm)	Lowest Monthly Rainfall (mm)	Mean 9am Relative Humidity (%)	Mean 3pm Relative Humidity (%)
Jan	34.3	21.3	96.2	425.8	0.0	65	43
Feb	33.4	21.2	115.6	628.1	0.0	69	46
Mar	32.5	19.3	73.5	333.3	0.0	67	41
Apr	30.3	16.0	44.8	421.6	0.0	67	42
May	26.5	12.2	41.7	267.3	0.0	69	42
Jun	23.5	8.9	34.9	189.6	0.0	74	46
Jul	23.1	7.4	28.6	183.3	0.0	70	40
Aug	25.2	8.6	21.8	115.5	0.0	66	38
Sep	28.4	11.9	25.6	160.6	0.0	62	34
Oct	31.2	15.6	55.1	181.6	0.0	60	35
Nov	32.8	18.4	75.3	200.5	0.0	60	38
Dec	34.0	20.3	103.1	457.6	0.0	62	40
Annual	29.6	15.1	713.7	1348.6	349.9	66	40

Month	Mean Daily Maximum Temperature (°C)	Mean Daily Minimum Temperature (°C)	Mean Monthly Rainfall (mm)	Highest Monthly Rainfall (mm)	Lowest Monthly Rainfall (mm)	Mean 9am Relative Humidity (%)	Mean 3pm Relative Humidity (%)
Start Year	1966	1966	1926	1926	1926	1969	1969
End Year	2012	2012	2013	2013	2013	2010	2010

Table 5.2: Climate Statistics for Belvedere for the years from 1938 to 2022

Month	Mean Monthly Rainfall (mm)	Highest Monthly Rainfall (mm)	Lowest Monthly Rainfall (mm)
Jan	94.2	357.4	1.0
Feb	108.5	535.9	0
Mar	71.8	279.7	0
Apr	35.1	253.4	0
May	37.9	248.4	0
Jun	29.9	124.0	0
Jul	27.3	149.2	0
Aug	22.2	111.0	0
Sep	23.2	155.4	0
Oct	57.1	217.0	0
Nov	75.5	203.9	0
Dec	90.0	306.2	2.8
Annual	677.6	1222.6	316.8

5.4 Model Year Selection

Table 5.3 presents the percentage of wind conditions in each wind speed category of the most recent years with available data at the Baralaba North weather station. Weather data for 2018 and 2019 was only partially available, so it was not used in this analysis.

Calm and low wind speed conditions are important for this assessment as the sources are at ground level; hence, these conditions will have greater impacts. Additionally, higher wind speeds were also considered as some sources are wind speed dependent. The year 2015 was used because it has conservative proportions of calm and higher wind speed conditions.

Table 5.3: Percentage of Wind Conditions in Each Wind Speed Category at the Baralaba Mine Station

Year	Proportion Calm (%)	AVG WS (m/s)	0.5 - 1.5 m/s (%)	1.5 - 5 m/s (%)	> 5 m/s (%)
2014	4.7	2.1	31.3	61.3	2.7
2015	**9.6**	**1.8**	**35.5**	**53.7**	**1.2**
2016	11.0	1.6	37.0	51.5	0.5
2017	11.9	1.6	37.2	50.2	0.7

Year	Proportion Calm (%)	AVG WS (m/s)	0.5 - 1.5 m/s (%)	1.5 - 5 m/s (%)	> 5 m/s (%)
2020	5.6	2.1	32.0	61.3	4.1
2021	3.6	2.3	30.0	60.7	5.1
Average	**7.7**	**1.9**	**33.8**	**56.4**	**2.4**

5.5 TAPM Meteorological Modelling

5.5.1 TAPM Fundamentals

The meteorological component of The Air Pollution Model (TAPM) was evaluated to provide wind fields over the region.

The databases required to run TAPM are provided by CSIRO and include global and Australian terrain height data, vegetation and soil type datasets, sea surface temperature datasets and synoptic scale meteorological datasets.

The Australian terrain data are in the form of 9-second grid spacing (approximately 0.3 kilometres) and are based on data available from Geosciences Australia. Australian vegetation and soil type data are on a longitude/latitude grid at 3-minute grid spacing (approximately 5 kilometres) and is public domain data provided by CSIRO Wildlife and Ecology.

The synoptic scale meteorology dataset used is a six-hourly synoptic scale analysis on a longitude/latitude grid at 0.75 or 1.0-degree grid spacing (approximately 75 kilometres or 100 kilometres). The database is derived from US NCEP reanalysis synoptic products.

TAPM dynamically fits the gridded data for the selected region to finer grids including the influences of terrain, surface type and surface moisture conditions. It produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

5.5.2 TAPM Configuration

TAPM was setup using four nested 30 x 30 grids centred on latitude 24°16.0′ south, longitude 149°52.0′ east for the BSP and 24°33.0′ south, longitude 150°0.5′ east for the TLO.

The four nested grids for the BSP were as follows:

- 750 km x 750 km with 25 km resolution
- 300 km x 300 km with 10 km resolution
- 90 km x 90 km with 3 km resolution
- 30 km x 30 km with 1 km resolution

And for TLO:

- 750 km x 750 km with 30 km resolution
- 250 km x 250 km with 10 km resolution
- 75 km x 75 km with 3 km resolution
- 22.5 km x 22.5 km with 0.9 km resolution

Thirty (30) vertical levels were used with lower-level steps at 10, 25, 50, 75 and 100 metres up to 8 kilometres in altitude. This is a greater than normal number of vertical layers in order to provide better resolution of vertical layers. Boundary conditions on the outer grid were derived from the synoptic analysis. Non-hydrostatic pressures were ignored due to the gentle terrain and moderate resolution.

TAPM land use data was updated using the latest aerial photography available from Google Earth.

5.5.3 Observational Data Assimilation

Meteorological data from the Baralaba Mine station for the period 1 January to 31 December 2015 were available for assimilation into the model run. TAPM observation assimilation was undertaken only for the TLO assessment since the weather station is located too distant to be included in the CALMET run. For the BSP, data assimilation was performed during the CALMET run as explained in **Section 5.6.3.**

5.6 CALMET Modelling

5.6.1 Configuration

The CALMET configuration used is consistent with NSW OEH guidance (TRC 2011).

The model was run over the full year of 2015 based on a 3-dimensional grid produced using the CALTAPM utility program to convert TAPM data to M3D format suitable for CALMET to read.

The CALMET grid was set to a grid spacing of 295 metres and 80 by 80 grid points. Twelve vertical layers were modelled with cell face heights between 0, 20, 40, 80, 160, 320, 640, 900, 1200, 1800, 2500, 3000 and 4000 metres. This is greater than the normal number of vertical layers to provide better resolution.

Mixing height calculation parameters were set to default values. Temperature prediction parameters were set to default. Divergence minimisation was used. The critical Froude number was set to 1. Slope flow effects were included. The radius of influence of terrain features for the CALMET setup was set to 2 km for the BSP and 3 km for the TLO.

CALMET was run in hybrid mode to utilise the Baralaba North surface data and TAPM prognostic upper air data. The maximum radius of influence for the surface data (RMAX1) was set to 20 km, whilst the weighting parameter for Step 1 wind field vs surface observations (R1) was set to 10 km.

The output from CALMET was a three-dimensional grid of wind-field data, and it was then used as input into CALPUFF.

5.6.2 Terrain and Land Use Data

Terrain height was based on data from the Shuttle Radar Imaging Mission (SRTM) and obtained from Geoscience Australia. This produced terrain height data on 1 arc-second longitude/latitude grid (approximately 0.03 kilometres) for a grid representative of the area around the proposed BSP and TLO. Site-specific terrain data was also included in order to account for the yearly terrain variations due to the mining activities. **Figure 5.1** to **Figure 5.3** present the modelled terrain for each BSP modelled scenario.

Figure 5.1: Calmet Terrain for Year 1 BSP

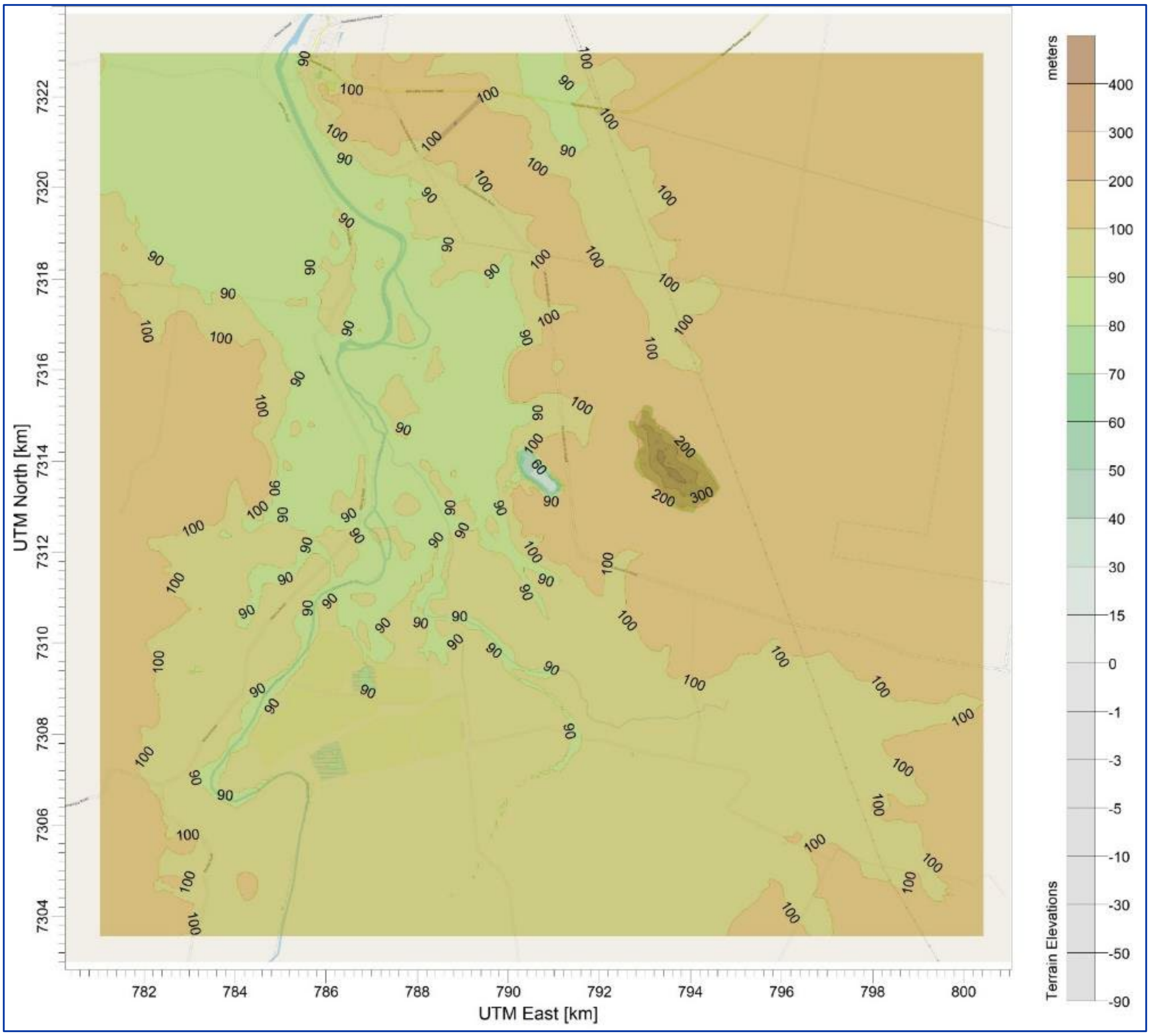


Figure 5.2: Calmet Terrain for Year 3 BSP

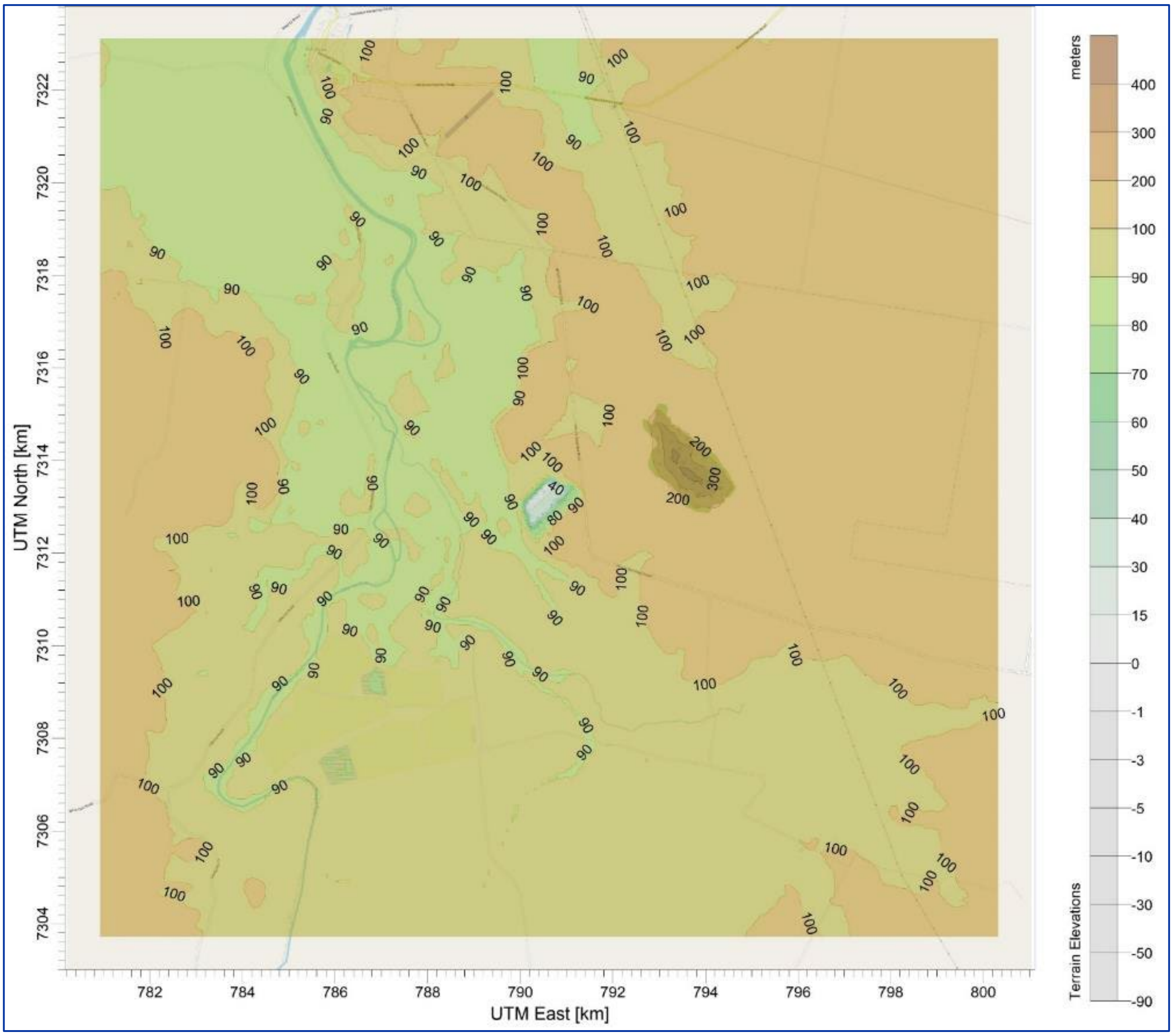
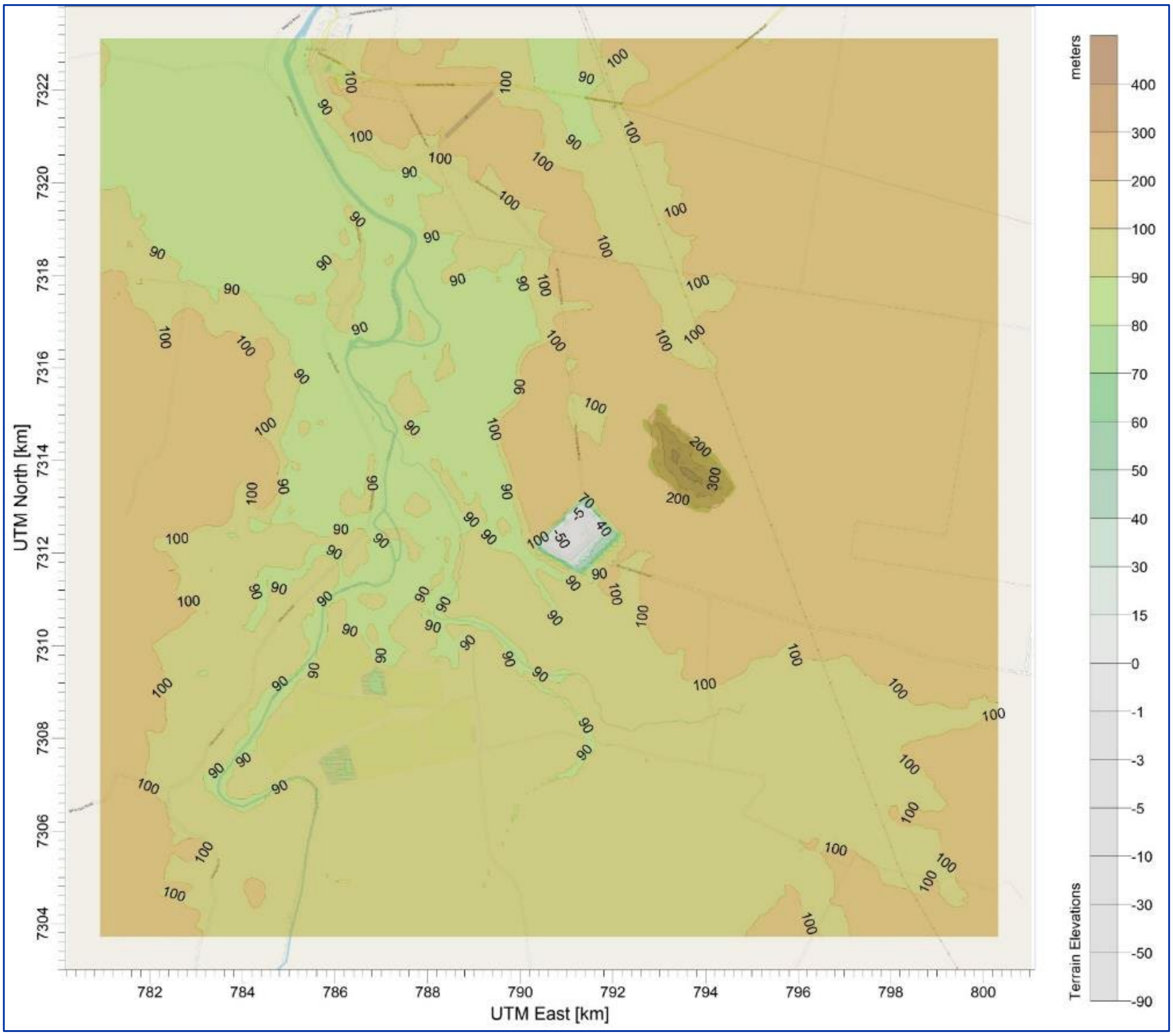


Figure 5.3: Calmet Terrain for Year 11 BSP



Land use data from Queensland Spatial Catalogue was incorporated into the CALMET model. The land use in Calmet is shown in **Figure 5.4.**

Figure 5.4: Land Use in Calmet Model for the BSP

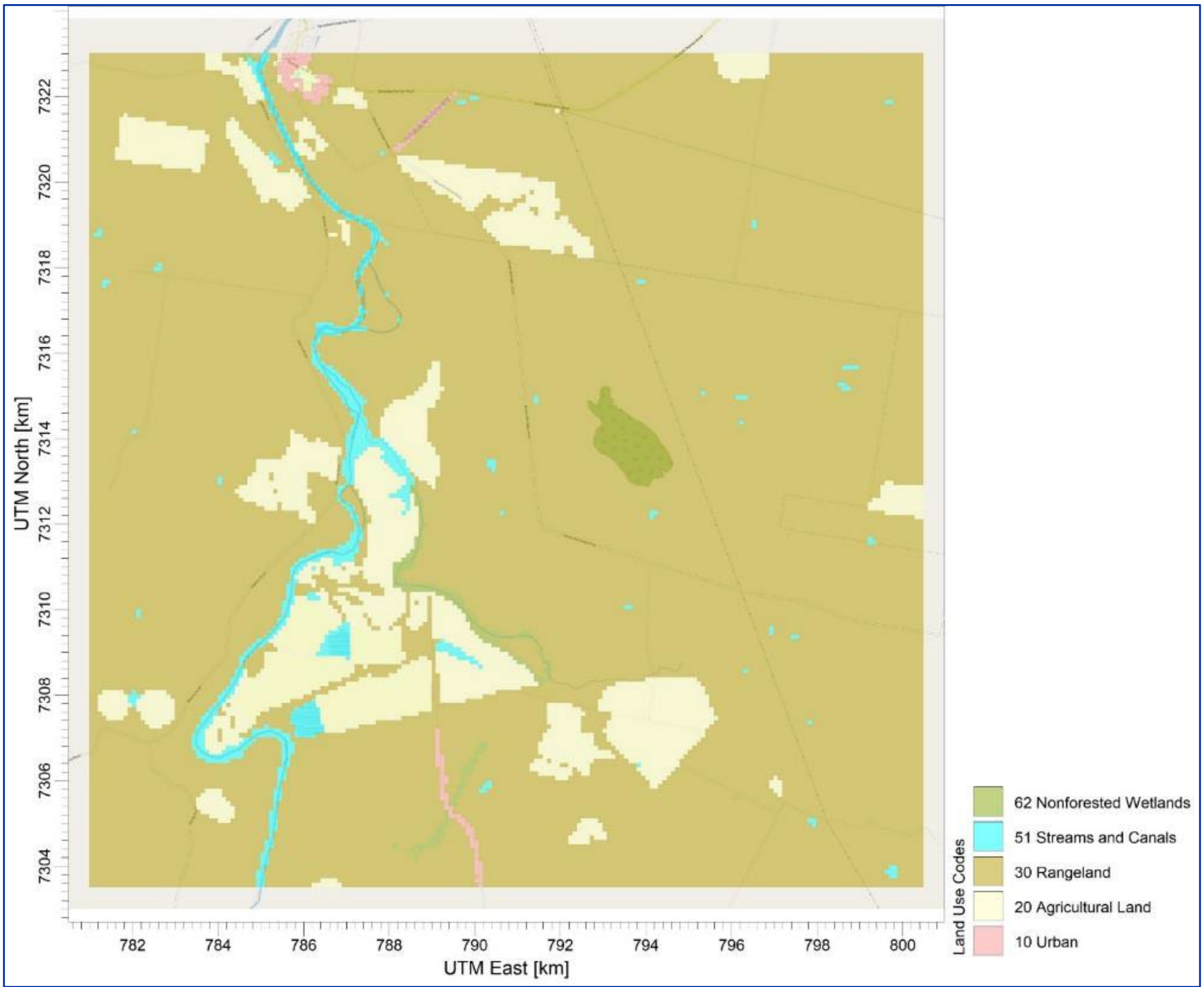


Figure 5.5 and **Figure 5.6** present the terrain and land use used in CALMET for the TLO assessment.

Figure 5.5: Calmet Terrain for the TLO

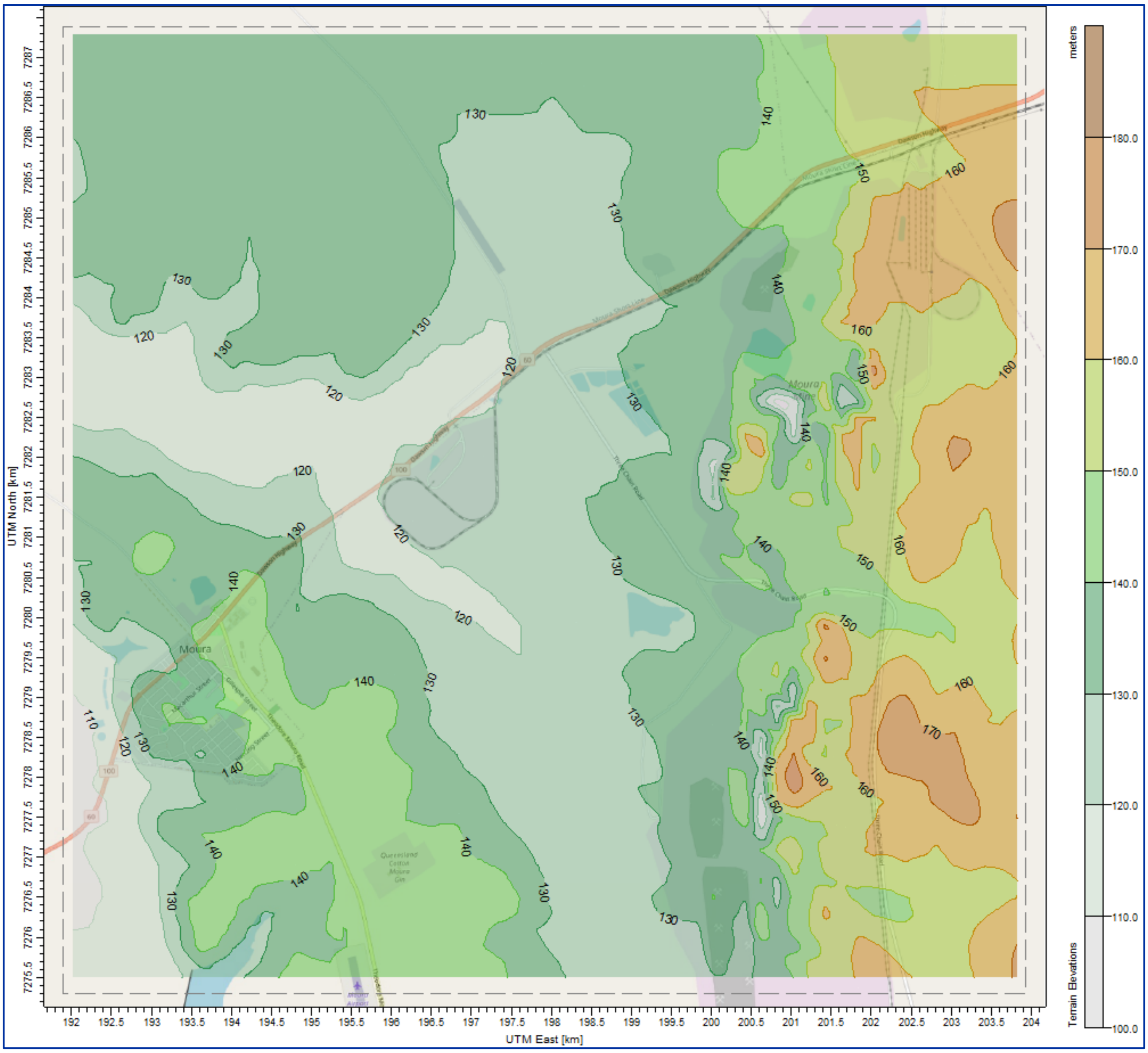
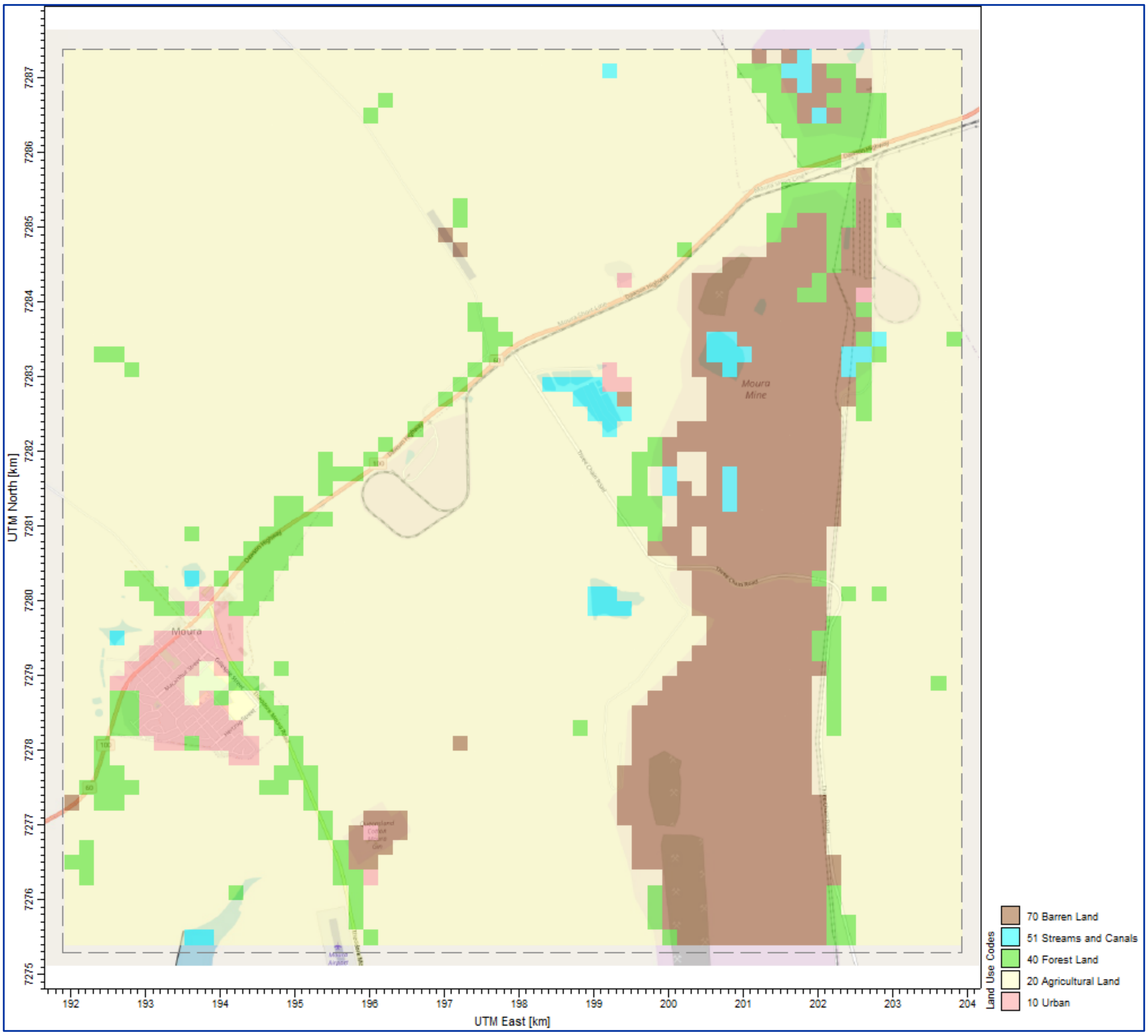


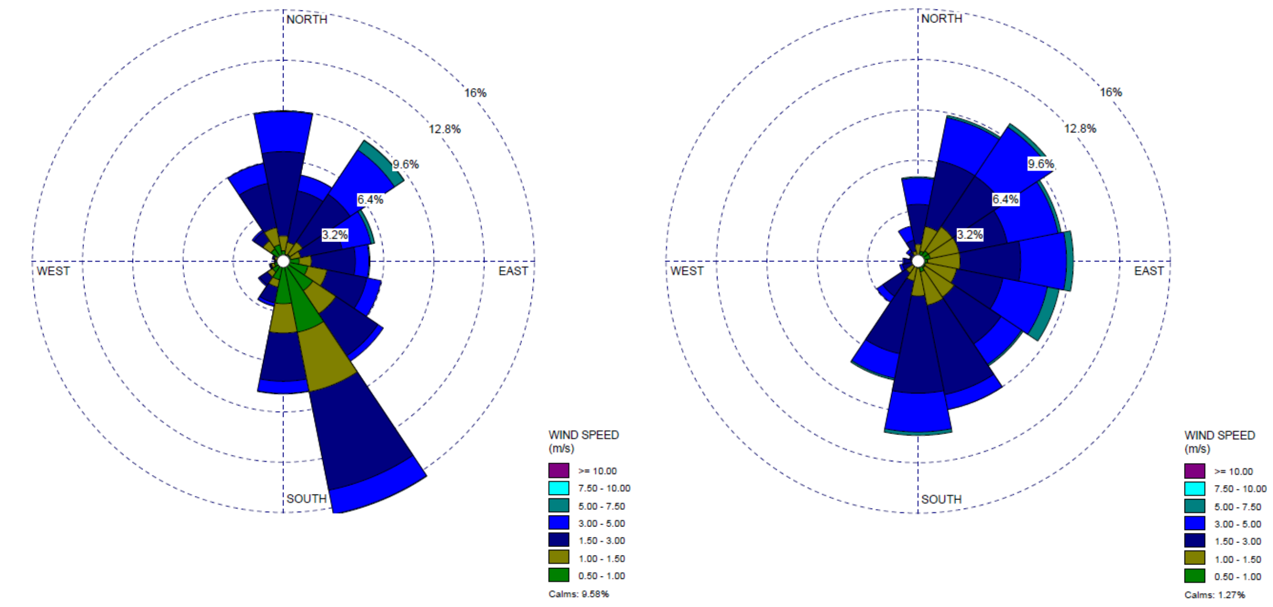
Figure 5.6: Land Use in Calmet Model for the TLO



5.6.3 Observational Data

Meteorological data from the Baralaba Mine station for the period 1 January to 31 December 2015 were available for assimilation into the BSP CALMET run. A windrose of this data is compared to a windrose of the TAPM predicted data for the same location is shown in **Figure 5.7**. TAPM was run without assimilation of this data and the windrose for the same period is also shown in **Figure 5.7**. The monitoring station shows a higher proportion of calm conditions and winds from the south-southeast, and a lower proportion of winds from the northeast quarter and south, which is dominant in the TAPM prediction. All other wind conditions appear to be similar between the two datasets.

Figure 5.7: Baralaba North Weather Station Windrose vs TAPM Predicted Windrose



Baralaba North Weather Station **TAPM Predicted Baralaba North**

Statistical parameters were calculated to determine the relative agreement between the two and are presented in **Table 5.4**. As shown, the agreement between the two datasets is relatively good. Therefore, the observational data was included in the CALMET model for generating data for the project.

Table 5.4 Statistical Agreement Between the Data from the Baralaba North Weather Station and TAPM

Statistical Parameter	Wind Speed	u-Component of Wind Speed	v-Component of Wind Speed
RMSE	0.94	1.19	1.21
Index of Agreement	0.83	0.75	0.86

5.7 Meteorological Predictions

5.7.1 Wind Speed and Direction

The frequency distributions of occurrences of winds for each direction sector and for each wind speed class as predicted by CALMET for BSP and TLO are shown in **Table 5.5** to **Table 5.6** and illustrated as wind roses in **Figure 5.8**. The wind rose at the BSP shows predominant winds from the northeast and southeast quarters, a combination of wind conditions from the observational data and the TAPM prediction. The wind rose at the TLO facility shows a more even distribution of winds from various directions.

Table 5.5: Frequency Distribution of Wind Speed (m/s) and Direction Predicted by CALMET for BSP

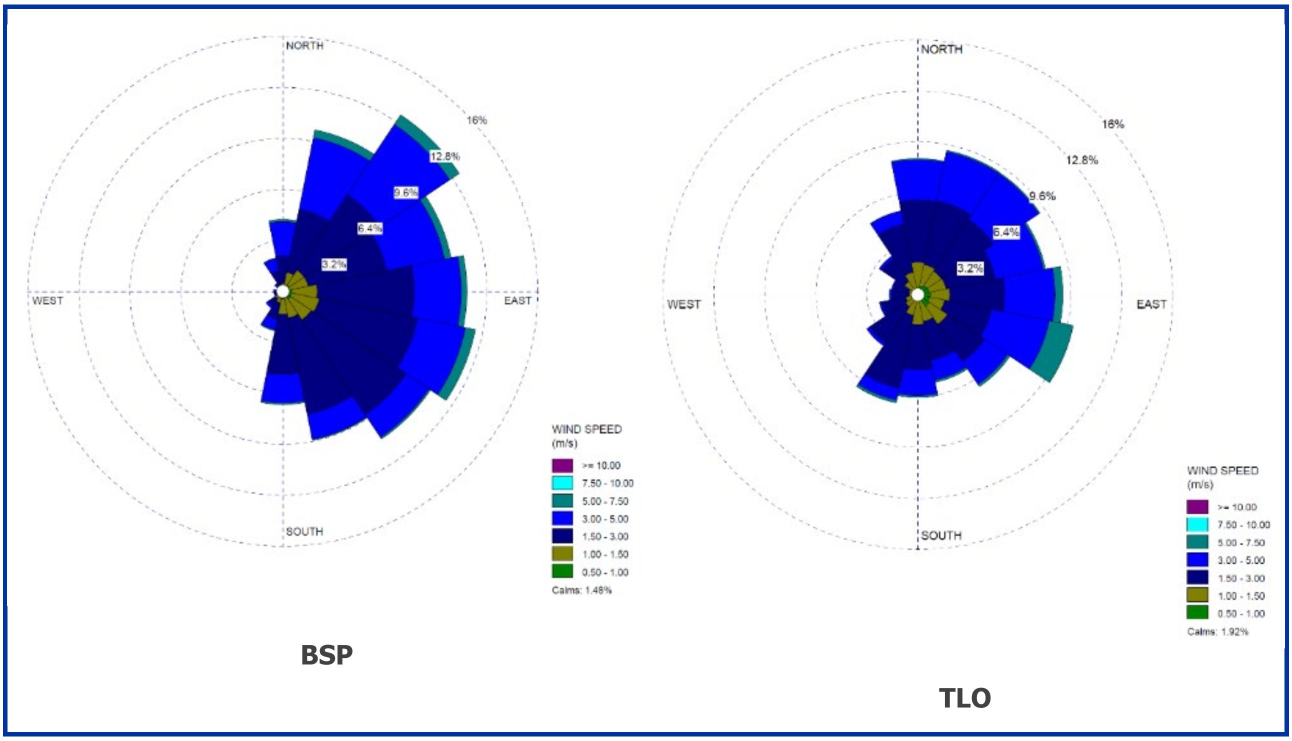
Direction	Frequency Distribution (%)							Total (%)
-	0.0 – 0.5 (m/s)	0.5 – 1.0 (m/s)	1.0 – 1.5 (m/s)	1.5 – 3.0 (m/s)	3.0 – 5.0 (m/s)	5.0 – 7.5 (m/s)	7.5 – 10.0 (m/s)	> 10.0 (m/s)	-
Calm	-	-	-	-	-	-	-	-	**1.5**
N	-	0.2	0.3	1.7	2.1	0.1	0.0	0.0	**4.5**
NNE	-	0.4	0.8	4.0	4.6	0.5	0.0	0.0	**10.3**
NE	-	0.5	1.1	5.7	5.3	0.7	0.0	0.0	**13.3**
ENE	-	0.4	1.2	5.0	3.7	0.4	0.0	0.0	**10.7**
E	-	0.6	1.6	6.1	2.9	0.4	0.0	0.0	**11.5**
ESE	-	0.5	1.8	6.3	3.1	0.6	0.0	0.0	**12.3**
SE	-	0.6	1.6	7.1	1.7	0.1	0.0	0.0	**11.1**
SSE	-	0.4	1.3	6.1	1.6	0.1	0.0	0.0	**9.5**
S	-	0.5	1.0	3.8	1.8	0.1	0.0	0.0	**7.1**
SSW	-	0.4	0.3	1.1	0.7	0.1	0.0	0.0	**2.5**
SW	-	0.3	0.3	0.5	0.2	0.0	0.0	0.0	**1.3**
WSW	-	0.1	0.2	0.2	0.1	0.0	0.0	0.0	**0.6**
W	-	0.2	0.1	0.2	0.1	0.0	0.0	0.0	**0.6**
WNW	-	0.1	0.1	0.1	0.0	0.0	0.0	0.0	**0.4**
NW	-	0.1	0.1	0.3	0.1	0.0	0.0	0.0	**0.6**
NNW	-	0.2	0.2	0.9	0.8	0.0	0.0	0.0	**2.1**
Total %	**1.5**	**5.6**	**11.8**	**49.1**	**28.8**	**3.2**	**0.0**	**0.0**	**100**

Table 5.6: Frequency Distribution of Wind Speed (m/s) and Direction Predicted by CALMET for TLO

Direction	Frequency Distribution (%)								Total (%)
-	0.0 – 0.5 (m/s)	0.5 – 1.0 (m/s)	1.0 – 1.5 (m/s)	1.5 – 3.0 (m/s)	3.0 – 5.0 (m/s)	5.0 – 7.5 (m/s)	7.5 – 10.0 (m/s)	> 10.0 (m/s)	-
Calm	-	-	-	-	-	-	-	-	**1.9**
N	-	0.5	1.6	3.9	2.5	0.1	0.0	0.0	**8.5**
NNE	-	0.6	1.4	4.1	3.1	0.1	0.0	0.0	**9.2**
NE	-	0.7	1.1	3.9	3.4	0.1	0.0	0.0	**9.2**
ENE	-	0.7	1.1	3.2	3.1	0.1	0.0	0.0	**8.2**
E	-	0.8	1.2	3.4	3.2	0.5	0.0	0.0	**9.1**
ESE	-	0.7	1.0	3.0	3.7	1.5	0.0	0.0	**9.9**
SE	-	0.9	1.4	2.8	1.7	0.2	0.0	0.0	**6.9**
SSE	-	0.5	1.2	2.5	1.3	0.1	0.0	0.0	**5.6**
S	-	0.3	1.5	2.8	1.6	0.1	0.0	0.0	**6.5**

Direction	Frequency Distribution (%)								Total (%)
SSW	-	0.4	0.9	4.6	0.8	0.2	0.0	0.0	**6.9**
SW	-	0.3	0.6	2.7	0.2	0.0	0.0	0.0	**3.9**
WSW	-	0.3	0.4	1.6	0.1	0.0	0.0	0.0	**2.5**
W	-	0.2	0.3	1.1	0.1	0.0	0.0	0.0	**1.8**
WNW	-	0.2	0.4	1.0	0.1	0.0	0.0	0.0	**1.7**
NW	-	0.3	0.7	1.7	0.2	0.0	0.0	0.0	**2.9**
NNW	-	0.4	1.0	3.1	0.8	0.0	0.0	0.0	**5.4**
Total %		**7.7**	**15.9**	**45.4**	**26.0**	**3.2**	**0.0**	**0.0**	**100**

Figure 5.8: Wind Rose from Calmet at the BSP and TLO



5.7.2 Stability Class

Figure 5.9 and **Figure 5.10** show the frequency of stability classes throughout the day. Daytime conditions are either neutral or unstable, while nighttime conditions are stable or neutral.

Figure 5.9 Diurnal Frequency of Stability Classes for BSP

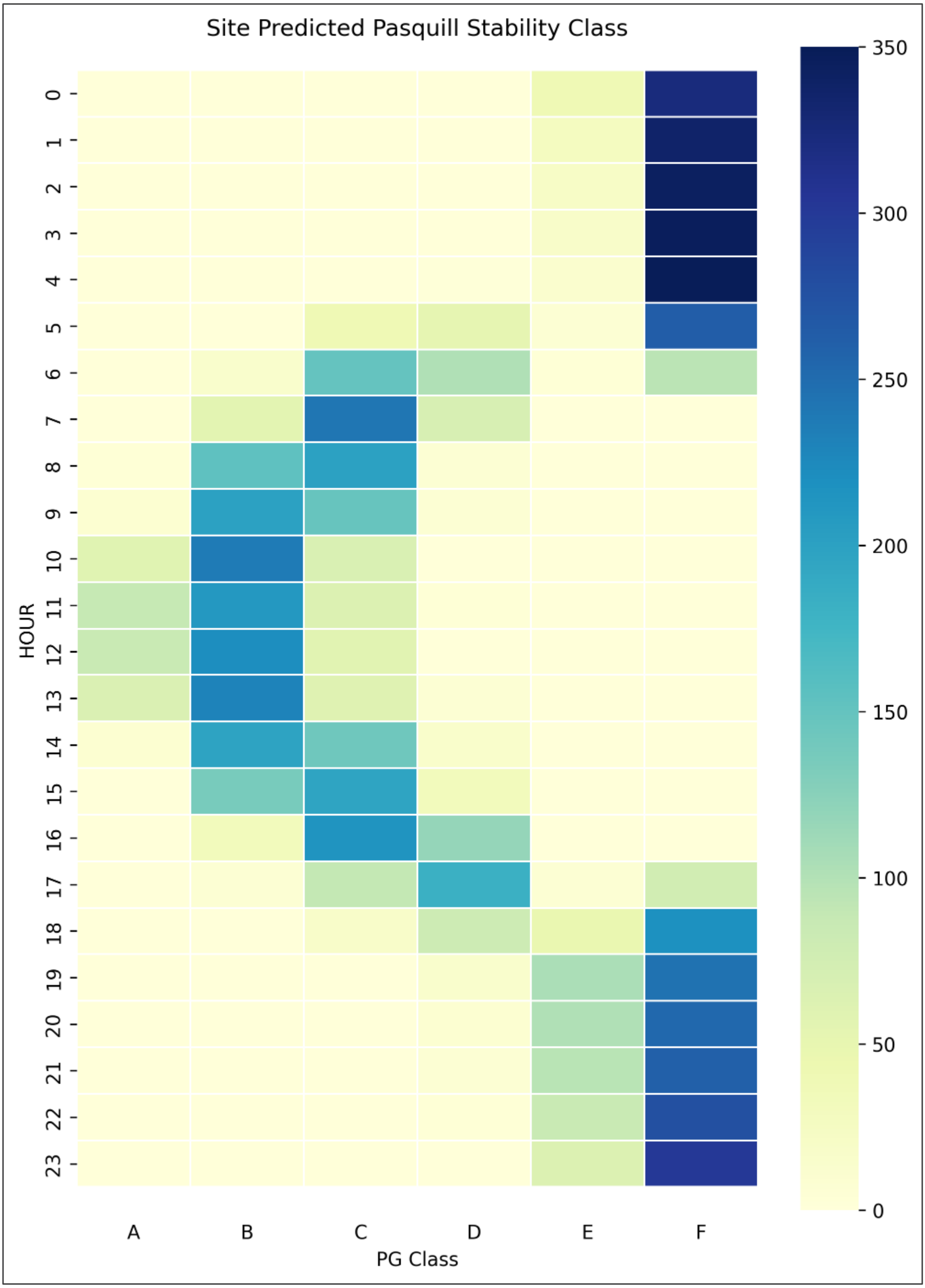
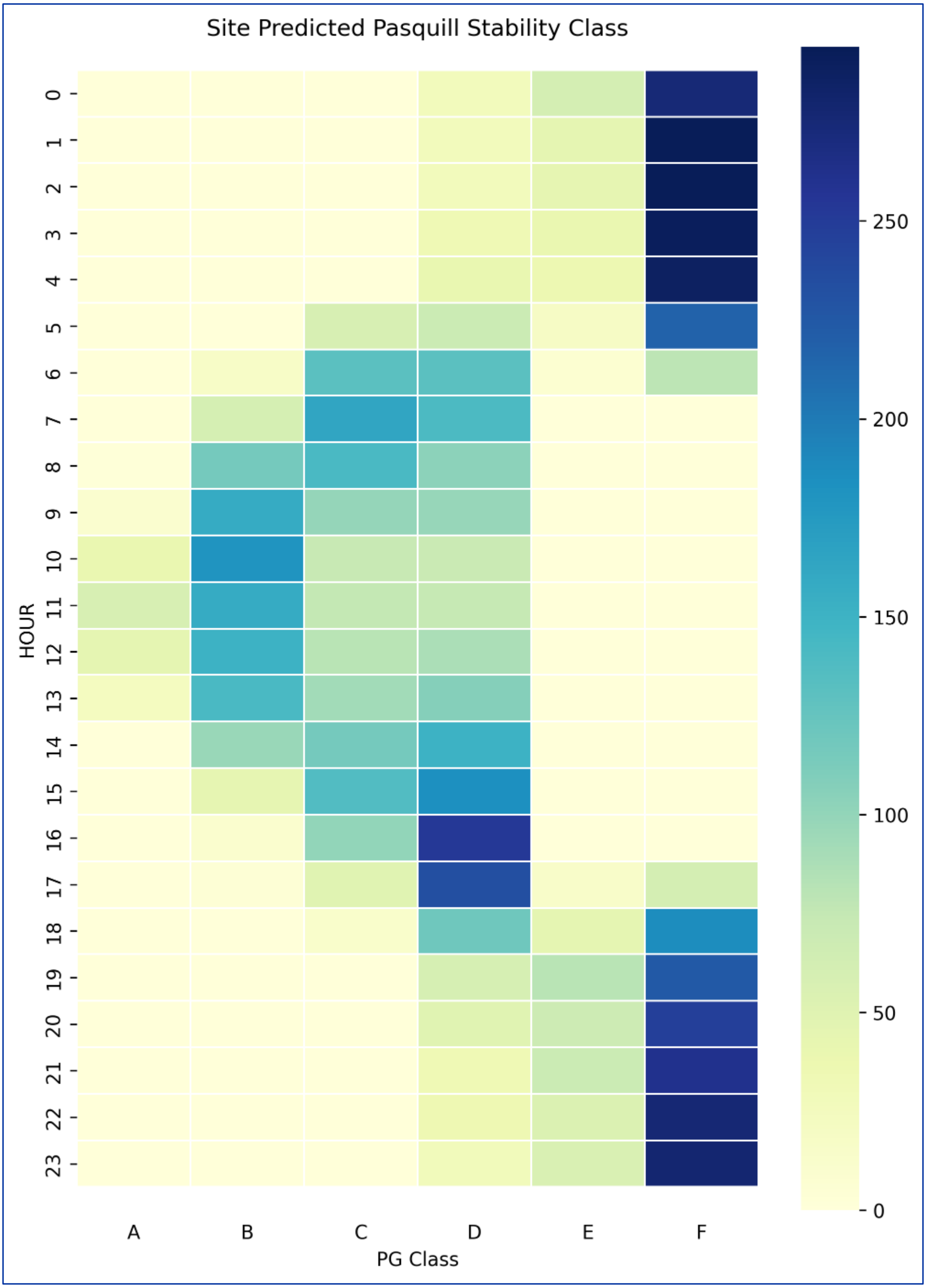


Figure 5.10 Diurnal Frequency of Stability Classes for TLO



5.7.3 Mixing Height

Figure 5.11 and **Figure 5.12** show the variation in mixing height throughout the day.

In the morning, the mixing height rises gradually, reaching an average of approximately 1.5 kilometres by the afternoon, then rapidly reforming at ground level again at nightfall.

Figure 5.11 Prediction of Mixing Height from CALMET Model for BSP

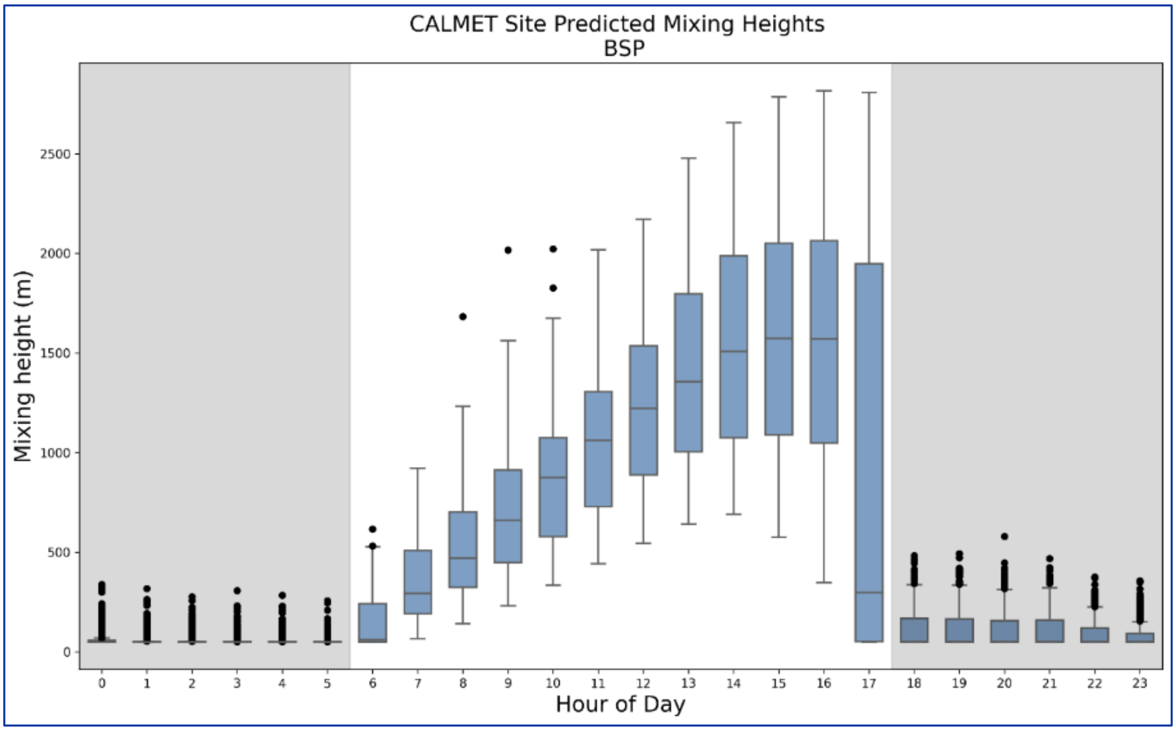
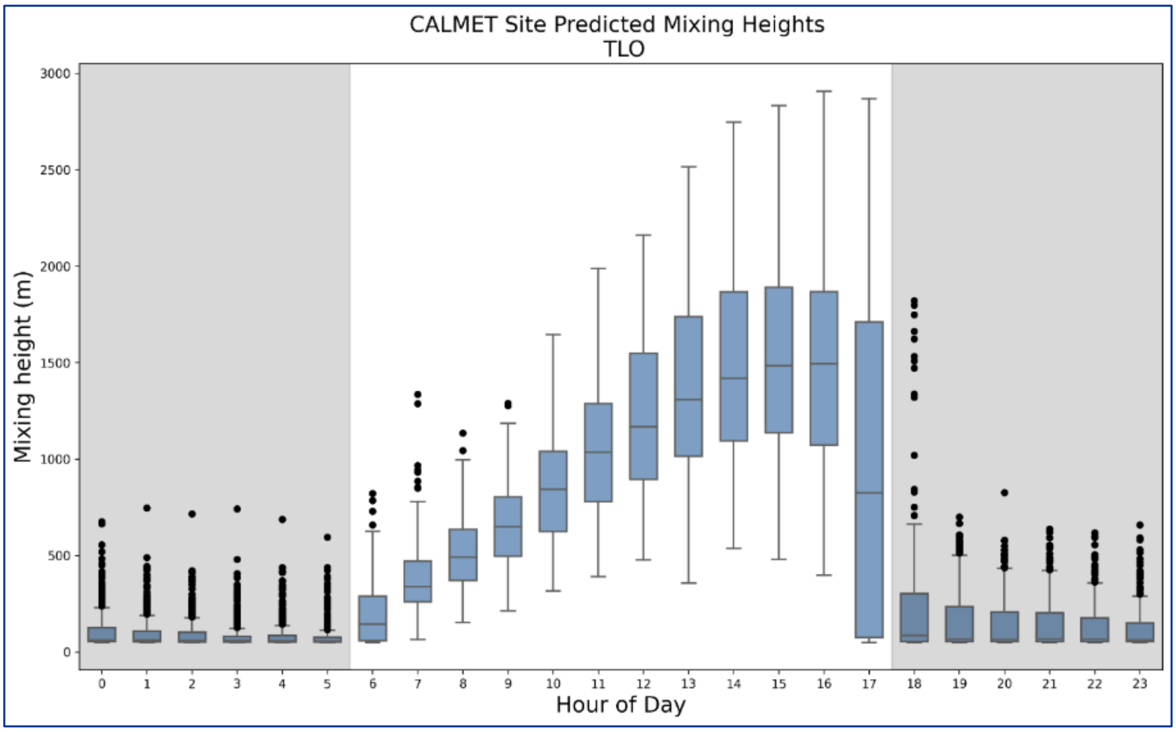


Figure 5.12 Prediction of Mixing Height from CALMET Model for TLO



6. DISPERSION MODELLING METHODOLOGY

6.1 Overview

In order to predict what happens to the pollutants after they are emitted into the air, a mathematical model is used to simulate their dispersion and deposition. It is accepted by regulatory agencies that this type of modelling has associated uncertainties. These are normally addressed by using statistics over long simulation times and deriving emission rates based on published emission factors of data representing high emission conditions.

With sources close to ground level, the critical wind conditions tend to be near-calm, i.e. low wind speeds. Gaussian plume models such as Ausplume and Aermod cannot model near-calm conditions and have low accuracy in light winds, especially in valleys where katabatic flows are present, and drainage flows turn to follow the valley. Calpuff, being a non-steady-state Lagrangian puff model, is able to simulate stagnation over time, which is critical in near-calm conditions. Its meteorological pre-processor, Calmet, performs diagnostic simulation of terrain effects on the wind field. It has a specific slope flow algorithm that predicts katabatic flows (Scire, J.S. & Robe, F.R., 1997).

In near-calm conditions, there is little turbulent mixing and less dilution by incoming wind. Large sources (such as mine dust) can travel long distances (slowly) with only a slight reduction in concentration. Windy conditions cause more dust emission from some sources, but with much greater mixing and dispersion of the dust before it travels far.

Thus, Calpuff (Version 7.2.1) was chosen as the most appropriate model. The predictions undertaken for this assessment are based on the following method:

- The modelled scenarios selected for modelling were based on the highest potential to cause impact to nearby sensitive receivers.
- Dust emission estimates were based on accepted methods and data consolidated by the National Pollutant Inventory (NPI) and the United States Environmental Protection Agency (USEPA). The main emission calculation methods utilised are included in **Section 6.3**.
- Prediction of input meteorology was completed using TAPM developed by the CSIRO Division of Atmospheric Research. TAPM has a prognostic 3-dimensional meteorological component, which can be used to generate hourly meteorological data for input into dispersion models. TAPM was run over a full representative year (2015) to include all seasons. It uses gridded terrain data at approximately 30-metre grid spacing to shape the windfields.
- TAPM input meteorology was enhanced using Calmet, the meteorological pre-processor for Calpuff. This fits the wind fields to the terrain based on gridded terrain data at approximately 100-metre grid spacing.
- Dust concentrations and dust deposition were predicted using Calpuff.

6.2 CALPUFF Configuration

The three-dimensional wind fields from Calmet were entered into Calpuff for the full year 2015. For the BSP assessment, Calpuff was run over a computational grid (19.5 kilometres x 19.5 kilometres) with a spacing of 100 metres, the same as the outer Calmet grid. For the TLO assessment, Calpuff was run over a computational grid (12 kilometres x 12 kilometres) with spacing of 200 metres, the same as the outer Calmet grid, and with receptors gridded over a smaller domain (8.2 kilometres x 8.2 kilometres) with a nesting factor of 1.

Dry deposition was modelled with vegetation state set to active and unstressed.

Wind speed profile was set to the Industrial Source Complex (ISC) Rural exponents. Calm conditions were not invoked until the wind speed dropped below 0.5 m/s.

The emissions were modelled as puffs (not slugs). Puff-splitting was turned off.

Dispersion coefficients were derived by the model using turbulence generated by micrometeorology. The Heffter curve was used to compute time-dependent dispersion beyond 550 metres. The partial plume height adjustment method was used to allow winds to approach hills as terrain increases.

The minimum turbulence velocity, sigma v, was set to 0.2 m/s.

For the purpose of calculating the influence of deposition, Calpuff only allows each particulate species to be characterised by a single mean diameter and standard deviation. Therefore, suspended TSP concentrations were modelled as three separate components: $PM_{2.5}$, coarse (between 2.5 and 10 microns) and "large" (between 10 and 75 microns). Emission rates of the species "large" were calculated as the difference between TSP and PM_{10} emissions from the inventory. Emission rates of the species "coarse" were calculated as the difference between PM_{10} and $PM_{2.5}$ emissions from the inventory. The predicted TSP results were then calculated as the sum of the model outputs for each of the three components. Similarly, dust deposition was predicted as the sum of the deposition of each of the three components.

6.3 Emission Inventory Calculations

The emission rates entered into the dispersion modelling are based on the activity and source information provided by Baralaba Coal Company Pty Ltd, as listed in **Section 2**. **Appendix B** provides the calculation methods for significant particulate sources.

Insubstantial sources not included in the dispersion model were:

- dust from covered product in haul trucks on sealed public roads
- particulates from engine exhausts (except for particulates from train exhausts)
- dust from light vehicles and water trucks.

Note that the NPI manual is designed for estimating total annual emissions. Some of the equations are based on annual wind speed averages and rainfall. Using annual averages is not appropriate for dispersion modelling where maximum 24-hour concentrations may occur during dry, windy conditions.

Therefore, rain has been removed from the emission calculations in this work, and emission rates are variable and dependent on the wind speed category.

6.4 Haul Road Watering

The NPI efficiency rate (Environment Australia (2012)) for road watering is either 50% or 75% depending on watering rates. However Cox (2014) reports that watering can achieve up to 85% to 95% control efficiency. According to Cox (2014), the NPI rates are based on the following equation from Buonicore and Davis (1992).

$$\text{control efficiency, } c = 100 - (0.8\ p\ d\ t\ /\ i)$$

where

p = potential average daytime evaporation rate (mm/h)

d = average daytime traffic rate (vehicles/hour)

i = application intensity (L/m^2)

t = time between applications (hours).

The average and median annual evaporation rate for the site is 1,971 mm/year. This equates to an average daily evaporation rate of 5.4 mm/day. Assuming that evaporation only occurs during the daytime (12 hours), leads to an evaporation rate of 0.45 mm/hour.

Table 6.1: Calculation of Haul Route Watering Efficiency

	Year 1	Year 3	Year 11
Material quantity (Mbcm/y)	29,917,134	37,146,816	27,048,859
Average Daytime Traffic Rate per Circuit (vehicles/h)	0.3 - 393	1 - 71	1 - 54
Water Application Rate (L/m^2/h)	0.01 – 1.33	0.01 – 1.71	0.02 – 1.30
Control Efficiency	85%	85%	85%
One-way circuit distance (m)	94 – 1,597	61 – 1,545	88 – 3,921
Total Water Usage Required (ML/day) [1,2]	2.0	2.3	1.1

Notes: 1. Assumes 30 metre wide 2-way haul route.
2. Water application during daytime.

The estimated total water usage required for the BSP is of similar magnitude to the existing water usage at Baralaba North coal mine, which was 703 ML for the July 2022 to June 2023 period.

6.5 Dust Control Measures

Emission controls proposed to be used to reduce particulate emissions included in the dispersion modelling are presented in **Table 6.2** and **Table 6.3**. The control efficiencies of these technologies are derived from Environment Australia (2012).

Table 6.2: Dust Emission Controls for the BSP

Emission Source	Control(s) Utilised	Control Efficiency Applied
Trucks loading and unloading overburden and coal	Watering	70%
Drilling	Water used in holes	70%
Vehicles on unpaved roads	Chemical suppressants and/or watering	85%
Loading to coal stockpiles	Water sprays on stacker	50%
Wind erosion	Rehabilitated areas	90%

In addition to **Table 6.2**, pit retention factors of 50% for TSP and 5% for PM_{10} were utilised for activities located within the pit. These factors are specified by Environment Australia (2012).

Table 6.3: Dust Emission Controls for the TLO

Emission Source	Control(s) Utilised	Control Efficiency Applied
Dozing coal	Water sprays on coal stockpile	50%
Trucks unloading coal	Water sprays at unloading hopper	70%
Loading stockpiles	Water sprays and variable height radial stacker	62.5% (50% for water spray and 25% for variable height stacker)
Unloading from stockpiles	Under-stockpile chute (reclaim tunnel)	99%
Conveyor transfer	Chute and water sprays	75%
Wind erosion	Water sprays on coal stockpile	50%
Trucks hauling	Roads paved	75%

Note:
A 75% control factor was applied to paved road emissions to account for the lesser dust emissions on paved roads. The emission factor for unpaved roads has been used as the emission factor for paved roads could substantially overestimate emissions (Utah DAQ, 2015). There is no readily and publicly available silt loading information for either coal mines or coal at the TLO. The control efficiency for paved roads has been estimated using the control efficiencies presented in Utah DAQ (2015) and using a silt content of 1%, assuming most of the particles on the road would be washed coal itself.

6.6 Summary of Emission Inventory

The scenario years chosen for the modelling were years 1, 3 and 11. As discussed in **Section 2.4**, these will predict the worst impacts at the receptors. The total emission inventory for all sources of each scenario is provided in **Table 6.4** to **Table 6.7.**

Table 6.4: Total Controlled Emission Rates for Year 1

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Loading trucks with overburden	6,626	5,955	949
Loading trucks with rejects	221	105	16
Loading trucks with ROM coal	14,386	3,494	547
Loading trucks with product coal	72,623	9,283	1,380
Dozing on overburden in pit	14,805	4,995	3,109
Dozing on overburden in dump	74,024	13,146	7,772
Trucks unloading overburden	13,252	6,268	949
Trucks unloading rejects	41	19	3
Trucks unloading ROM coal	3,753	1,576	71
Drilling	7,275	3,822	579
Blasting	86,825	45,149	2,605
Trucks hauling (segment 1)	42,593	13,039	1,304
Trucks hauling (segment 2)	21,686	6,639	664

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Trucks hauling (segment 3)	182	56	6
Trucks hauling (segment 4)	63	19	4
Trucks hauling (segment 5)	5,050	1,546	309
Trucks hauling (segment 6)	8,517	2,607	521
Trucks hauling (segment 7)	8,252	2,526	505
Trucks hauling (segment 8)	5,441	1,666	333
Trucks hauling (segment 9)	8,591	2,630	526
Trucks hauling (segment 10)	451	138	28
Trucks hauling (segment 11)	960	294	59
Trucks hauling (segment 12)	74,360	22,763	2,276
Trucks hauling (segment 13)	40,760	12,477	1,248
Trucks hauling (segment 14)	570	174	17
Trucks hauling (segment 15)	3,880	1,188	119
Scraper in travel mode	64,283	8,839	1,993
Scraper removing topsoil	18,481	4,620	573
Scraper unloading topsoil	12,746	3,186	395
Grader (in pit)	1,069	908	66
Grader (out of pit)	6,415	2,869	199
Crushing, transfers to stockpiles	33,779	14,200	404
Unloading coal to stockpile (conveying transfer point)	213	101	4
Wind erosion	81,054	40,527	3,040
Total	**733,226**	**236,824**	**32,572**

Table 6.5: Total Controlled Emission Rates for Year 3

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Loading trucks with overburden	8,227	7,393	1,179
Loading trucks with rejects	403	191	29
Loading trucks with ROM coal	23,343	5,669	887
Loading trucks with product coal	112,665	14,401	2,141
Dozing on overburden in pit	44,414	7,887	4,663
Dozing on overburden in dump	103,633	18,404	10,881
Trucks unloading overburden	16,455	7,783	1,179
Trucks unloading rejects	75	35	5
Trucks unloading ROM coal	6,090	2,558	116
Drilling	9,021	4,740	718
Blasting	107,665	55,986	3,230
Trucks hauling (segment 1)	1,649	959	101
Trucks hauling (segment 2)	4,893	2,846	300

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Trucks hauling (segment 3)	8,418	4,896	515
Trucks hauling (segment 4)	34,162	19,870	2,092
Trucks hauling (segment 5)	42,030	12,866	1,287
Trucks hauling (segment 6)	805	468	49
Trucks hauling (segment 7)	815	474	50
Trucks hauling (segment 8)	64	37	4
Trucks hauling (segment 9)	21,797	6,673	667
Trucks hauling (segment 10)	309	95	9
Trucks hauling (segment 11)	2,582	1,502	158
Trucks hauling (segment 12)	632	193	19
Trucks hauling (segment 13)	5,544	1,697	170
Trucks hauling (segment 14)	73,250	22,424	2,242
Trucks hauling (segment 15)	43,081	13,188	1,319
Scraper in travel mode	64,283	8,839	1,993
Scraper removing topsoil	11,269	2,817	349
Scraper unloading topsoil	7,772	1,943	241
Grader (in pit)	1,069	908	66
Grader (out of pit)	6,415	2,869	199
Crushing, transfers to stockpiles	54,811	23,041	656
Unloading coal to stockpile (conveying transfer point)	331	156	6
Wind erosion	86,287	43,144	3,236
Total	**882,188**	**296,622**	**40,755**

Table 6.6: Total Controlled Emission Rates for Year 11

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Loading trucks with overburden	5,991	5,384	858
Loading trucks with rejects	425	201	30
Loading trucks with ROM coal	25,872	6,283	983
Loading trucks with product coal	127,451	16,291	2,422
Dozing on overburden in pit	22,207	7,493	4,663
Dozing on overburden in dump	88,828	15,775	9,327
Trucks unloading overburden	11,982	5,667	858
Trucks unloading rejects	79	37	6
Trucks unloading ROM coal	6,750	2,835	128
Drilling	6,547	3,440	521
Blasting	78,143	40,634	2,344
Trucks hauling (segment 1)	13,927	4,263	426
Trucks hauling (segment 2)	316	97	10

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Trucks hauling (segment 3)	11,882	3,637	727
Trucks hauling (segment 4)	6,208	1,900	380
Trucks hauling (segment 5)	4,175	1,278	256
Trucks hauling (segment 6)	884	271	54
Trucks hauling (segment 7)	36,343	11,125	2,225
Trucks hauling (segment 8)	4,693	1,436	144
Trucks hauling (segment 9)	838	257	26
Trucks hauling (segment 10)	1,474	451	45
Trucks hauling (segment 11)	2,520	772	154
Trucks hauling (segment 12)	1,021	312	31
Scraper in travel mode	64,283	8,839	1,993
Scraper removing topsoil	5,979	1,495	185
Scraper unloading topsoil	4,124	1,031	128
Grader (in pit)	1,069	908	66
Grader (out of pit)	4,276	1,913	133
Crushing, transfers to stockpiles	60,750	25,537	727
Unloading coal to stockpile (conveying transfer point)	374	177	7
Wind erosion	97,240	48,620	3,647
Total	**696,803**	**218,432**	**33,505**

Table 6.7: Total Controlled Emission Rates for the TLO Facility (maximum 2.5 Mtpa cumulative scenario)

Source	TSP (kg/y)	PM_{10} (kg/y)	$PM_{2.5}$ (kg/y)
Dozing coal	1,709	304	32
Trucks unloading coal	7,500	3,150	143
Trucks hauling	14,525	2,705	271
Loading stockpiles (stacker dropping coal onto stockpile)	3,750	1,594	116
Loading from stockpiles to conveyor (under-stockpile chutes)	750	325	14
Transfer to reclaim conveyor	144	68	3
Load out to train wagons	1,000	425	19
Train locomotives 1	113	113	113
Wind erosion	282	141	21
Total	**29,774**	**8,825**	**732**

Notes:

1. *Diesel locomotive emission rates derived from Connell Hatch (2009). It has been further assumed that the particulate emissions are in the $PM_{2.5}$ size fraction.*

6.7 Other Source Parameters

Other source parameters used in modelling are provided in **Table 6.8** to **Table 6.11**. The modelled source locations are presented in **Figure 6.1** to **Figure 6.77**.

Table 6.8: Other Source Parameters for Year 1 Scenario

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Loading trucks with overburden	LOADOB1	790429.4	7314043.7	4.7	8.8	9.5
	LOADOB2	790155.4	7313508.1	4.7	8.8	9.5
	LOADOB3	790906.0	7313419.9	4.7	8.8	9.5
Loading trucks with rejects	LOADREJ1	792589.0	7312533.0	4.7	8.8	9.5
Loading trucks with ROM coal	LOADROM1	790484.4	7314027.4	4.7	8.8	9.5
	LOADROM2	790945.0	7313561.0	4.7	8.8	9.5
Loading trucks with product coal	LOADPCI1	792720.2	7312320.4	4.7	8.8	9.5
Dozing on overburden in pit	DOZER1	790355.3	7314023.9	23.3	4.7	2.5
	DOZER2	790091.6	7313483.1	23.3	4.7	2.5
Dozing on overburden in dump	DOZER3	789749.0	7315313.0	23.3	4.7	2.5
	DOZER4	790749.6	7316364.4	23.3	4.7	2.5
	DOZER5	790290.0	7316333.0	23.3	4.7	2.5
	DOZER6	790435.3	7315931.9	23.3	4.7	2.5
	DOZER7	790882.1	7313961.6	23.3	4.7	2.5
Trucks unloading overburden	DUMPOB1	790426.2	7316425.2	7.0	7.0	6.0
Trucks unloading rejects	DUMPREJ1	790636.3	7316420.2	7.0	7.0	6.0
Trucks unloading ROM coal	DUMPROM1	792509.0	7312674.0	4.7	7.0	6.0
Drilling	DRIL1	790382.5	7314200.5	2.3	4.7	2.5
	DRIL2	790277.8	7313885.4	2.3	4.7	2.5
	DRIL3	790036.0	7313280.1	2.3	4.7	2.5
	DRIL4	791012.0	7313383.0	2.3	4.7	2.5
Blasting	BLAST1	790388.6	7314179.3	46.5	46.5	50.0
	BLAST2	790300.7	7313884.4	46.5	46.5	50.0
	BLAST3	790038.5	7313302.3	46.5	46.5	50.0
	BLAST4	791030.0	7313418.0	46.5	46.5	50.0

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Trucks hauling	ROAD1 to ROAD15	Various	Various	60.8	5.9	6.3
Grader (in pit)	GRAD1	790571.0	7313489.0	23.3	4.7	2.0
Grader (out of pit)	GRAD2	790301.3	7316162.7	23.3	4.7	2.0
	GRAD3	790249.0	7314975.8	23.3	4.7	2.0
	GRAD4	790753.3	7314050.8	23.3	4.7	2.0
Crushing, transfers to stockpiles	CRUSH1	792640.5	7312585.5	23.3	4.7	3.0
Unloading coal to stockpile (conveying transfer point)	DUMPPCI1	792797.7	7312392.1	2.3	4.7	2.5
	DUMPPCI2	792866.3	7312412.0	2.3	4.7	2.5
Scraper in travel mode	ROADSCRP	Various	Various	87.4	3.7	4.0
Scraper removing topsoil	SCRAPER1	790174.4	7313405.3	11.6	4.7	2.0
Scraper unloading topsoil	DUMPTOP1	789832.0	7315443.0	11.6	4.7	2.0
Wind erosion (ROM & product stockpile)	WINDROM	Various	Various	-	2.0	5.0
	WINDPCI				2.0	5.0
Wind erosion (exposed coal in pit)	WINDCOAL				1.0	0
Wind erosion (overburden, topsoil dumps and pit & rehabilitated areas)	WINDPIT				1.0	0
	WINDDUMP				1.0	1.0

Table 6.9: Other Source Parameters for Year 3 Scenario

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Loading trucks with overburden	LOADOB1	790786.4	7313212.8	4.7	8.8	9.5
	LOADOB2	790567.6	7312988.8	4.7	8.8	9.5
	LOADOB3	790271.6	7312679.9	4.7	8.8	9.5

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Loading trucks with rejects	LOADREJ1	792589.0	7312533.0	4.7	8.8	9.5
Loading trucks with ROM coal	LOADROM1	790799.2	7313316.6	4.7	8.8	9.5
	LOADROM2	790281.5	7312789.4	4.7	8.8	9.5
Loading trucks with product coal	LOADPCI1	792720.2	7312320.4	4.7	8.8	9.5
Dozing on overburden in pit	DOZER1	790881.1	7313261.2	23.3	4.7	2.5
	DOZER2	790643.4	7312908.6	23.3	4.7	2.5
	DOZER7	790348.5	7312616.3	23.3	4.7	2.5
Dozing on overburden in dump	DOZER3	790571.7	7315236.9	23.3	4.7	2.5
	DOZER4	790941.1	7315170.0	23.3	4.7	2.5
	DOZER5	789734.0	7315274.0	23.3	4.7	2.5
	DOZER6	790217.8	7314779.7	23.3	4.7	2.5
	DOZER8	790197.4	7313368.6	23.3	4.7	2.5
	DOZER9	790343.5	7314089.7	23.3	4.7	2.5
	DOZER10	790902.0	7313872.4	23.3	4.7	2.5
Trucks unloading overburden	DUMPOB1	790659.9	7315295.6	7.0	7.0	6.0
Trucks unloading rejects	DUMPREJ1	790980.4	7315268.0	7.0	7.0	6.0
Trucks unloading ROM coal	DUMPROM1	792503.0	7312675.0	4.7	7.0	6.0
Drilling	DRIL1	791294.5	7313220.3	2.3	4.7	2.5
	DRIL2	790982.2	7312947.3	2.3	4.7	2.5
	DRIL3	790620.2	7312608.3	2.3	4.7	2.5
	DRIL4	790360.2	7312332.5	2.3	4.7	2.5
Blasting	BLAST1	791216.3	7313283.4	46.5	46.5	50.0
	BLAST2	790917.4	7313008.0	46.5	46.5	50.0
	BLAST3	790600.0	7312692.1	46.5	46.5	50.0
	BLAST4	790340.5	7312414.0	46.5	46.5	50.0
Trucks hauling	ROAD1 to ROAD15	Various	Various	60.8	5.9	6.3
Grader (in pit)	GRAD1	790996.0	7313184.0	23.3	4.7	2.0
Grader (out of pit)	GRAD2	790531.8	7314981.2	23.3	4.7	2.0
	GRAD3	790511.9	7314287.7	23.3	4.7	2.0
	GRAD4	790707.9	7313765.1	23.3	4.7	2.0

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Crushing, transfers to stockpiles	CRUSH1	792640.5	7312585.5	23.3	4.7	3.0
Unloading coal to stockpile (conveying transfer point)	DUMPPCI1	792797.7	7312392.1	2.3	4.7	2.5
	DUMPPCI2	792866.3	7312412.0	2.3	4.7	2.5
Scraper in travel mode	ROADSCRP	Various	Various	87.4	3.7	4.0
Scraper removing topsoil	SCRAPER1	790852.4	7312753.9	11.6	4.7	2.0
Scraper unloading topsoil	DUMPTOP1	789781.0	7315352.0	11.6	4.7	2.0
Wind erosion (ROM & product stockpile)	WINDROM	Various	Various	-	2.0	5.0
	WINDPCI				2.0	5.0
Wind erosion (exposed coal in pit)	WINDCOAL				1.0	0
Wind erosion (overburden, topsoil dumps and pit & rehabilitated areas)	WINDPIT				1.0	0
	WINDDUMP				1.0	1.0

Table 6.10: Other Source Parameters for Year 11 Scenario

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Loading trucks with overburden	LOADOB1	791127.0	7312413.0	4.7	8.8	9.5
	LOADOB2	791787.3	7312023.8	4.7	8.8	9.5
	LOADOB3	791451.0	7311793.0	4.7	8.8	9.5
Loading trucks with rejects	LOADREJ1	792589.0	7312533.0	4.7	8.8	9.5
Loading trucks with ROM coal	LOADROM1	791219.0	7312368.0	4.7	8.8	9.5

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Loading trucks with product coal	LOADPCI1	792720.2	7312320.4	4.7	8.8	9.5
Dozing on overburden in pit	DOZER1	791173.0	7312498.0	23.3	4.7	2.5
	DOZER2	791902.0	7312085.0	23.3	4.7	2.5
	DOZER7	791433.0	7311666.0	23.3	4.7	2.5
Dozing on overburden in dump	DOZER3	790347.9	7312438.5	23.3	4.7	2.5
	DOZER4	791940.8	7313691.7	23.3	4.7	2.5
	DOZER5	789978.0	7312585.0	23.3	4.7	2.5
	DOZER6	791576.4	7314169.8	23.3	4.7	2.5
	DOZER8	790197.4	7313368.6	23.3	4.7	2.5
	DOZER9	791884.3	7312989.8	23.3	4.7	2.5
Trucks unloading overburden	DUMPOB1	790254.7	7312539.8	7.0	7.0	6.0
Trucks unloading rejects	DUMPREJ1	791895.2	7313820.6	7.0	7.0	6.0
Trucks unloading ROM coal	DUMPROM1	792507.0	7312673.0	4.7	7.0	6.0
Drilling	DRIL1	790990.0	7312375.0	2.3	4.7	2.5
	DRIL2	791482.0	7312178.0	2.3	4.7	2.5
	DRIL3	792011.0	7312148.0	2.3	4.7	2.5
	DRIL4	791609.0	7311776.0	2.3	4.7	2.5
Blasting	BLAST1	790986.0	7312422.0	46.5	46.5	50.0
	BLAST2	791503.0	7312226.0	46.5	46.5	50.0
	BLAST3	792063.0	7312184.0	46.5	46.5	50.0
	BLAST4	791607.0	7311727.0	46.5	46.5	50.0
Trucks hauling	ROAD1 to ROAD12	Various	Various	60.8	5.9	6.3
Grader (in pit)	GRAD1	790905.6	7311855.7	23.3	4.7	2.0
Grader (out of pit)	GRAD2	790635.0	7312691.0	23.3	4.7	2.0
	GRAD3	791708.4	7313253.3	23.3	4.7	2.0
Crushing, transfers to stockpiles	CRUSH1	792640.5	7312585.5	23.3	4.7	3.0
Unloading coal to stockpile (conveying transfer point)	DUMPPCI1	792797.7	7312392.1	2.3	4.7	2.5
	DUMPPCI2	792866.3	7312412.0	2.3	4.7	2.5

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Scraper in travel mode	ROADSCRP	Various	Various	87.4	3.7	4.0
Scraper removing topsoil	SCRAPER1	792052.8	7311789.0	11.6	4.7	2.0
Scraper unloading topsoil	DUMPTOP1	789992.0	7312665.0	11.6	4.7	2.0
Wind erosion (ROM & product stockpile)	WINDROM	Various	Various	-	2.0	5.0
	WINDPCI				2.0	5.0
Wind erosion (exposed coal in pit)	WINDCOAL				1.0	0
Wind erosion (overburden, topsoil dumps and pit & rehabilitated areas)	WINDPIT				1.0	0
	WINDDUMP				1.0	1.0
	WINDRH				1.0	1.0

Table 6.11: Other Source Parameters for the TLO Facility (maximum 2.5 Mtpa cumulative scenario)

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Dozing coal	DOZER1	196528	7281759	9.2	5.0	2.5
Trucks unloading coal	DUMPCOAL	196700	7281748	12.0	12.0	6.0
Trucks hauling	ROAD1 to ROAD10	Various	Various	9.3	1.4	3.0
Loading stockpiles	UNLOAD1	196636	7281754	6.0	6.8	3.5
Loading from stockpiles to conveyor	LOADCON1 and LOADCON2	196636 196635	7281754 7281751	6.0	6.8	3.5
Transfer to reclaim conveyor	CONVEY1	196674	7281725	6.0	6.0	3.0
Load out to train wagons	LOADRAIL	196467	7281593	6.0	6.0	3.0

Source	Source ID	Easting (m) WGS84	Northing (m) WGS84	Horizontal spread (m)	Vertical spread (m)	Effective Height (m)
Train locomotives	TRAIN1 TO TRAIN10	Various	Various	4.0	8.0	4.0
Wind erosion	STOCK	Various	Various	-	2.0	3.0

Figure 6.1: Year 1 Modelled Source Locations (Pit, ROM, Product)

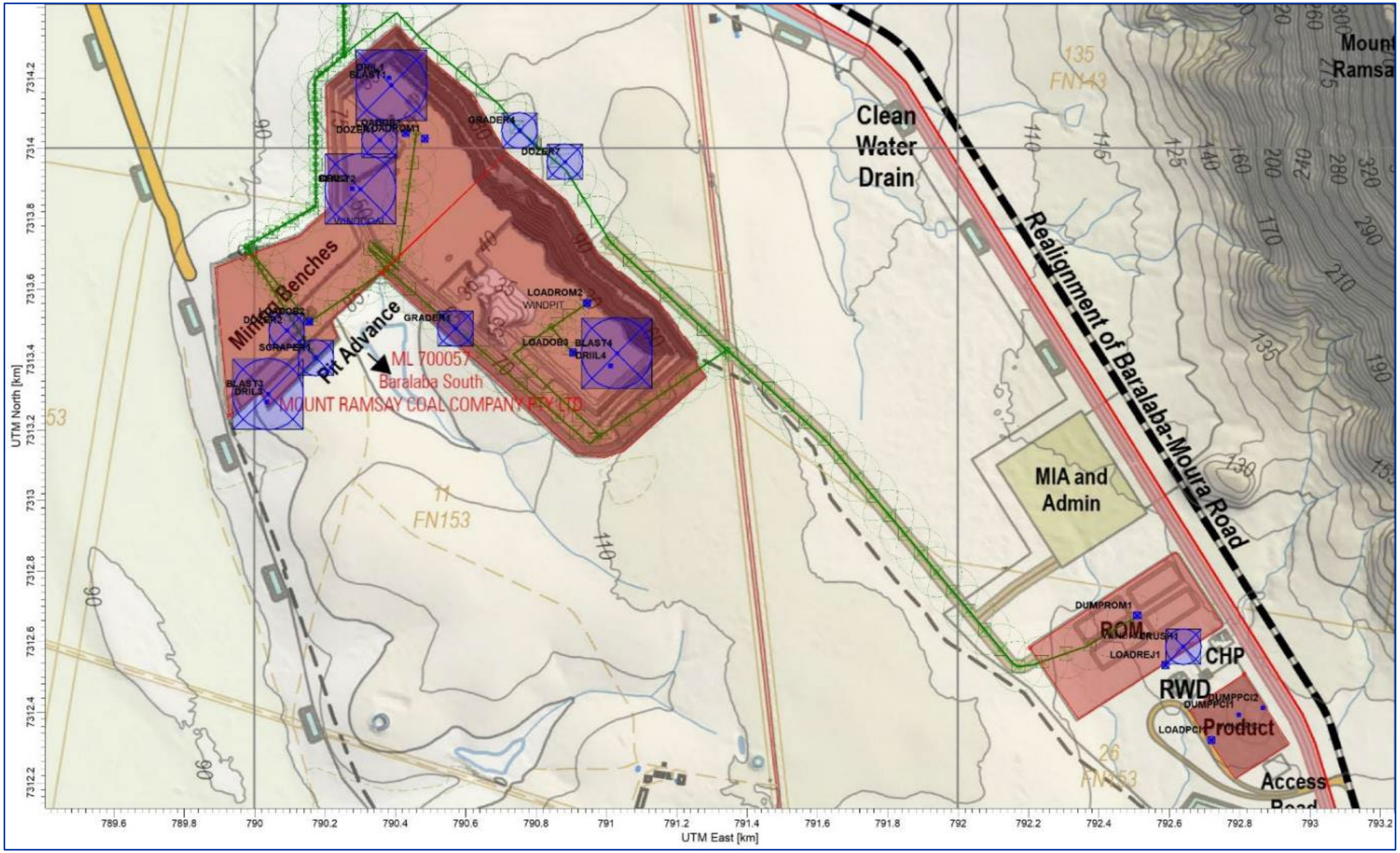


Figure 6.2: Year 1 Modelled Source Locations (Dump)

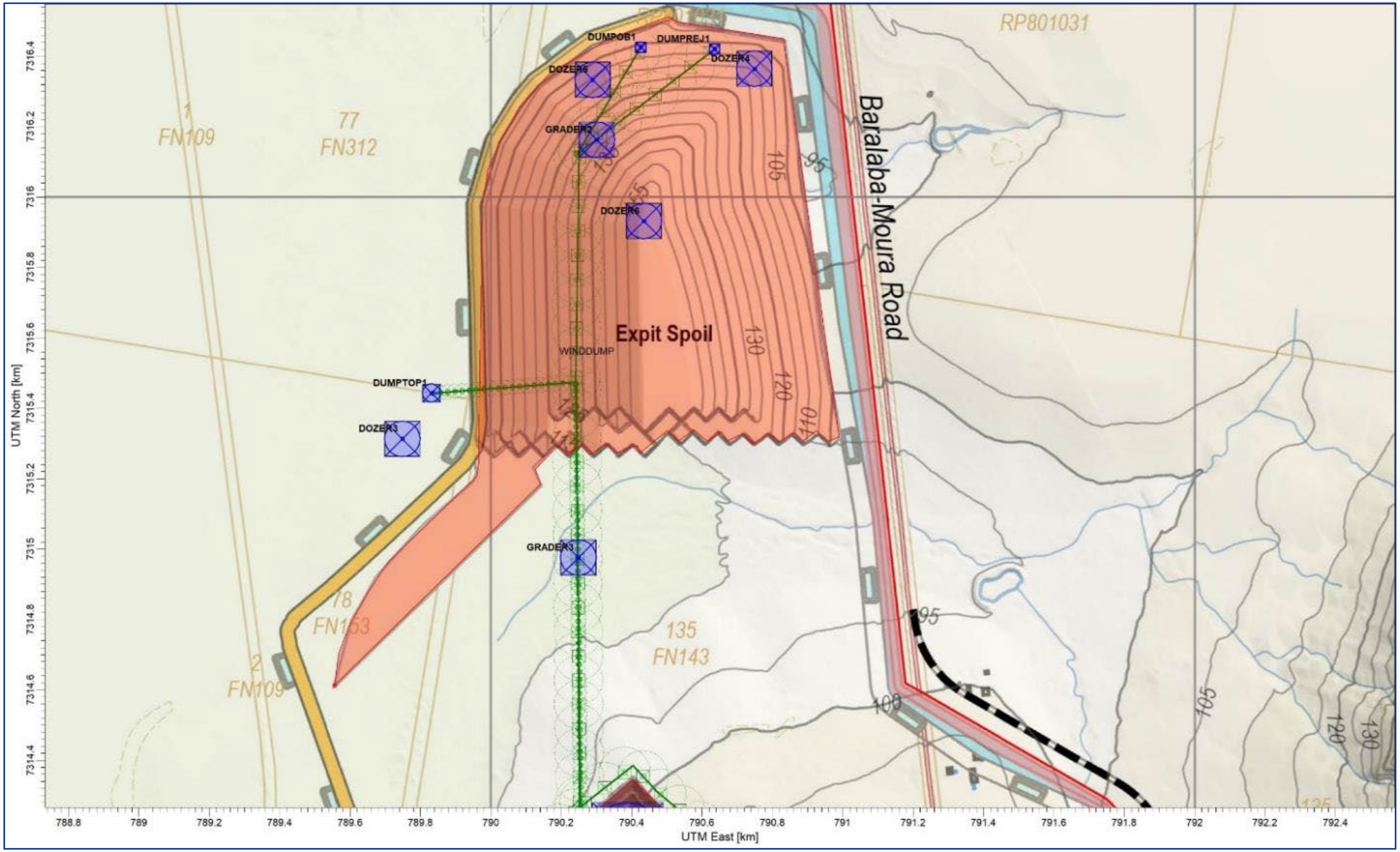


Figure 6.3: Year 3 Modelled Source Locations (Pit, ROM, Product)

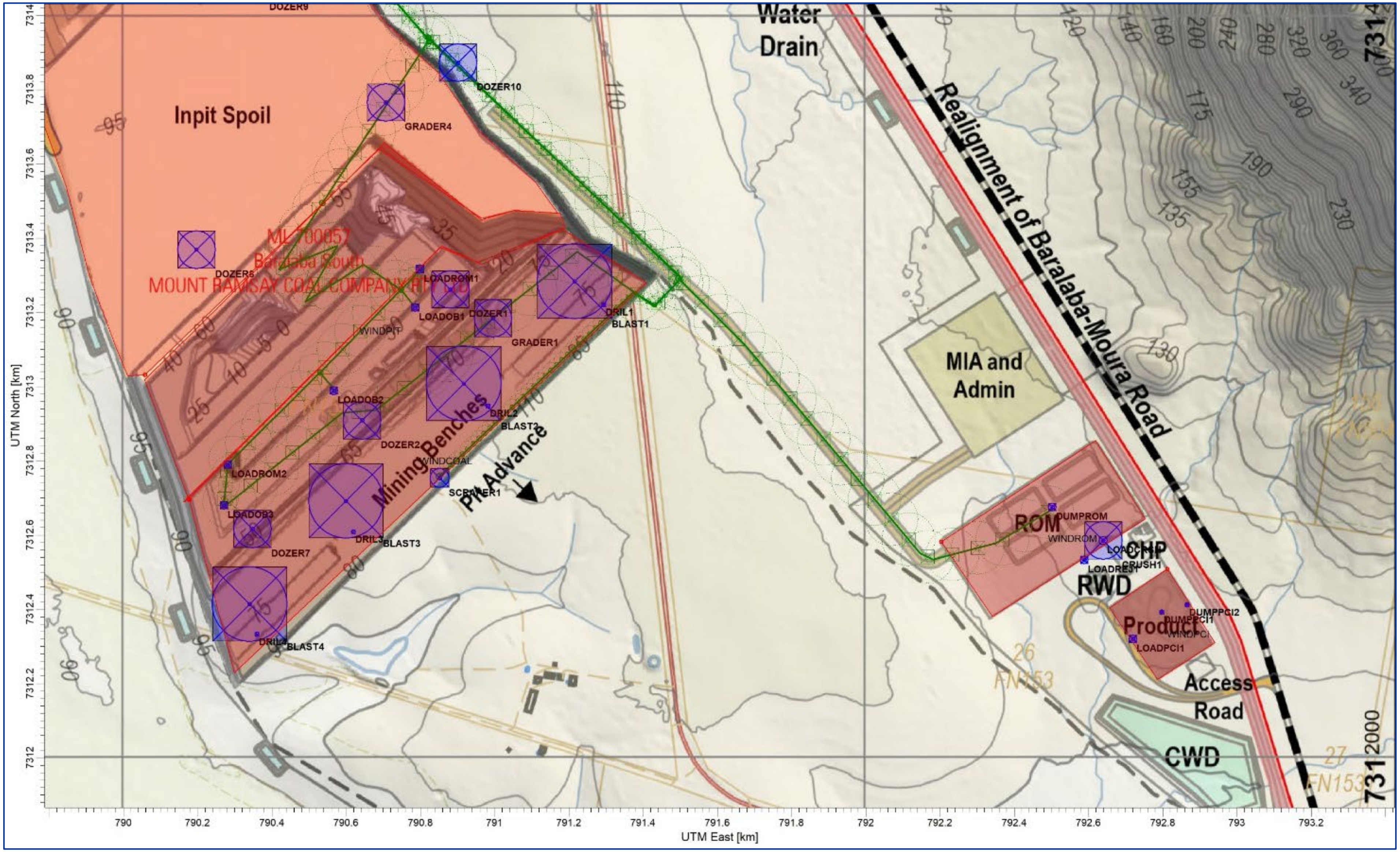


Figure 6.4: Year 3 Modelled Source Locations (Dump)

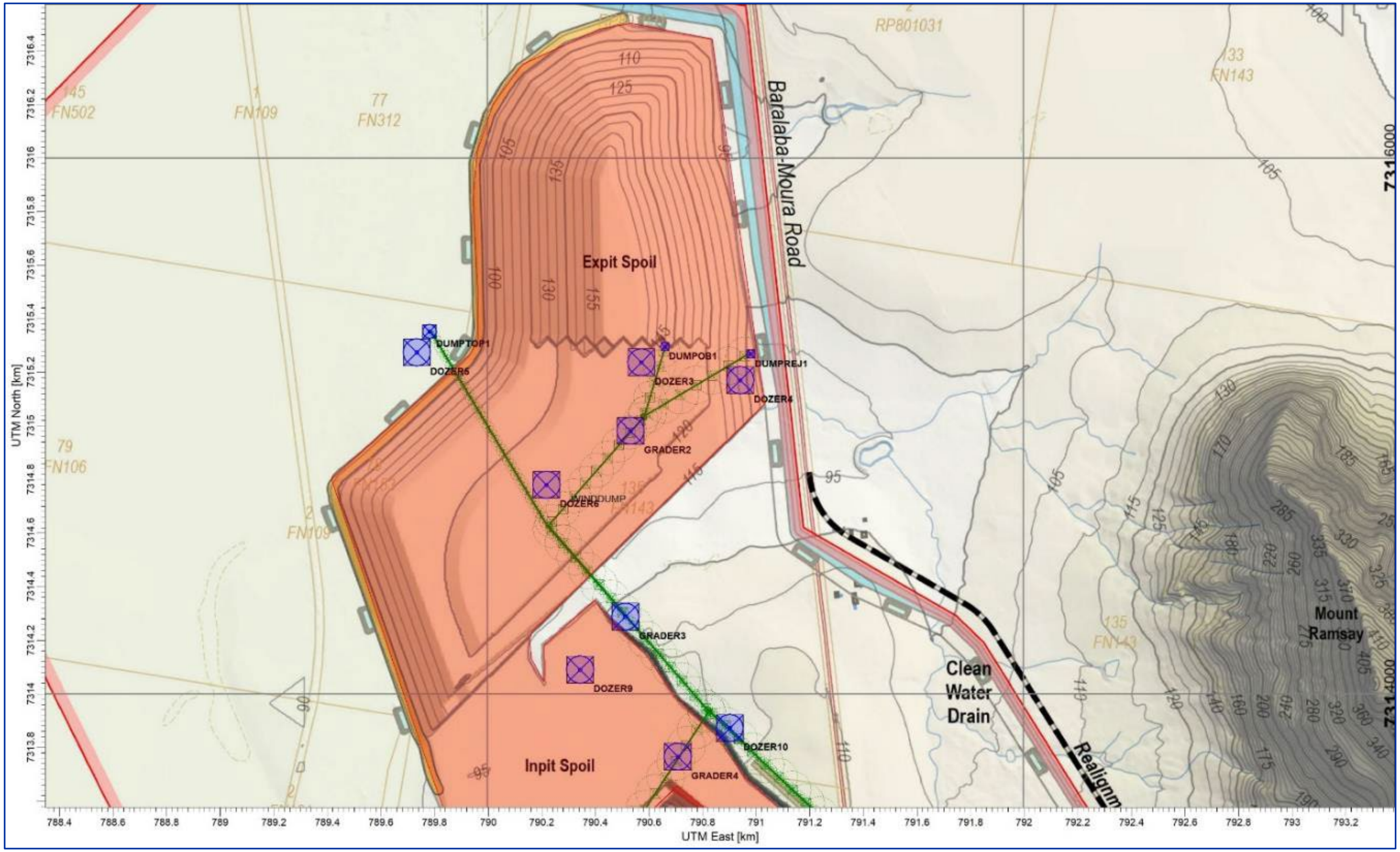


Figure 6.5: Year 11 Modelled Source Locations (Pit, ROM, Product)

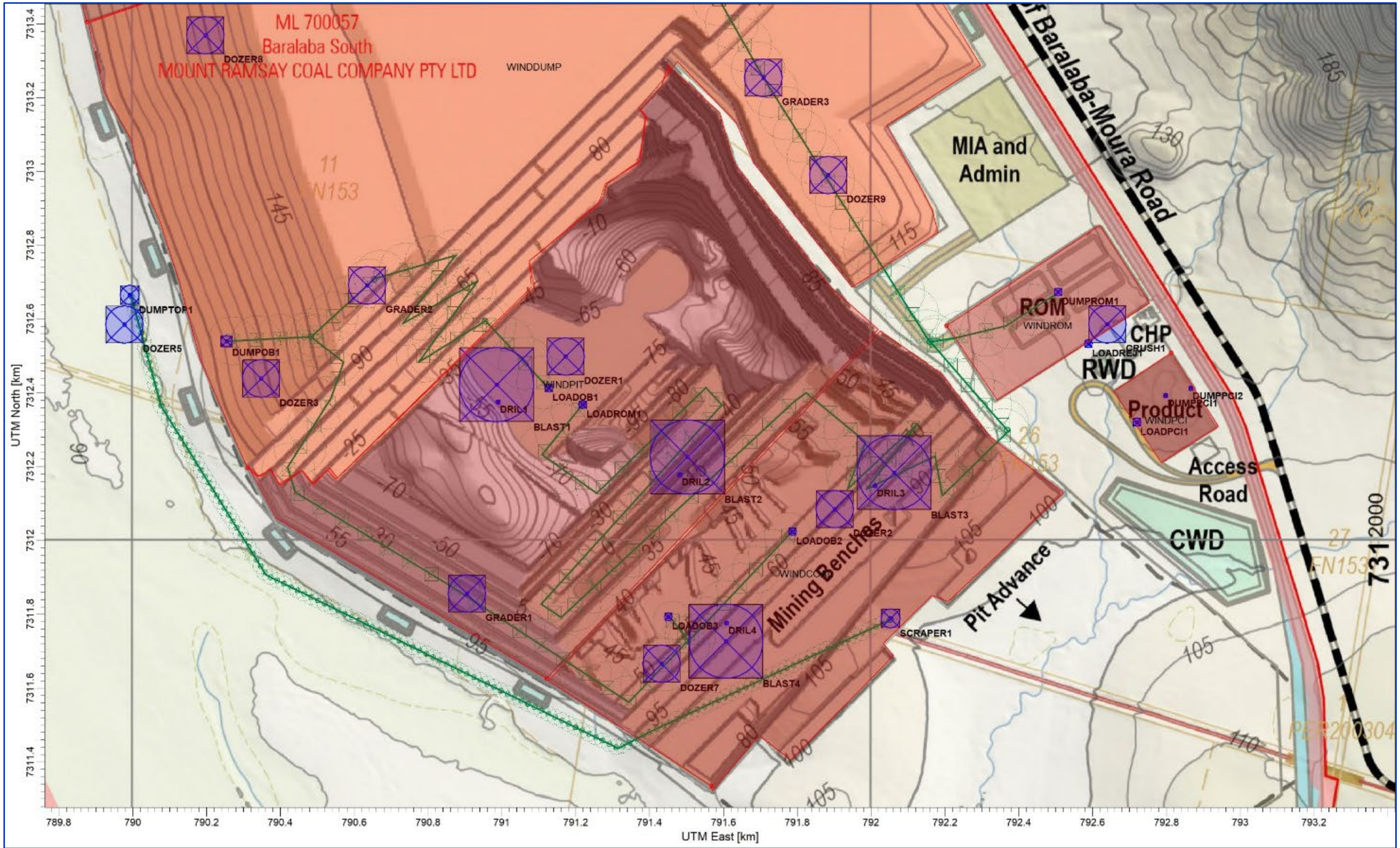


Figure 6.6: Year 11 Modelled Source Locations (Dump)

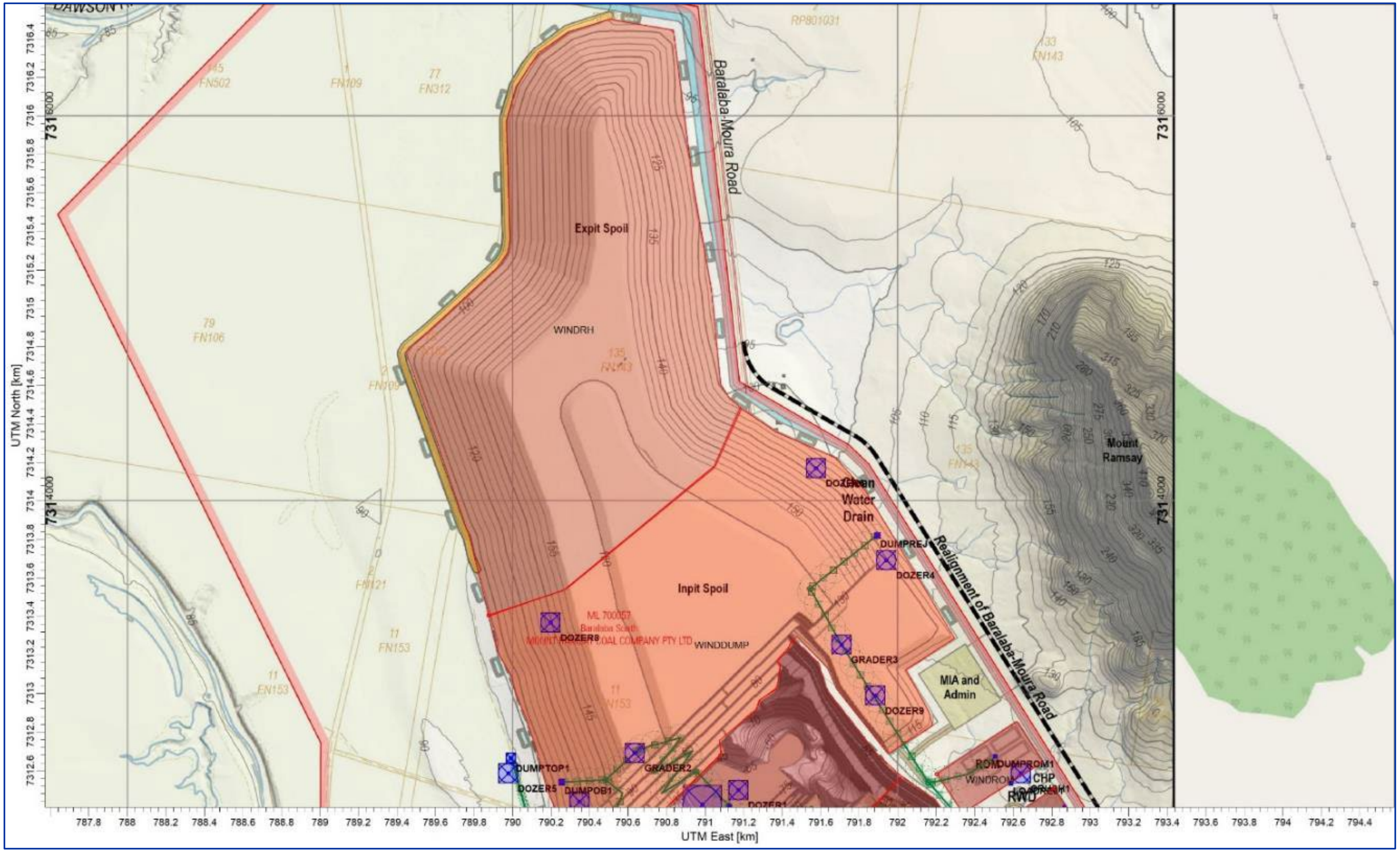
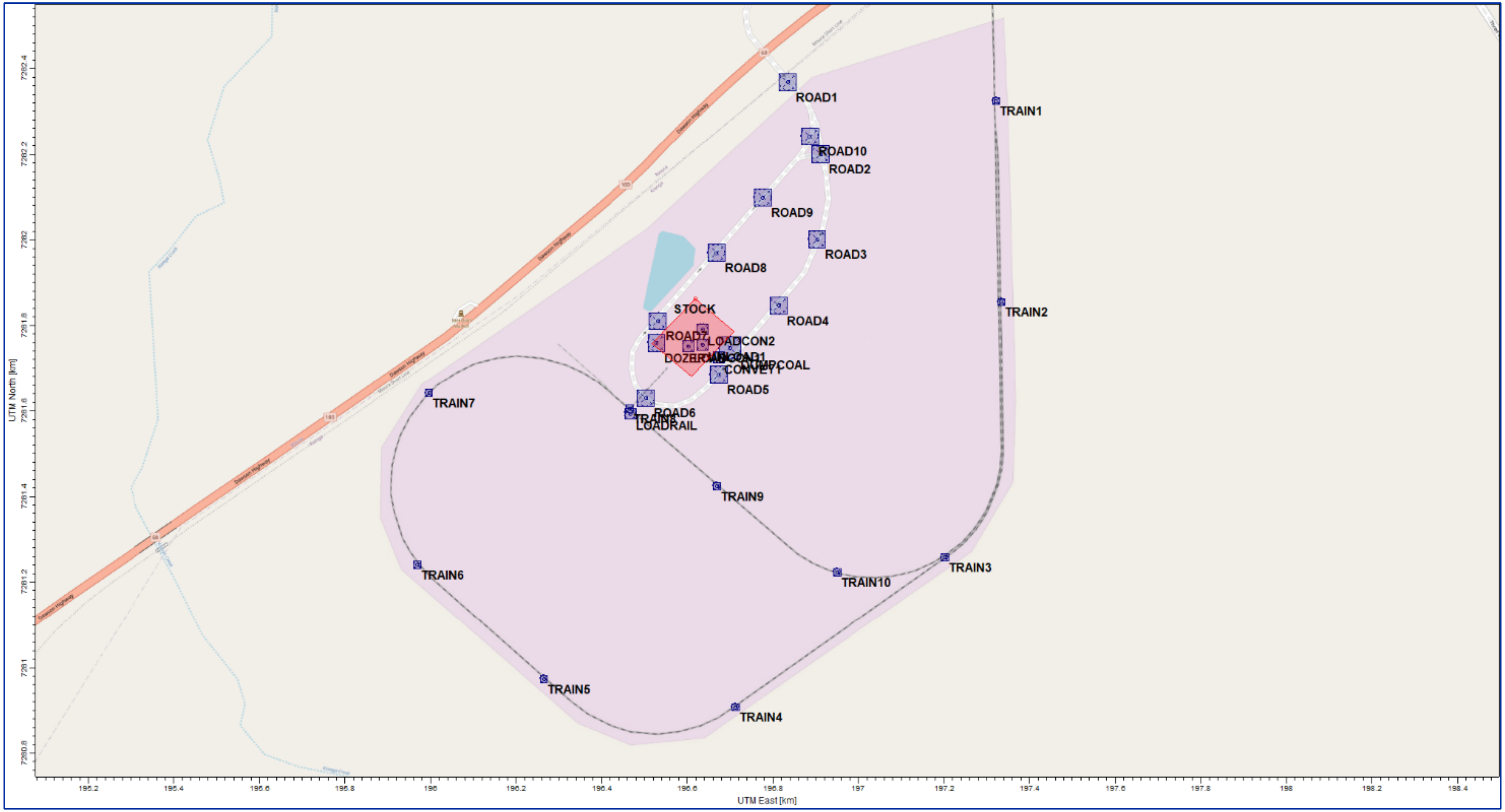


Figure 6.7: TLO Modelled Source Locations



7. DISPERSION MODELLING RESULTS

7.1 Limitations

The uncertainties associated with this type of assessment are normally only dealt with in a qualitative manner, but include:

- emission estimation techniques
- meteorological data variability
- inherent uncertainty in dispersion modelling.

In this case, the uncertainty is mostly due to assumptions regarding the applicability of emission factors. This has been addressed by conservative assumptions that will over-predict the ambient concentrations.

7.2 BSP Model Results

7.2.1 Suspended Particulates Results

The predicted concentrations at receptors are shown in **Table 7.1** to **Table 7.5** along with the criterion. The estimated background levels are listed separately. The tables show both the incremental impacts and the cumulative impacts. Incremental impacts are those due to the activities of the BSP only, and cumulative impacts include the background concentrations.

Exceedances are predicted at some of the receptors located within the mining lease boundary for the assessed size fractions. Receptors 1, 2, 3 and 14 are within the mining lease boundary. Conversely, at sensitive receptors locations outside the mining lease boundary exceedances are not predicted to occur for any of the assessed size fractions (TSP, PM_{10} and $PM_{2.5}$).

Concentration plots for PM_{10} 24-hour and annual averages are presented in **Figure 7.1** to **Figure 7.6**.

Concentrations provided in tabular form are a prediction at a point in space and hence more accurate than the contours, which are graphical interpolations.

Table 7.1: Predicted Annual Average TSP (μg/m^3) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**90**					
Background	**40**					
	Incremental			**Cumulative**		
1 [1]	2.3	4.2	152.5	42.3	44.2	192.5
2 [1]	2.8	5.0	55.9	42.8	45.0	95.9
3 [2]	0.8	1.1	1.4	40.8	41.1	41.4
4	0.5	0.7	0.8	40.5	40.7	40.8
5	0.8	0.7	0.3	40.8	40.7	40.3
6	0.8	0.8	0.4	40.8	40.8	40.4
7	0.5	0.5	0.3	40.5	40.5	40.3
8	0.5	0.5	0.3	40.5	40.5	40.3
9 [2]	2.9	2.5	0.6	42.9	42.5	40.6
10	0.2	0.2	0.2	40.2	40.2	40.2
11	1.3	1.1	0.4	41.3	41.1	40.4
12	0.7	0.7	0.3	40.7	40.7	40.3
13	0.1	0.2	0.1	40.1	40.2	40.1
14 [2]	1.9	3.4	7.0	41.9	43.4	47.0
15	0.7	0.8	0.5	40.7	40.8	40.5
16	1.6	2.1	1.7	41.6	42.1	41.7
17	0.0	0.0	0.0	40.0	40.0	40.0
18	0.0	0.0	0.0	40.0	40.0	40.0
19	0.8	0.8	0.4	40.8	40.8	40.4
20	1.1	1.8	1.9	41.1	41.8	41.9
21	0.7	0.9	0.7	40.7	40.9	40.7

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Table 7.2: Predicted Maximum 24-Hour Average PM_{10} ($\mu g/m^3$) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**50**					
Background	**17**					
	Incremental			**Cumulative**		
1 [1]	26.9	28.8	637.0	43.9	45.8	654.0
2 [1]	41.4	42.5	154.2	58.4	59.5	171.2
3 [2]	14.7	15.7	20.4	31.7	32.7	37.4
4	6.5	7.4	8.7	23.5	24.4	25.7
5	8.4	9.6	4.2	25.4	26.6	21.2
6	6.6	8.2	4.6	23.6	25.2	21.6
7	4.1	4.2	3.7	21.1	21.2	20.7
8	4.8	5.6	3.9	21.8	22.6	20.9
9 [2]	30.5	32.0	9.3	47.5	49.0	26.3
10	4.2	3.8	2.8	21.2	20.8	19.8
11	16.4	14.9	6.6	33.4	31.9	23.6
12	9.2	9.8	5.2	26.2	26.8	22.2
13	3.3	3.3	3.5	20.3	20.3	20.5
14 [2]	26.6	43.8	16.6	43.6	60.8	33.6
15	3.7	4.9	5.4	20.7	21.9	22.4
16	9.6	13.3	21.1	26.6	30.3	38.1
17	0.7	0.9	0.9	17.7	17.9	17.9
18	0.8	0.9	0.8	17.8	17.9	17.8
19	4.8	6.8	3.5	21.8	23.8	20.5
20	9.6	10.7	15.2	26.6	27.7	32.2
21	6.1	6.7	8.9	23.1	23.7	25.9

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Table 7.3: Predicted Annual Average PM_{10} (µg/m³) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**25**					
Background	**15.6**					
	Incremental			**Cumulative**		
1 [1]	1.8	3.3	74.6	17.4	18.9	90.2
2 [1]	2.3	4.0	25.0	17.9	19.6	40.6
3 [2]	0.6	0.8	1.0	16.2	16.4	16.6
4	0.4	0.6	0.8	16.0	16.2	16.4
5	0.7	0.7	0.3	16.3	16.3	15.9
6	0.8	0.8	0.4	16.4	16.4	16.0
7	0.5	0.5	0.2	16.1	16.1	15.8
8	0.5	0.5	0.3	16.1	16.1	15.9
9 [2]	2.6	2.3	0.6	18.2	17.9	16.2
10	0.1	0.2	0.1	15.7	15.8	15.7
11	1.3	1.1	0.4	16.9	16.7	16.0
12	0.7	0.6	0.2	16.3	16.2	15.8
13	0.1	0.1	0.1	15.7	15.7	15.7
14 [2]	1.6	2.8	4.1	17.2	18.4	19.7
15	0.6	0.8	0.5	16.2	16.4	16.1
16	1.5	2.0	1.5	17.1	17.6	17.1
17	0.0	0.0	0.0	15.6	15.6	15.6
18	0.0	0.0	0.0	15.6	15.6	15.6
19	0.7	0.8	0.3	16.3	16.4	15.9
20	1.0	1.7	1.7	16.6	17.3	17.3
21	0.7	0.9	0.7	16.3	16.5	16.3

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Table 7.4: Predicted Maximum 24-Hour Average $PM_{2.5}$ (µg/m³) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**25**					
Background	**5.8**					
	Incremental			**Cumulative**		
1 [1]	4.3	7.3	78.9	10.1	13.1	84.7
2 [1]	4.0	12.0	51.6	9.8	17.8	57.4
3 [2]	1.3	3.4	8.8	7.1	9.2	14.6
4	0.9	1.6	1.2	6.7	7.4	7.0
5	1.9	2.1	1.0	7.7	7.9	6.8
6	1.3	1.5	1.1	7.1	7.3	6.9
7	0.7	1.0	0.8	6.5	6.8	6.6
8	0.9	1.0	0.9	6.7	6.8	6.7
9 [2]	7.2	6.3	1.8	13.0	12.1	7.6
10	1.2	0.8	0.7	7.0	6.6	6.5
11	3.6	3.0	1.4	9.4	8.8	7.2
12	2.0	2.0	1.0	7.8	7.8	6.8
13	0.9	1.1	0.7	6.7	6.9	6.5
14 [2]	22.3	10.5	8.7	28.1	16.3	14.5
15	0.9	1.2	1.3	6.7	7.0	7.1
16	2.0	3.5	2.4	7.8	9.3	8.2
17	0.3	0.3	0.3	6.1	6.1	6.1
18	0.3	0.2	0.2	6.1	6.0	6.0
19	1.1	1.3	0.9	6.9	7.1	6.7
20	1.5	2.6	2.5	7.3	8.4	8.3
21	1.6	2.2	1.0	7.4	8.0	6.8

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Table 7.5: Predicted Annual Average $PM_{2.5}$ ($\mu g/m^3$) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**8**					
Background	**5.5**					
	Incremental			**Cumulative**		
1 [1]	0.2	0.6	9.3	5.7	6.1	14.8
2 [1]	0.3	0.7	5.2	5.8	6.2	10.7
3 [2]	0.1	0.1	0.2	5.6	5.6	5.7
4	0.1	0.1	0.1	5.6	5.6	5.6
5	0.2	0.2	0.1	5.7	5.7	5.6
6	0.2	0.2	0.1	5.7	5.7	5.6
7	0.1	0.1	0.1	5.6	5.6	5.6
8	0.1	0.1	0.1	5.6	5.6	5.6
9 [2]	0.7	0.5	0.2	6.2	6.0	5.7
10	0.0	0.0	0.0	5.5	5.5	5.5
11	0.3	0.2	0.1	5.8	5.7	5.6
12	0.2	0.1	0.1	5.7	5.6	5.6
13	0.0	0.0	0.0	5.5	5.5	5.5
14 [2]	0.4	0.5	2.1	5.9	6.0	7.6
15	0.1	0.2	0.1	5.6	5.7	5.6
16	0.3	0.4	0.3	5.8	5.9	5.8
17	0.0	0.0	0.0	5.5	5.5	5.5
18	0.0	0.0	0.0	5.5	5.5	5.5
19	0.2	0.2	0.1	5.7	5.7	5.6
20	0.2	0.3	0.3	5.7	5.8	5.8
21	0.1	0.2	0.1	5.6	5.7	5.6

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Figure 7.1: Predicted Maximum 24-Hour PM_{10} Concentrations (µg/m^3) Including Background – Year 1 Scenario

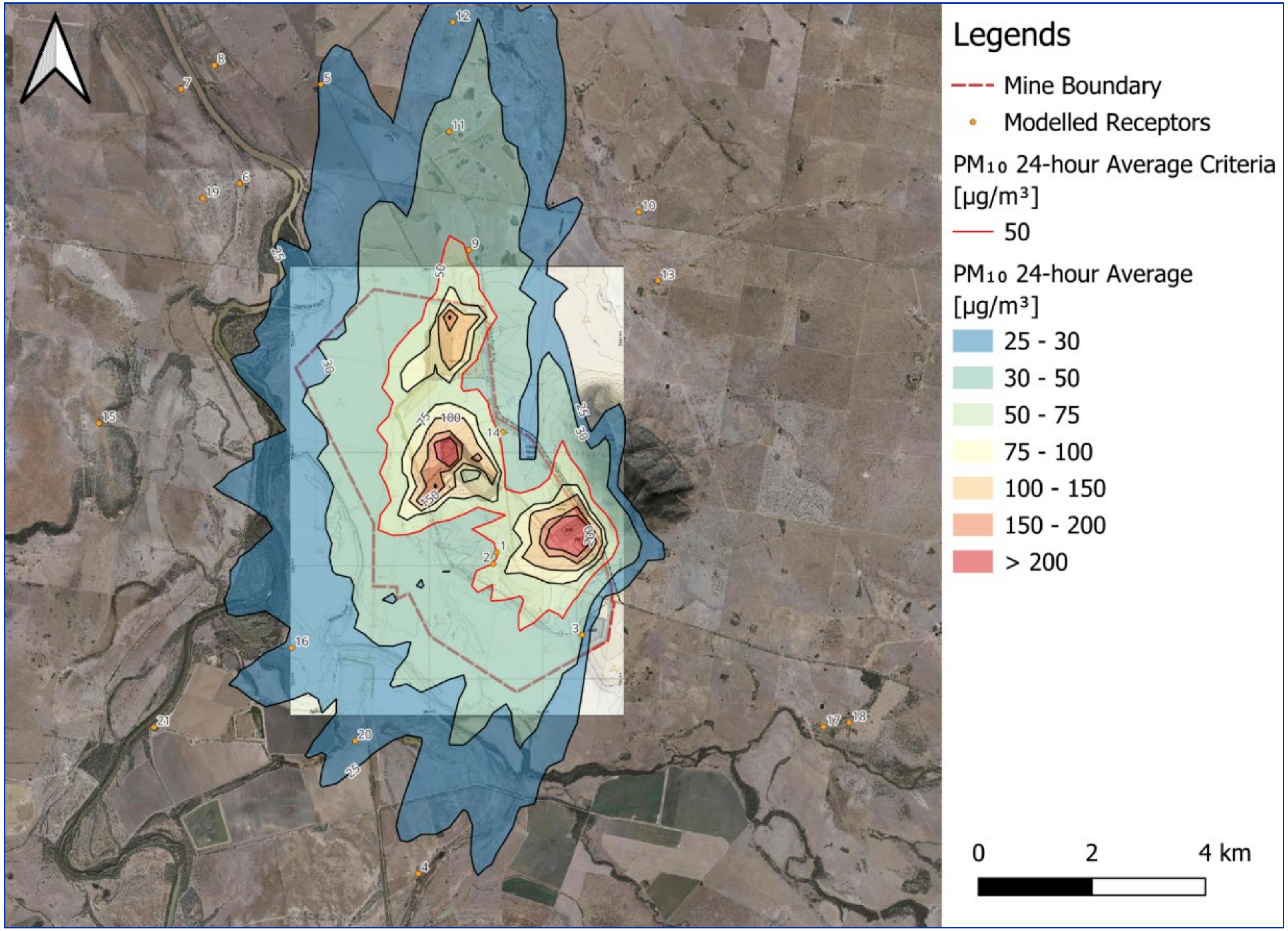


Figure 7.2: Predicted Maximum 24-Hour PM_{10} Concentrations (µg/m³) Including Background – Year 3 Scenario

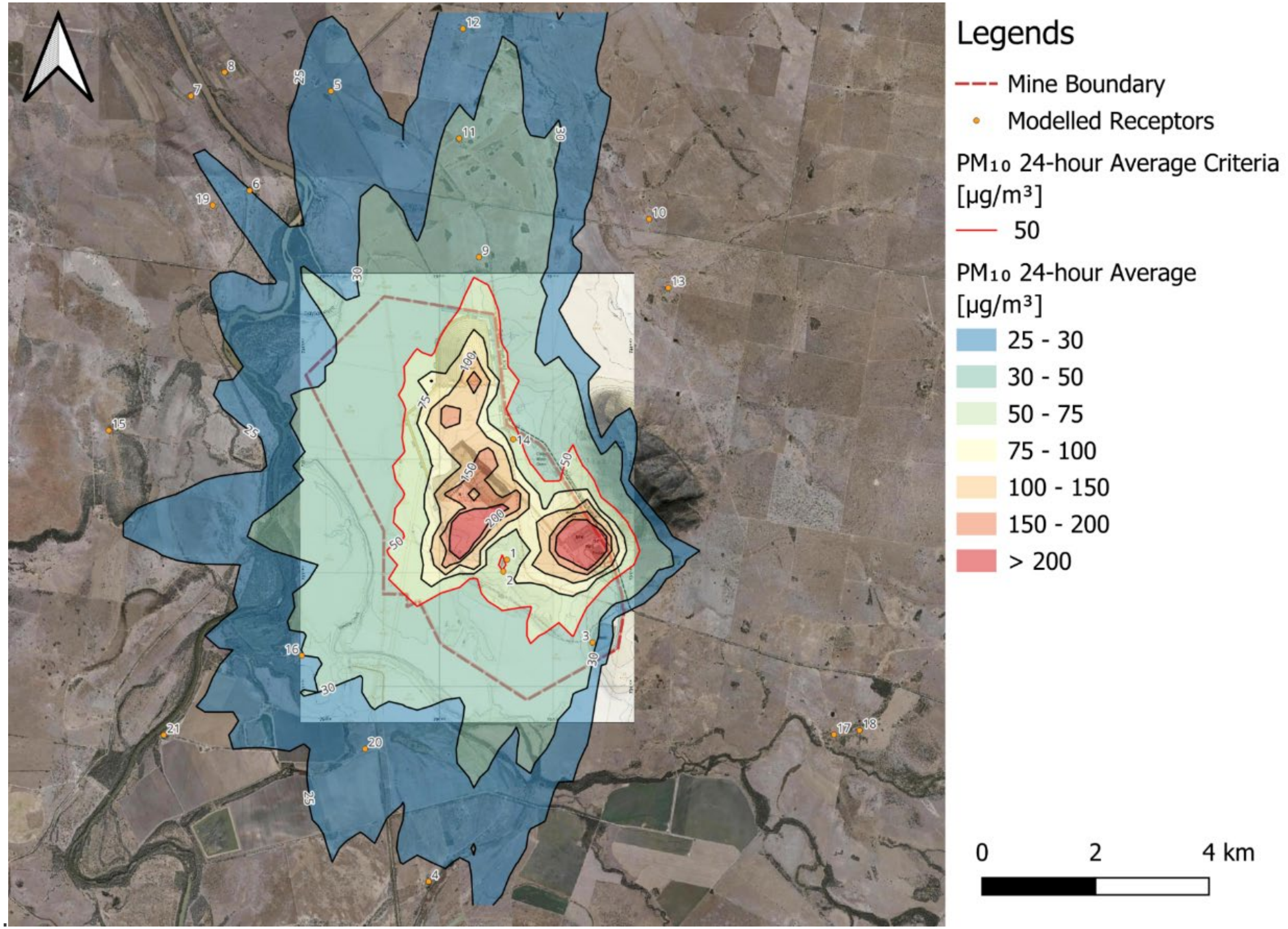


Figure 7.3: Predicted Maximum 24-Hour PM_{10} Concentrations (µg/m³) Including Background – Year 11 Scenario

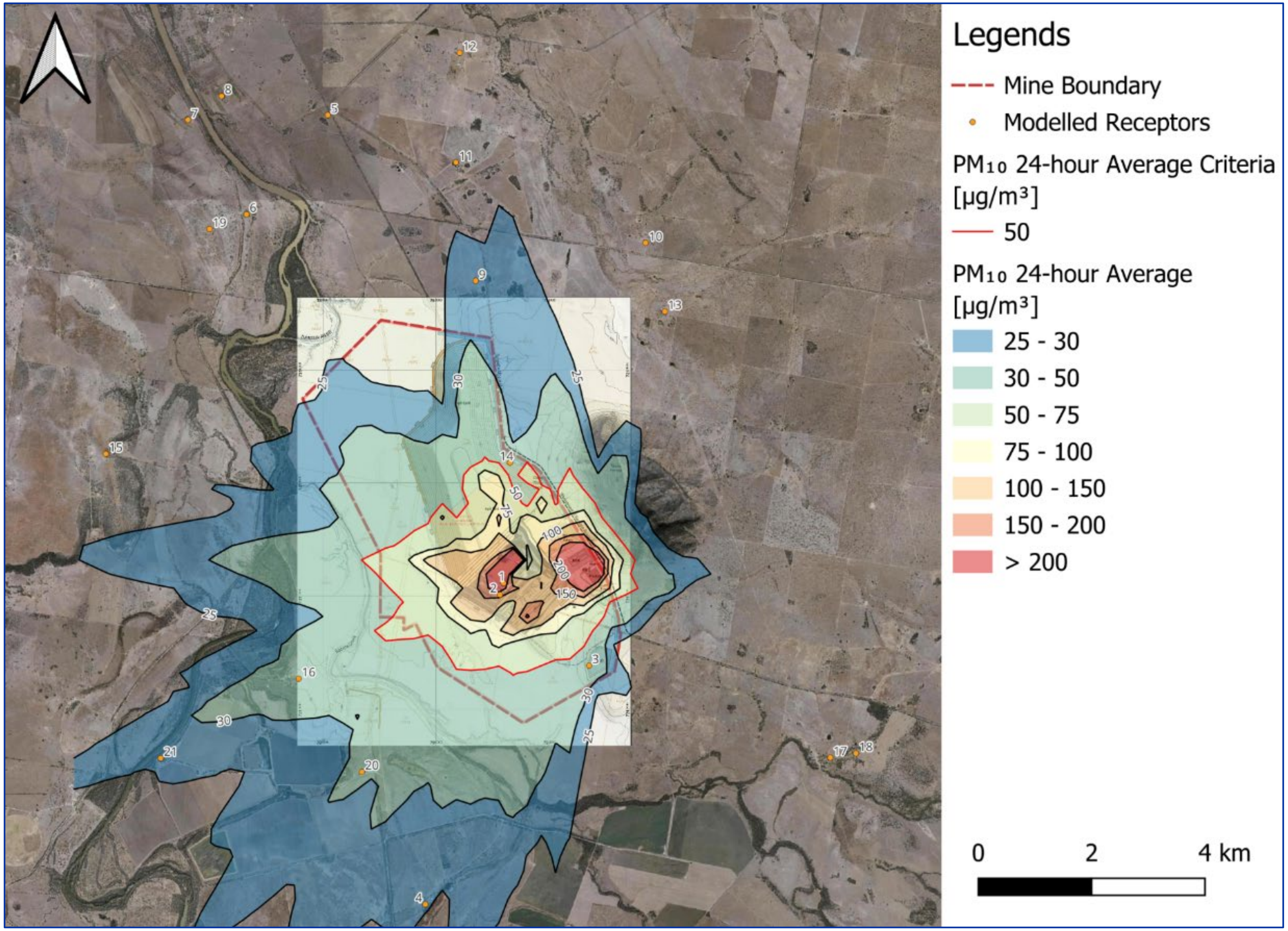


Figure 7.4: Predicted Annual Average PM_{10} Concentrations (µg/m³) Including Background – Year 1 Scenario

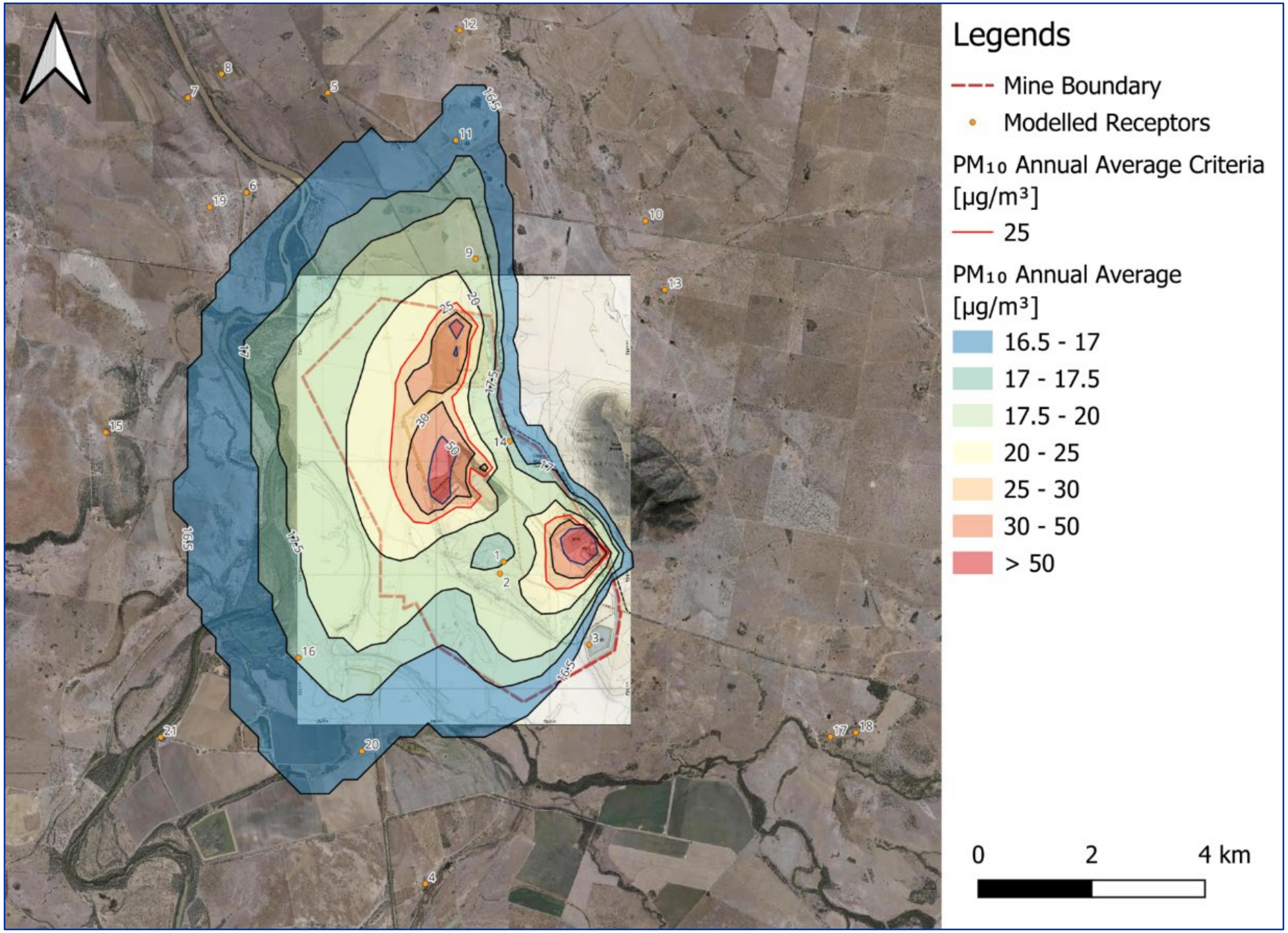


Figure 7.5: Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$) Including Background – Year 3 Scenario

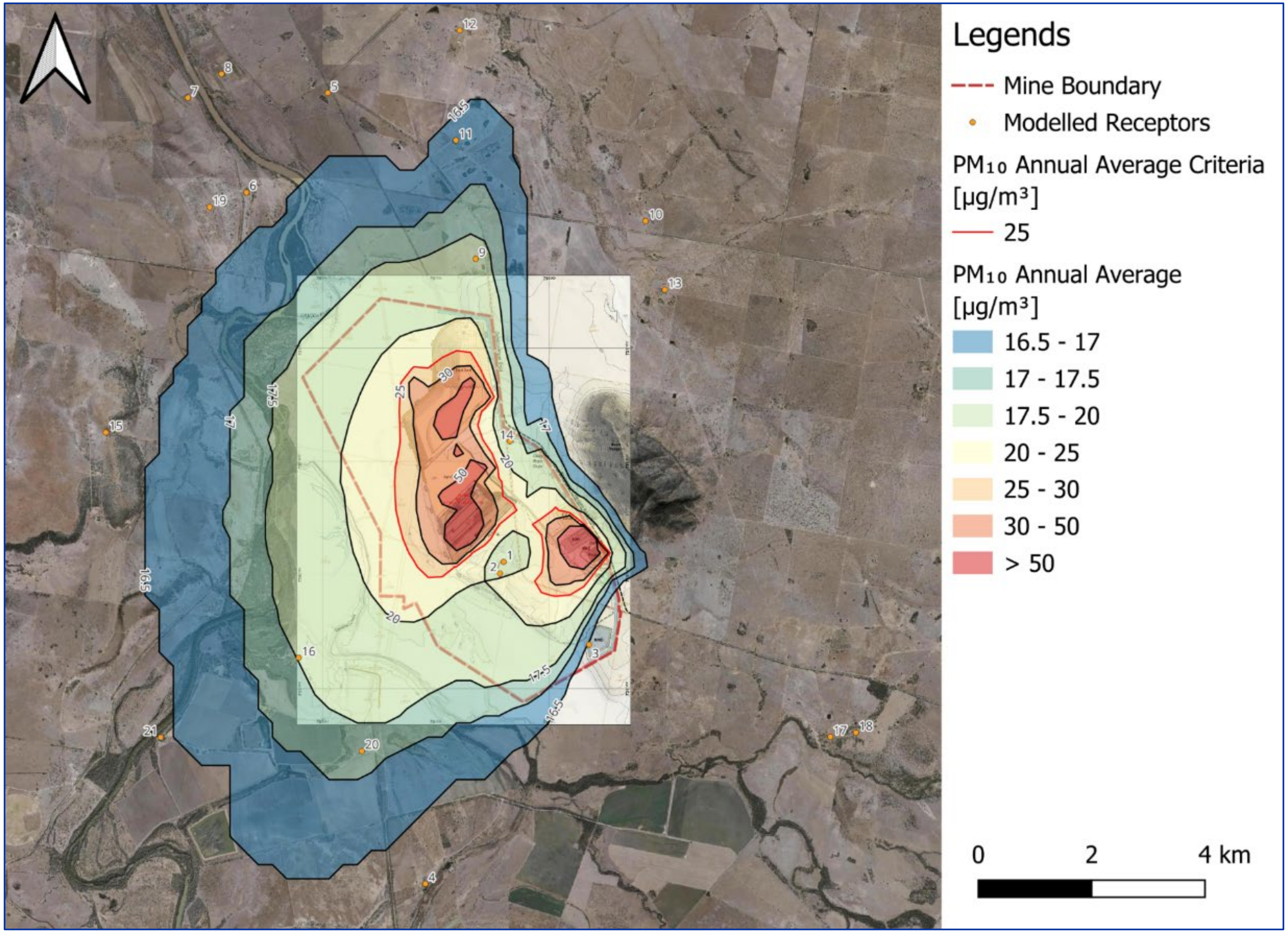
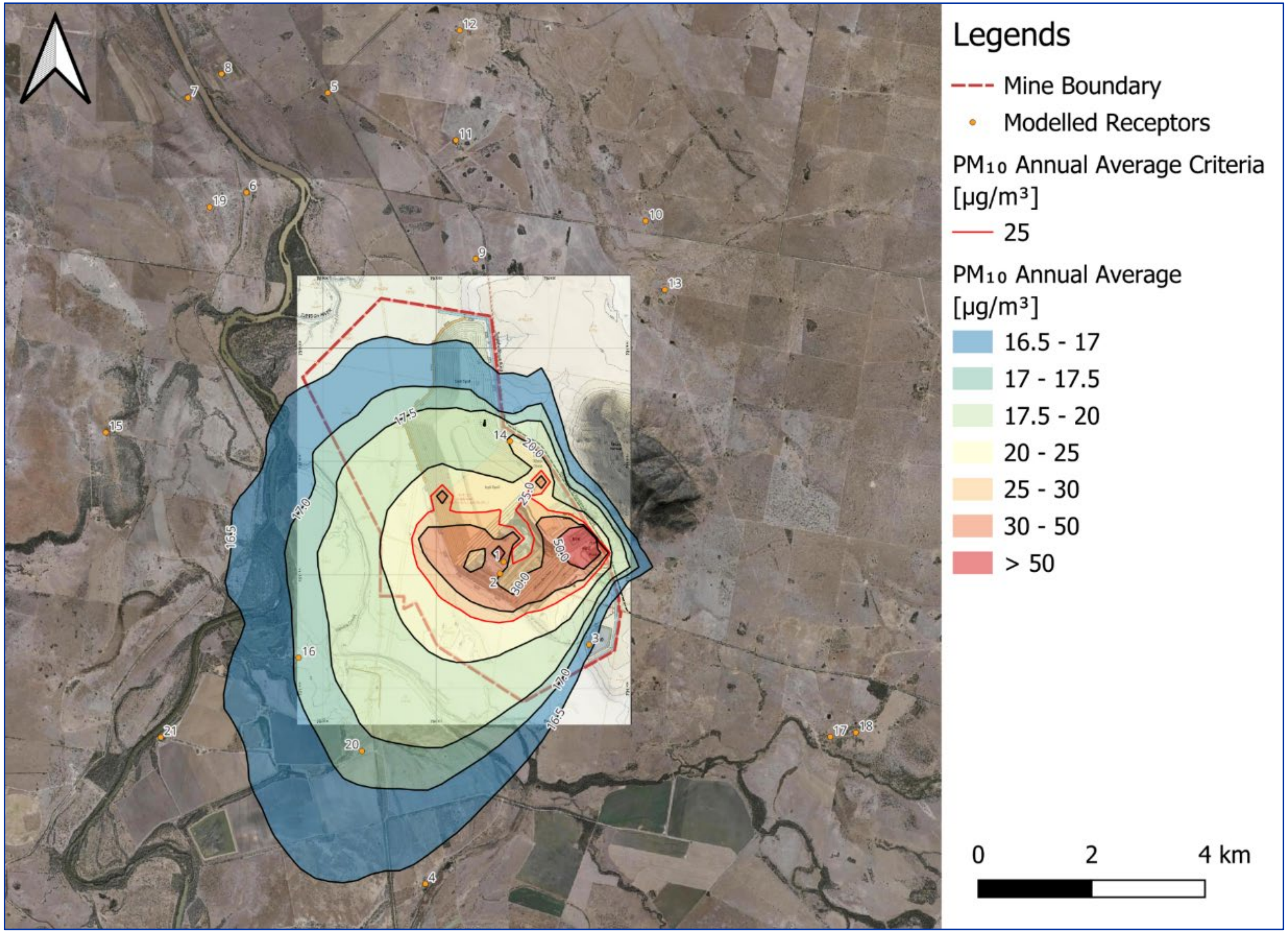


Figure 7.6: Predicted Annual Average PM_{10} Concentrations (µg/m³) Including Background – Year 11 Scenario



7.2.2 Dust Deposition Results

The results of the dust deposition modelling are illustrated in **Figure 7.7** to **Figure 7.9**. The predicted dust deposition levels at sensitive receptors are shown in **Table 7.6** along with the guideline and estimated background levels. The cumulative levels including background at all sensitive receptors outside the MLA boundary are within the guideline of 120 mg/m^2/day. The most-affected receptor outside the MLA boundary is Receptor 9 which is predicted to experience a maximum 30 day average dust deposition level of 59 mg/m^2/day including background, which is well below the guideline value.

Table 7.6: Predicted Dust Deposition Levels (mg/m^2/day) at BSP

Receptor ID	Year 1	Year 3	Year 11	Year 1	Year 3	Year 11
Criterion	**120**					
Background	**50**					
	Incremental			**Cumulative**		
1 [1]	13.0	20.8	1328.3	63.0	70.8	1378.3
2 [1]	14.6	22.3	348.8	64.6	72.3	398.8
3 [2]	4.4	6.1	8.2	54.4	56.1	58.2
4	1.3	1.7	2.4	51.3	51.7	52.4
5	0.8	0.5	0.4	50.8	50.5	50.4
6	1.0	0.5	0.4	51.0	50.5	50.4
7	0.4	0.3	0.2	50.4	50.3	50.2
8	0.4	0.3	0.2	50.4	50.3	50.2
9 [2]	9.3	4.9	2.8	59.3	54.9	52.8
10	0.5	0.5	0.8	50.5	50.5	50.8
11	2.7	1.7	1.4	52.7	51.7	51.4
12	1.0	0.8	0.8	51.0	50.8	50.8
13	0.6	0.6	0.8	50.6	50.6	50.8
14 [2]	7.4	14.3	33.5	57.4	64.3	83.5
15	1.3	1.0	1.4	51.3	51.0	51.4
16	3.7	5.4	7.0	53.7	55.4	57.0
17	0.0	0.1	0.1	50.0	50.1	50.1
18	0.0	0.1	0.1	50.0	50.1	50.1
19	0.9	0.6	0.4	50.9	50.6	50.4
20	2.3	3.5	6.3	52.3	53.5	56.3
21	1.5	1.7	2.0	51.5	51.7	52.0

Notes:

1. *Receptors owned by Baralaba Coal Company, and therefore, not considered sensitive.*
2. *Baralaba Coal Company must agree compensation and reach agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. These dwellings should not be used as accommodation for non-mine workers during operation of the mine.*

Figure 7.7: Predicted Dust Deposition Levels (mg/m²/day) Including Background – Year 1 Scenario

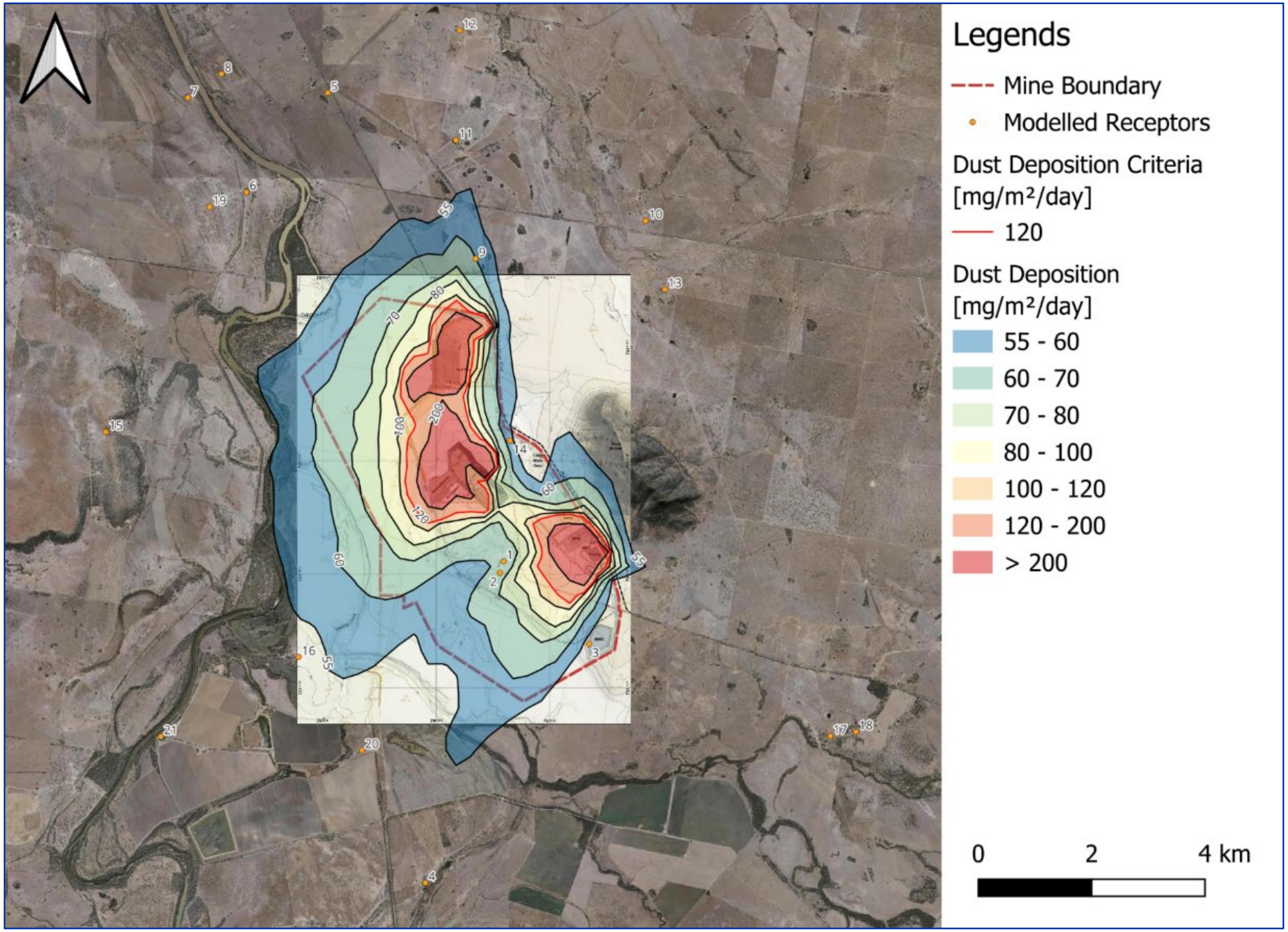


Figure 7.8: Predicted Dust Deposition Levels (mg/m²/day) Including Background – Year 3 Scenario

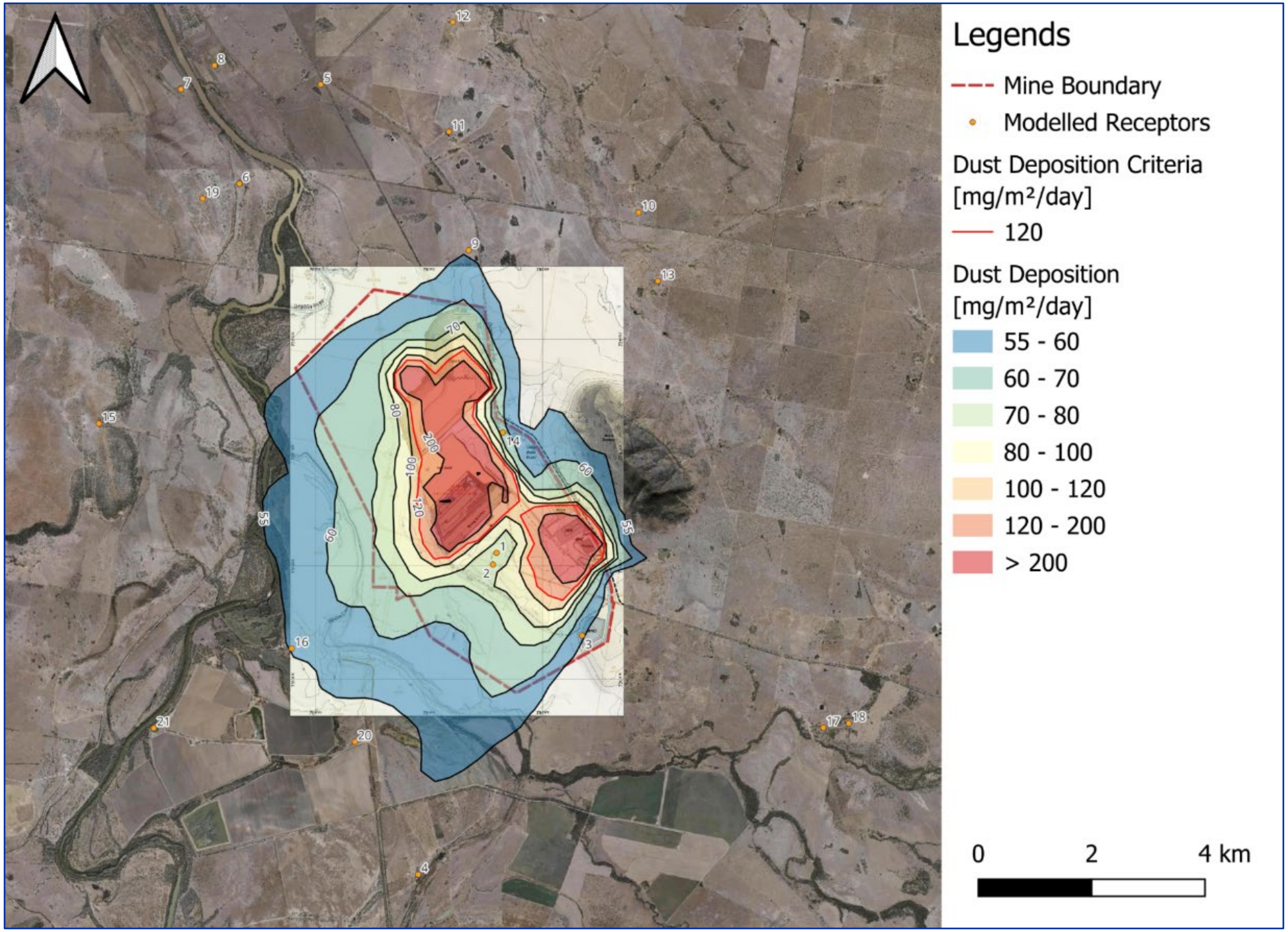
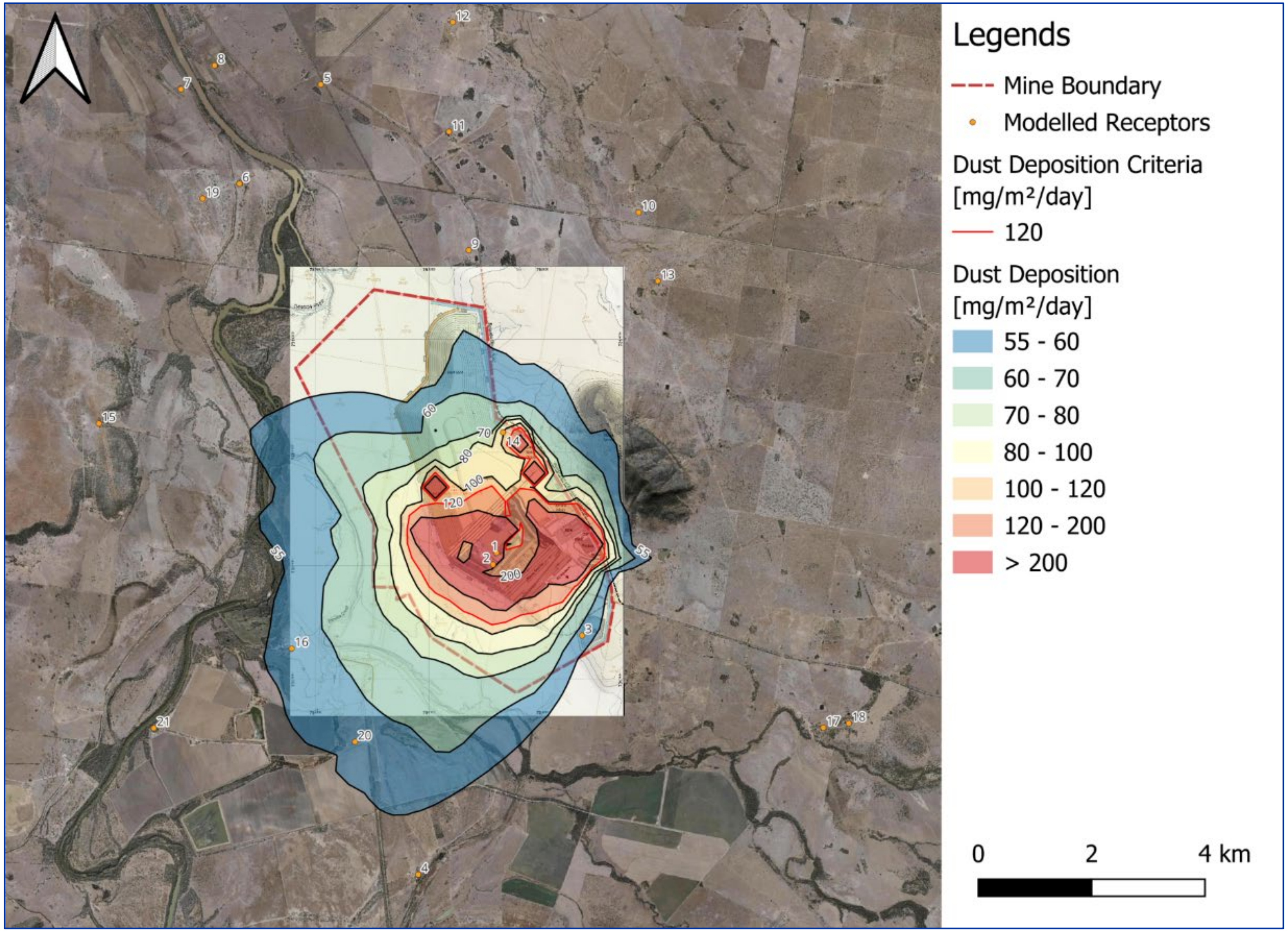


Figure 7.9: Predicted Dust Deposition Levels (mg/m²/day) Including Background – Year 11 Scenario



7.3 TLO Model Results

7.3.1 Suspended Particulates Results

The predicted incremental suspended particle concentrations at sensitive receptors are shown in **Table 7.7** together with the criterion. The estimated background levels are listed separately and are not included in the predicted concentrations. The predicted cumulative concentrations are shown in **Table 7.8**.

The table shows that all the predicted suspended particulate concentrations, including background, are within the relevant criteria at the sensitive receptor locations.

The maximum annual average $PM_{2.5}$ concentrations are the closest to the criterion among all the modelled pollutants due to the high background concentration used. Incremental concentrations are lower than 0.1 µg/m^3. The annual average PM_{10} concentration is the next closest to the criterion. The maximum annual average PM_{10} concentration, including background, is 18.4 µg/m^3 or 74% of the 25 µg/m^3 criterion at the most impacted receptor, receptor N.

The modelling results of the $PM_{2.5}$ and PM_{10} annual averages are illustrated in **Figure 7.10** and **Figure 7.11.**

Table 7.7: Predicted Incremental Suspended Particulate Concentrations at the TLO

Receptor ID	Annual Average TSP (µg/m^3)	Maximum 24-Hour Average PM10 (µg/m^3)	Annual Average PM_{10} (µg/m^3)	Maximum 24-Hour Average $PM_{2.5}$ (µg/m^3)	Annual Average $PM_{2.5}$ (µg/m^3)
Criterion	**90**	**50**	**25**	**25**	**8**
Background	**45.9**	**19.5**	**17.9**	**6.6**	**6.3**
A	0.0	0.6	0.0	0.1	0
B	0.1	1.7	0.1	0.2	0
C	0.2	2.2	0.2	0.2	0
D	0.1	1.5	0.1	0.1	0
E	0.0	0.7	0.0	0.1	0
F	0.1	1.1	0.1	0.1	0
G	0.1	1.1	0.1	0.1	0
H	0.2	2.7	0.2	0.2	0
I	0.2	2.8	0.2	0.3	0
J	0.1	1.8	0.1	0.2	0
K	0.1	2.0	0.1	0.2	0
L	0.2	3.3	0.2	0.3	0
M	0.5	3.5	0.4	0.3	0
N	0.5	6.1	0.5	0.6	0
O	0.3	2.6	0.3	0.2	0
P	0.2	1.9	0.2	0.2	0
Q	0.2	1.7	0.1	0.2	0

Table 7.8: Predicted Cumulative Suspended Particulate Concentrations at the TLO

Receptor ID	Annual Average TSP (µg/m³)	Maximum 24-Hour Average PM10 (µg/m³)	Annual Average PM_{10} (µg/m³)	Maximum 24-Hour Average $PM_{2.5}$ (µg/m³)	Annual Average $PM_{2.5}$ (µg/m³)
Criterion	**90**	**50**	**25**	**25**	**8**
Background	**45.9**	**19.5**	**17.9**	**6.6**	**6.3**
A	45.9	20.1	17.9	6.7	6.3
B	46.0	21.2	18.0	6.8	6.3
C	46.1	21.7	18.1	6.8	6.3
D	46.0	21.0	18.0	6.7	6.3
E	45.9	20.2	17.9	6.7	6.3
F	46.0	20.6	18.0	6.7	6.3
G	46.0	20.6	18.0	6.7	6.3
H	46.1	22.2	18.1	6.8	6.3
I	46.1	22.3	18.1	6.9	6.3
J	46.0	21.3	18.0	6.8	6.3
K	46.0	21.5	18.0	6.8	6.3
L	46.1	22.8	18.1	6.9	6.3
M	46.4	23.0	18.3	6.9	6.3
N	46.4	25.6	18.4	7.2	6.3
O	46.2	22.1	18.2	6.8	6.3
P	46.1	21.4	18.1	6.8	6.3
Q	46.1	21.2	18.0	6.8	6.3

Figure 7.10: Predicted Annual Average PM_{10} Concentrations (µg/m³) Including Background – TLO Facility

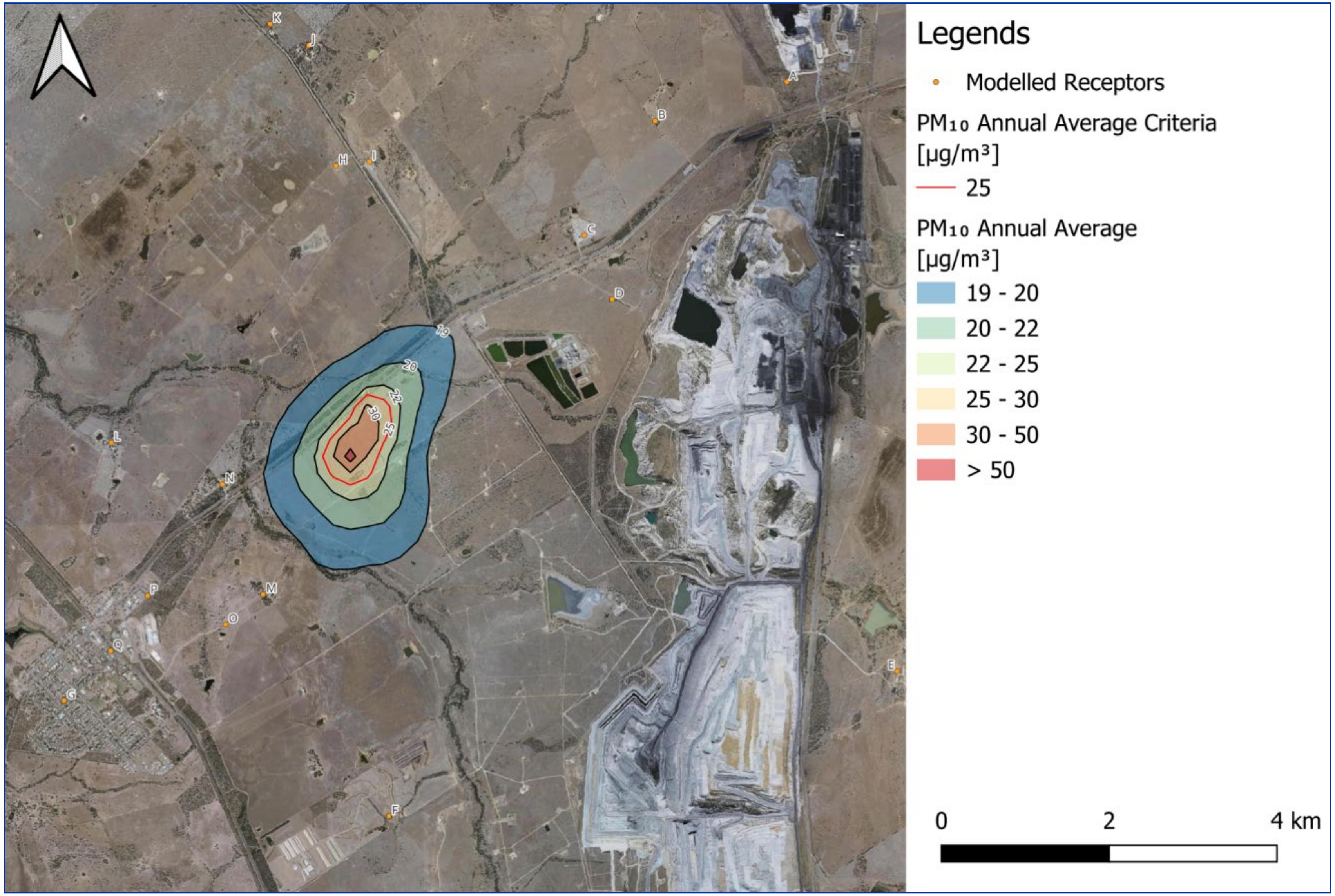
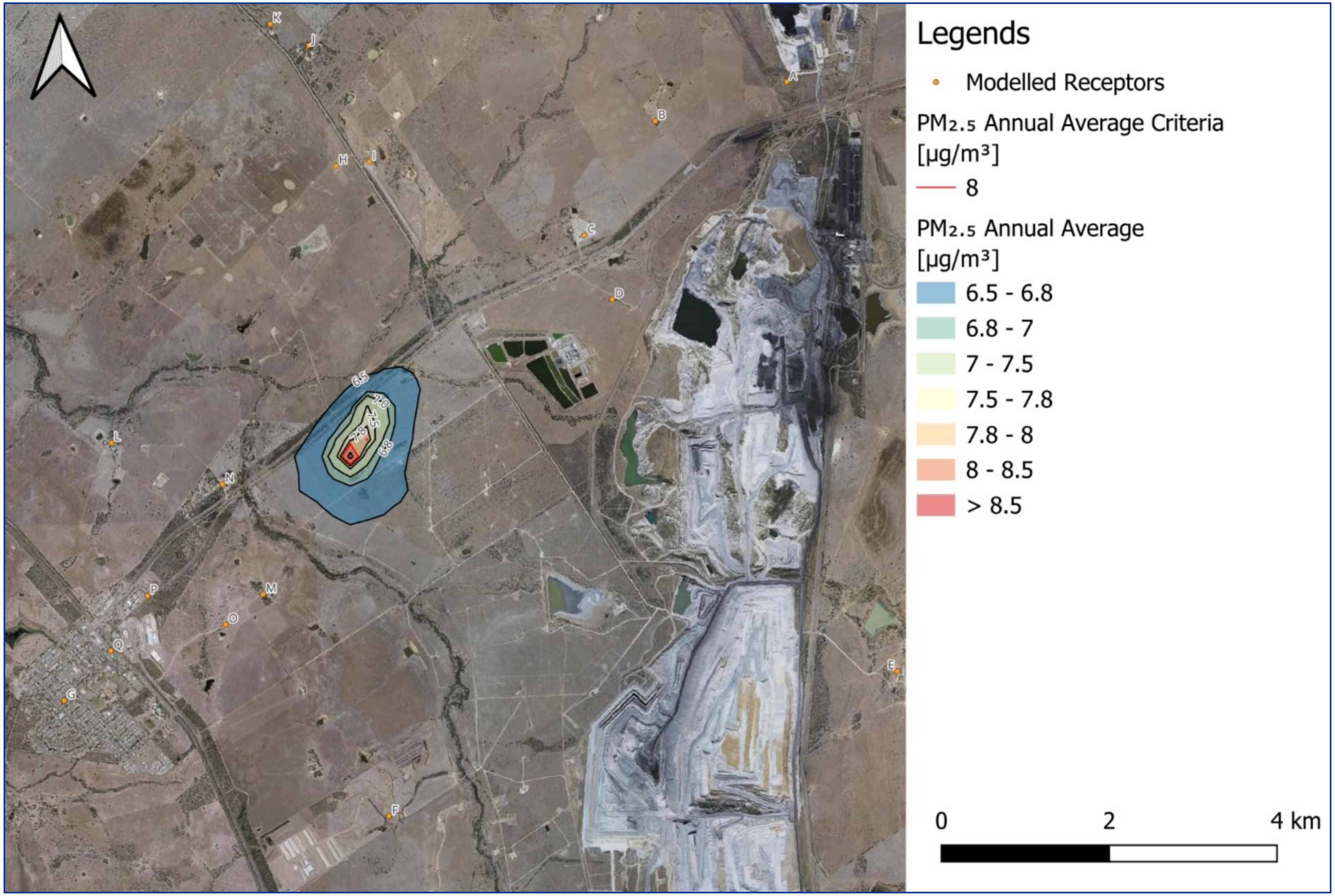


Figure 7.11: Predicted Annual Average $PM_{2.5}$ Concentrations (μg/m³) Including Background – TLO Facility



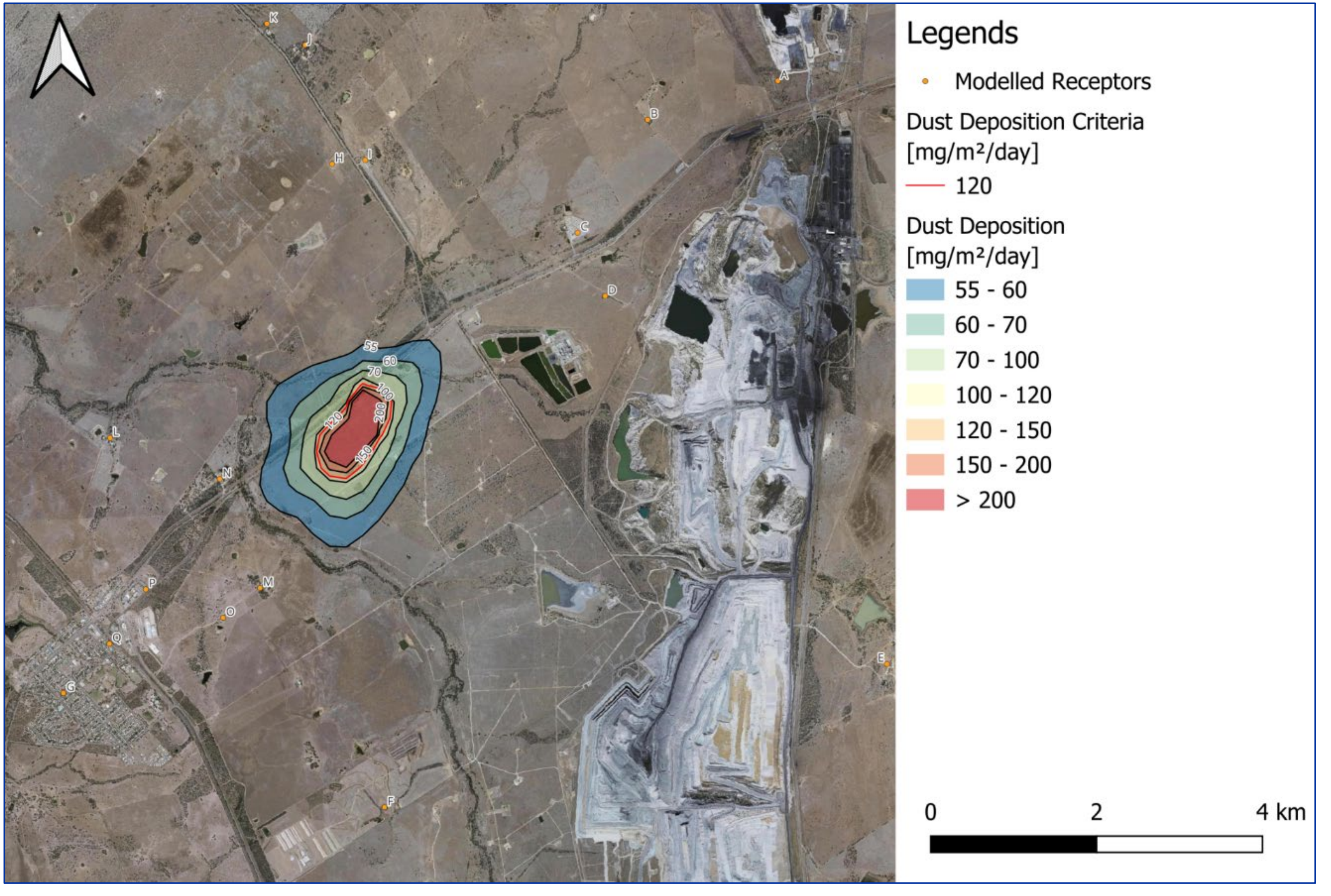
7.3.2 Dust Deposition Results

The results of the 30-day dust deposition modelling are illustrated in **Figure 7.12**. The predicted dust deposition levels at sensitive receptors are shown in **Table 7.9,** along with the criterion and estimated background levels. The cumulative level, including background at the most affected receptor, receptor N, is 52 mg/m²/day, well within the criterion of 120 mg/m²/day and dominated by the background level of 50 mg/m²/day.

Table 7.9: Predicted Dust Deposition Levels at the TLO

Receptor ID	Maximum 30-Day Dust Deposition (mg/m²/day)	
Criterion	**120**	
Background	**50**	
	Incremental	**Cumulative**
A	0.0	50.0
B	0.1	50.1
C	0.2	50.2
D	0.2	50.2
E	0.0	50.0
F	0.1	50.1
G	0.2	50.2
H	0.3	50.3
I	0.3	50.3
J	0.1	50.1
K	0.1	50.1
L	0.4	50.4
M	1.0	51.0
N	1.8	51.8
O	0.7	50.7
P	0.6	50.6
Q	0.4	50.4

Figure 7.12: Predicted Dust Deposition Levels (mg/m²/day) Including Background – TLO Facility



8. ASSESSMENT OF THE RAIL ROUTE TO GLADSTONE

8.1 Overview

The Moura rail system is owned and operated by Aurizon (formerly QR National). It is described as a single line with passing loops. Balloon loops are located at Boundary Hill, Callide Coalfields, and Moura Mine. The line roughly parallels the Dawson Highway and serves the industrial operators and rural communities in the Dawson and Callide Valleys. Towns located along the rail line include Banana, Calliope, and the Gladstone suburbs of Burua and Beecher. Outside of the populated areas, the land use is primarily comprised of agricultural land and forested areas.

Quarterly Reports from Aurizon indicate that the rail line services an average of 473.17 trains in any given month (range: 378-637), or approximately 109.19 trains per week (Aurizon Network Quarterly Reports, 2018/19 and 2019/20). The TLO train load out near Moura would have an average of 17.5 train trips per week. Of these 17.5 trains, approximately 8.2 per week are currently operating on the line; production at the BSP would add approximately 6 trains per week; representing an increase of approximately 6% to the existing rail traffic on the Moura rail line.

8.2 Coal Dust Monitoring

The primary pollutants of concern along the rail line are fugitive emissions of coal dust and particles which are lost during transport. Coal dust can be lost during transport due to:

- lift off from the surface of loaded wagons
- leakage from wagon doors
- dust deposits left on sills of wagons
- parasitic or residual coal on unloaded wagons.

This dust is generally within the range of 50-200 µm, which is both greater than that commonly monitored for environmental health purposes and does not disperse far due to its relatively high settling velocity. Dust particles larger than ~10 µm do not reach the lower airways. These larger particles can cause nuisance by soiling property and surfaces in proximity to the passing trains. Very little coal dust travels more than 10 metres beyond the rail corridor.

Aurizon's Coal Dust Monitoring Program requires that all coal wagons travelling on the Moura rail system undergo profiling and veneering immediately after loading, prior to transport to Gladstone Port. Profiling involves neatening the exposed part of the coal at the top of the wagon to a uniform shape (commonly a "garden bed" profile), which reduces lift-off along the rail corridor by approximately 80%. Veneering is the application of a biodegradable dust suppressant spray that further reduces lift-off by up to 85%.

Aurizon monitors coal dust using opacity monitors along the Moura rail system at Graham, outside of Gladstone. The monitors take a three-minute average opacity reading which commences when the lead locomotive passes the monitoring station and allows time (typically one minute) after the train has passed to monitor any residual dust. Monitor readings exceeding 5% opacity are reported to the relevant coal producer for corrective action. Monitoring station data is provided to Aurizon clients and the Queensland DES; they are not publicly available and thus cannot be utilised in this study.

8.3 DES Monitoring Stations

The Queensland DES established an air quality monitoring station in Blackwater in 2019 to assess the impact of coal mining operations on the community and the surrounding area. The towns of Bluff and Emerald were added in 2020. The three stations measure $PM_{2.5}$ and PM_{10}. However, TSP and dust deposition sampling, which would measure larger particles, is not undertaken. These three towns are located along the Blackwater rail system, also owned and operated by Aurizon to transport coal to the port of Gladstone. The rail traffic on the

Blackwater system is approximately 4.5 times greater than the traffic on the Moura system (Aurizon Network Quarterly Reports, 2018/19 and 2019/20). In addition, the rail line passes through the centre of these towns with monitoring, whereas rural town centres are largely bypassed on the Moura line. Of the three monitoring stations, the Bluff station is closest to the rail line, located approximately 100 metres north of the tracks. The other two are further away; Emerald and Blackwater monitoring stations are located approximately 800 metres and 2.5 kilometres to the north of the railways, respectively. As such, these stations can be considered to provide estimates of background $PM_{2.5}$ and PM_{10} concentrations at locations in the vicinity of a busy coal train rail line. The measurements from these stations are detailed in **Table 8.1**.

Table 8.1: Background Air Quality on Coal Rail Line

Pollutant	Concentration (µg/m³)	Air Quality Criteria (µg/m³)	Averaging Period	Years Reported	Station
$PM_{2.5}$	5.4	8	Annual	2019 – 2022	Blackwater
	5.7			2020 – 2022	Emerald
PM_{10}	17.8	25	Annual	2019 – 2022	Blackwater
	16.8			2020 – 2022	Emerald
	17.5			2021 – 2022 [1]	Bluff

Note: 1. Bluff station started operating in 2020 but has only 1 month of data.

8.4 Other Monitoring Studies

Several monitoring studies have been conducted assessing the impact of coal dust on the residents living in proximity to coal transport railways. While the rail traffic of the lines has not been indicated on these studies, the findings can be considered indicative of the conditions in the region.

8.4.1 Boonal

TSP monitoring was conducted approximately 10 metres from the rail tracks at Boonal (Connell Wagner, 2008) from December 2007 – February 2008. Boonal is located east of Blackwater and this line is part of the Blackwater rail system. It should be noted that this measurement took place when the rail system was under the management of QR National. In addition, dust suppression technologies were not fully implemented across the system at that time. The average concentration reported was 32 µg/m3, and the maximum 24-hour concentration was 66 µg/m3.

8.4.2 Callemondah

Simtars (2008) reported measurement of dust deposition undertaken 10 metres from rail tracks at Callemondah, north of Gladstone, in April-October 2007. The average deposition rate was 38 mg/m2/day.

8.4.3 Western-Metropolitan Rail Systems Coal Dust Monitoring Program

The Department of Science, Information, Technology, Innovation, and the Arts conducted a study in 2013 investigating particle levels around suburban railways used by coal trains transporting cargo to the Port of Brisbane. Ambient particulate monitoring was conducted at six locations along the Western and Metropolitan rail systems, with a control along rail not used for coal transport. This study indicates both the potential exposures of urban populations to coal dust as well as the impacts of treating cargo with dust suppressants. Overall, their study found that regional urban particle emissions were the dominant driver of observations and dust deposition rates did not trigger dust nuisance levels of 4 g/m^2 averaged over 30 days above background levels (or 130 mg/m^2/day averaged over 30 days) recommended by the New Zealand Ministry for the

Environment. They found coal particles comprised, on average, 10% of the surface area in deposited dust samples (range: trace to 20%). The samples containing trace levels were collected from backyard monitoring sites. Their report indicates that dust impacts are primarily in the immediate rail corridor.

8.5 Summary

The background literature and data from the available monitoring stations are based on higher levels of rail traffic than along the Moura line, and in the case of Boonal, Callemondah and Western-Metropolitan were in close proximity (10 metres) to the rail line. The residents along the Moura rail line are expected to experience similar or better air quality. The data indicates that compliance with the EPP (Air) criteria would not be compromised by the small additional rail traffic associated with the BSP.

9. DISCUSSION

9.1 Summary of Results

9.1.1 BSP

The predicted concentrations and levels of all indicators are within the relevant criteria at receptor locations outside the MLA boundary, as summarised in **Table 9.1** to **Table 9.3**. The most affected receptor is Receptor 9, especially during year 3 for the PM_{10} 24-hour average indicator when the predicted concentration is about 98% of the criteria. However, Receptor 9 is on a block of land that underlies the MLA and will require a compensation agreement as part of the Mount Ramsay/McLaughlin's agreement. Consequently, these results were not included in **Table 9.1** to **Table 9.3.** When considering only sensitive receptors that will not require a compensation agreement, Receptors 11 and 16 are predicted to be the most affected during years 1 and 3, and Receptors 16 and 20 during year 11. Nonetheless, concentrations are predicted to be well below the criteria.

Table 9.1: Summary of Year 1 Particulates Results (Outside the Mining Lease Boundary)

Pollutant	Averaging Period	Worst Affected Receptor	Prediction from Project (µg/m³)	Cumulative Prediction with Background (µg/m³)	Criterion (µg/m³)
TSP	Annual	Receptor 16	1.6	41.6	90
PM_{10}	24-hour	Receptor 11	16.4	33.4	50
	Annual	Receptor 16	1.5	17.1	25
$PM_{2.5}$	24-hour	Receptor 11	3.6	9.4	25
	Annual	Receptors 11 and 16	0.3	5.8	8
Dust Deposition	30-day	Receptor 16	3.7	53.7	120 mg/m²/day

Table 9.2: Summary of Year 3 Particulates Results (Outside the Mining Lease Boundary)

Pollutant	Averaging Period	Worst Affected Receptor	Prediction from Project (µg/m³)	Cumulative Prediction with Background (µg/m³)	Criterion (µg/m³)
TSP	Annual	Receptor 16	2.1	42.1	90
PM_{10}	24-hour	Receptor 11	14.9	31.9	50
	Annual	Receptor 16	2.0	17.6	25
$PM_{2.5}$	24-hour	Receptor 16	3.5	9.3	25
	Annual	Receptor 16	0.4	5.9	8
Dust Deposition	30-day	Receptor 16	5.4	55.4	120 mg/m²/day

Table 9.3: Summary of Year 11 Particulates Results (Outside the Mining Lease Boundary)

Pollutant	Averaging Period	Worst Affected Receptor	Prediction from Project (µg/m³)	Cumulative Prediction with Background (µg/m³)	Criterion (µg/m³)
TSP	Annual	Receptor 20	1.9	41.9	90
PM_{10}	24-hour	Receptor 16	21.1	38.1	50
	Annual	Receptor 20	1.7	17.3	25
$PM_{2.5}$	24-hour	Receptor 20	2.5	8.3	25
	Annual	Receptor 20	0.3	5.8	8
Dust Deposition	30-day	Receptor 16	7.0	57.0	120 mg/m²/day

9.1.2 TLO Facility

The predicted concentrations and levels of all indicators are within the relevant criteria at sensitive receptors in the vicinity of the TLO facility, as summarised in **Table 9.4**. Receptor N is the most affected receptor, but all the predicted particulate results are well below the criteria.

Table 9.4: Summary of Year 11 Particulates Results (Outside the Mining Lease Boundary)

Pollutant	Averaging Period	Worst Affected Receptor	Prediction from Project (µg/m³)	Cumulative Prediction with Background (µg/m³)	Criterion (µg/m³)
TSP	Annual	Receptor N	0.5	46.4	90
PM_{10}	24-hour	Receptor N	6.1	25.6	50
	Annual	Receptor N	0.5	18.4	25
$PM_{2.5}$	24-hour	Receptor N	0.6	7.2	25
	Annual	Receptor N	<0.1	6.3	8
Dust Deposition	30-day	Receptor N	1.8	51.8	120 mg/m²/day

9.2 Metals from Dust in Water Tanks

The concentration of metals from dust that could find its way into water tanks has been calculated based on the maximum metal concentration results from potential spoil samples. **Table 9.5** presents the calculated concentrations using the maximum predicted 30-day average dust deposition level without background at the most affected receptor over all three scenarios, which is Receptor 1 during the Year 11 scenario. The table also shows the health and aesthetic drinking water guidelines (NHMRC 2022).

Based on the results, the metal concentrations in tank waters are predicted to be well below the health and aesthetic criteria. As no health-based criterion is predicted to be exceeded, health risks are deemed acceptable.

Note that these predictions are conservative for the following reasons:

- Actual depositions are likely to be lower due to wind re-entrainment of dust from the rooves.
- This assessment also assumes that no first flush diverters or filters are used in the water tanks.

The predictions are consistent with a study that has been undertaken to investigate potential health impacts of trace elements in coal dust in rainwater (Lucas et al, 2009). Leaching experiments on a range of coal types suggest that "coal dusts are not likely to be a main contributor to trace elements found in rainwater" and "may assist in removing some trace elements from the rainwater in the tank" (Lucas et al, 2009). Rainwater samples from households in the vicinity of the Dalrymple Bay Coal Terminal show "concentrations far lower than Australian Drinking Water Guidelines for all tested elements" (Lucas et al, 2009). Processes operating within rainwater tanks help remove pollutants such as particles and heavy metals, with the main processes being flocculation and settlement.

Table 9.5: Metals from Dust in Water Tanks

Metal	Maximum Concentration (mg/L) [1]	Metals in Tanks (mg/L) [2,3]	Health (mg/L) [4]	Aesthetic (mg/L) [4]
antimony	0.02	0.00007	0.003	-
arsenic	0.74	0.003	0.01	-
cadmium	<0.02	<0.00007	0.002	-
chromium	<0.02	<0.00007	0.05	-
copper	<0.02	<0.00007	2	1
iron	<0.2	<0.0007	-	0.3
lead	<0.02	<0.00007	0.01	-
manganese	<0.02	<0.00007	0.5	0.1
mercury	<0.0001	<0.0000004	0.001	-
molybdenum	0.16	0.0006	0.05	
nickel	<0.02	<0.00007	0.02	-
selenium	0.04	0.00014	0.01	-
zinc	<0.02	<0.00007	-	3

Notes:

1. *Source: Table B9 of the Geochemical Assessment of Potential Spoil and Coal Reject Materials – Baralaba South Project. For concentrations below the analytical detection limit, the detection limit was used for conservatism.*
2. *Calculated using the maximum 30-day average dust deposition level at the worst affected receptor (Receptor 1, Year 11 scenario).*
3. *Calculated based on the mean monthly rainfall of 56.9 mm, which equates to 56.1 L/m^2/month at Belvedere from 1938 to 2022.*
4. *Drinking Water Guidelines (NHMRC 2022)*

9.3 Impacts of Dust on Flora

9.3.1 Regional Ecosystems (RE)

The landscape surrounding the Project has been heavily cleared and is subject to dust deposition caused by agricultural activities and wind erosion from exposed soils.

Much of the remnant vegetation surrounding MLA 700057 would be subject to dust deposition rates equal to or only marginally above background levels (**Figure 7.7** to **Figure 7.9**). As a result, there is no anticipated detrimental effect on their functioning due to the operation of the BSP.

The highest dust deposition levels over sensitive flora not being cleared are predicted to occur at the RE 11.3.25 Eucalyptus open woodland located on a drainage line outside the western boundary of the MLA. However those deposition levels are well within the nuisance criterion. Impacts (reduction in growth) to this vegetation community at the levels of dust deposition predicted are likely to be indiscernible compared to changes due to temperature and water availability. To ensure dust levels are minimised, watering should be undertaken on areas traversed by vehicles or equipment operating in the vicinity of the coolabah woodland in the southwest of the lease.

As mining activities will commence in the centre of the MLA and progress in a southerly direction, dust deposition levels at any location will vary over the mine life. It is also likely that seasonal rainfall would wash dust from the vegetation. Dust from the BSP is considered unlikely to significantly impact surrounding native vegetation.

9.3.2 Crops and Pastures

The closest agricultural crops are located approximately 500 metres west of the MLA boundary. Dust deposition levels are predicted to be highest at this location during Year 3 and 11, with a maximum 30-day average dust deposition level of approximately 65 mg/m^2/day (including background) at the closest edge only slightly over the adopted background level of 50 mg/m^2/day. For the year 1 scenario, the maximum 30-day average dust deposition level is predicted to be approximately 64 mg/m^2/day at the closest edge.

Dust deposited onto the surface of the crops will be washed off regularly during irrigation as well as during rainfall. The most-affected areas of dust would be at the edge where drying winds would have similar effect and where winds may dislodge dust to a greater extent. Hence, effects of dust deposition onto these irrigated crops are likely to be indiscernible. For unirrigated crops and pastures surrounding MLA 700057, the dust deposition rates are equal to or only marginally above background levels (**Figure 7.7** to **Figure 7.9**). As mining activities will commence in the centre of the MLA and progress in a southerly direction, dust deposition levels at any location will vary over the BSP life. While dust may accumulate on pasture foliage during the dry season, the growth of these pastures is dominated by water availability, and during the dry periods, leaves of unirrigated pastures are most likely inactive. Hence dust deposition on to these pastures is less likely to have harmful effects on production.

9.4 Impacts of Dust on Fauna

The two main pathways for dust to impact on fauna are ingestion of dust deposited onto plant feed and inhalation.

Andrews & Skriskandaraha (1992) found that cattle did not have a preference for feed free of coal dust over feed containing coal dust equivalent to deposition rates of up to 8000 mg/m^2/day. This very high threshold indicates that impacts of ingestion of dust from coal mining are not likely to cause impacts given the nuisance criterion of 120 mg/m^2/day. The New Acland Noise and Dust Project determined cattle grazing adjacent to an active mine where dust deposition would be expected to be greater showed similar weight gain compared to animals grazing at the control site (Pembroke and Sunland Cattle Co, 2020).

Cox et al (2016) found that in a Belgian summer, with average PM_{10} concentrations of 25 µg/m^3, an increase of 10 µg/m^3 resulted in a 3.2% increase in mortality of cattle over the following 25 days. These findings were consistent with the results of human health effects studies. Hence cattle and other mammals are considered no more sensitive to particulates than humans. At the New Acland Noise and Dust Project, where the concentration of PM_{10} was 29% higher at the trial site compared with the control site, the difference in weight gain for the cattle on the two sites was negligible, and there was no material difference between the stress level of cattle at the two sites (Pembroke and Sunland Cattle Co, 2020). Egberts, van Schaik, Brunekreef, and

Hoek (2019) demonstrated that PM_{10} has no significant short-term influence on cattle mortality. In this study, PM_{10} maximum concentration was 75% higher than the predicted level surrounding the BSP.

Recent research has shown significant correlation between particulate matter exposure and its impact on milk production in cows. Beaupied, et al. (2022) and Anderson, Rezamand, and Skibiel (2022) found a reduction in milk yield and quality as cows experience increased exposure to $PM_{2.5}$. It is important to highlight that the effects observed in these studies are linked to significantly elevated $PM_{2.5}$ concentrations, increasing to levels as high as 49.8 µg/m^3 and up to 282.54 µg/m^3 during episodes of wildfire.

In a separate study, Chirinos-Peinado and Castro-Bedriñana (2020) detected high levels of cadmium and lead in blood and milk of cows farmed near a metallurgical mine. This contamination was attributed to smelting activities. Similarly, Nieckarz, et al. (2023) observed significant differences only in cadmium and lead levels in milk samples collected during periods of high and low particulate pollution. Notably, these differences were observed when cows were exposed to maximum recorded PM_{10} and $PM_{2.5}$ levels of 138.8 and 119.7 µg/m^3, respectively. It is important to note that the predicted maximum PM_{10} and $PM_{2.5}$ concentrations in receptors outside the MLA, at 49 µg/m^3 and 13 µg/m^3, respectively, fall well below the maximum observed concentrations in the aforementioned studies which may be considered as thresholds at which adverse effects in cattle are observed.

In general, dust has the potential to impact organic farming if it also introduced toxic compounds such as heavy metals into soil and animal tissues. Further, the geochemical assessment indicates that bulk overburden and interburden (spoil) materials – and potential coal reject materials – have low levels of metal and metalloid enrichment, which is consistent with Permian-age coal measures throughout eastern Australia, and consistent with the Rangal Coal Measures in the Bowen Basin. Thus, there is no substantial risk of such contamination occurring in the areas surrounding the BSP. It is worth noting that dust from mining has been generally found to contain less toxic compounds than dust from combustion sources in urban air. By applying human health and nuisance criteria as a conservative indicator, dispersion modelling also affirms that predicted suspended particulates and dust deposition levels in receptors outside the MLA are below the applicable limits.

It is understood that cattle grazing occurs to the north of the BSP, but none will occur on the mining lease, which is common practice at Australian coal mines. Overall, the potential impacts of particulates from the BSP onto cattle or other fauna are likely to be insubstantial.

10. DUST MANAGEMENT PLAN

10.1 Overview

This Dust Management Plan (DMP) aims to assist in implementing mitigation measures to minimise dust impacts from the BSP to the surrounding areas. It contains the following components:

- plan objectives,
- performance indicators,
- dust control measures,
- monitoring, reporting and corrective actions.

10.2 Objectives

The objectives of this dust management plan are the following:

- To prevent dust nuisance as a result of the activities at the BSP site.
- To comply with the requirements of the Environmental Protection Act 1994 and air quality goals.

10.3 Performance Indicators

The performance indicators applicable to the BSP consist of:

- the relevant air quality criteria presented in **Section 3** and summarised in **Table 3.4** of this report
- no valid dust related complaints for the subject operations being received by Baralaba Coal Company.

10.4 Minimisation of Potential Dust Impacts

10.4.1 Dwellings On-site

Exceedances of the air quality criteria are predicted at dwellings within the mining lease (receptors 1 and 2, which are owned by Baralaba Coal Company, and receptors 3 and 14). Baralaba Coal Company must agree compensation and reach an agreement with these receptors before the mining lease may be granted. Where appropriate and where requested by the landholders, such agreements will involve the relocation of the receptors before operations commence. Dwellings at receptor locations 1, 2, 3, and 14 should not be used as accommodation for non-mine workers during the mine operation.

10.4.2 Vegetation Buffers

A vegetation buffer will reduce dust by increasing mixing and deposition onto vegetation surfaces in the BSP progressive rehabilitation program. Hence, rehabilitation and regrowth of vegetation should be commenced on overburden dumps as soon as they are available for rehabilitation.

10.4.3 Management During Adverse Winds

The USEPA AP-42 methods for estimating fugitive dust have, up until 2006, generally assumed a threshold for dust generation on exposed surfaces as being 5.4 m/s. However, the accepted knowledge was updated by AP-42 13.2.5 *Industrial Wind Erosion* (2006). Based on that publication Trinity has calculated emission rates for the different Pasquill Wind Speed Classes. These classes are commonly used in air quality to characterize the effect of wind on emissions and dispersion.

With units of m/s they are:

- 0 – 1.54
- 1.54 – 3.09

- 3.09 – 5.14
- 5.14 – 8.23
- 8.23 – 10.80
- > 10.80

For exposed earth (not including coal), Trinity calculated low emissions in the wind speed range of 5.14 – 8.23 m/s and substantial emissions in the wind speed ranges above 8.23 m/s. Hence, a suitable threshold for adverse wind conditions is 8 m/s.

For wind-blown dust, the adverse conditions would be high wind speeds with sensitive receptors downwind from the dust sources. Another weather condition that should be considered adverse is calm nights associated with low-temperature inversions, which will limit the dilution of airborne dust. Appropriate control measures should be applied as soon as or just before adverse conditions are experienced on-site. These control measures may include increasing water application on dust sources and/or reducing or ceasing activities.

10.4.4 Emission Controls

10.4.4.1 Review of NSW Dust Management Study

Methods to mitigate and manage dust emissions in the Hunter Valley have been described and benchmarked by Katestone (2011). Measures that may be relevant to the BSP are listed in **Table 10.1**.

Table 10.1: Key Management Options from Hunter Valley Study

Source	Measure Proposed for Hunter Valley
Haul roads	Watering, chemical surface suppressant (e.g. salt), conveyors, larger haul trucks
Wind erosion from overburden dumps	Windbreaks using shade cloth on fresh dumps, revegetating as soon as practical, hydraulic mulch seeding
Dozers	Watering by watering truck dedicated to this, apparently cost-effective on coal
Trucks dumping to ROM hopper (or FEL into hopper)	Best option is enclosure with fabric filter
Trucks dumping overburden	Minimise drop height
Grading and drilling	Controls not cost effective.
Drilling	Water injection at 58% of mines
Loaders on coal	Watering

In addition to the above control measures, the report also lists other management options that may be relevant to the BSP. Monitoring using a continuous particulate monitoring technique is undertaken at 48% of Hunter Valley open cut coal mines. Three of these mines have monitoring data automatically triggering control room alarms. Another 48% of mines modify or cease activities on dry or windy days based on weather monitoring data. Some have a system for forecasting particulate levels based on using predicted weather patterns in the dust dispersion modelling.

10.4.4.2 BPS

Controls 1 to 6 below were incorporated in the modelled scenarios with corresponding dust emission reduction specified in **Section 6.4**. These recommended controls may be required when activities are operating in high risk scenarios, such as mining at peak production rates close to sensitive receptors, in order for the particulate criteria to be met.

(1) Haul routes should be treated with gravel or a binding agent such as a lignosulphonate or polymer at the interval recommended by the supplier and reapplied after heavy rain.

(2) Undertake watering of all haul routes using both mine haul road water trucks and light on-road water trucks at a rate suitable for the conditions. In dry conditions without a binding agent the quantities of water required to achieve 85% dust suppression efficiency during the daytime are:

   (a) 2.0 ML/day in year 1

   (b) 2.3 ML/day in year 3

   (c) 1.1 ML/day in year 11.

(3) Water sprays should be used on overburden and coal in the pit prior to loading in dry conditions.

(4) Water sprays should be used on the ROM pad when dry.

(5) Water sprays should be used on the coal product stacker.

(6) Incorporate water injection in drill rigs.

Items 7 to 10 provide options for further mitigation, in addition to the modelled controlled measures, to further reduce impacts on nearby sensitive receptors if required.

(7) Drop heights when loading units load onto trucks should be reduced to less than two metres, and minimised when trucks unload to overburden dumps.

(8) Blasting restrictions should be put in place to avoid dust blowing towards sensitive receptors.

(9) Minimise exposed areas as much as practicable by rehabilitation and vegetating as soon as possible after activity has ceased. This should include treatment of steep slopes to prevent water erosion, which will also assist in minimising surfaces exposed to wind erosion.

(10) Follow proper blasting management to ensure NOx fumes are minimised and dispersed before leaving the mine site.

10.4.4.3 TLO

Items 11 to 17 below were incorporated into the model and are currently adopted in the existing operations of the TLO. It is recommended that these mitigation measures continue to be applied with the commencement of the BSP.

(11) Water sprays should be used on coal stockpiles to minimise dozing emissions and wind erosion.

(12) Water sprays should be used at the unloading hopper.

(13) Water sprays and variable height radial stacker should be used to load stockpiles.

(14) Under-stockpile chute (reclaim tunnel) should be used to unload stockpiles.

(15) Water sprays and chute should be used for conveyor transfer.

(16) Roads should be paved.

(17) Long-term stockpiling should be avoided to minimise risk of spontaneous combustions and consequently, emissions associated with it.

10.5 Monitoring

As discussed in **Section 7.1**, there are uncertainties associated with dispersion modelling, and the models are typically conservative, leading to over-prediction of impacts. Monitoring during operation provides a measure of actual impacts at the monitoring locations and can be used to validate and/or calibrate the dust dispersion models.

Real-time monitoring of weather and PM_{10} around the mining lease boundary enables a proactive approach to reducing impacts (by taking additional control measures or minimising or ceasing certain dust-generating activities) when wind conditions are adverse or when elevated PM_{10} levels are measured at areas downwind from the site.

Similarly, further monitoring prior to construction will provide additional information that will improve the assumptions regarding the background air quality.

1. Wind speed and direction monitoring would serve two purposes. Firstly, it would provide site-specific data for any future modelling studies. Secondly, it would provide current wind conditions to the mine operator so that additional control measures could be triggered. These triggers could occur during unfavourable conditions that may generate high levels of wind-blown dust during high wind speed events, especially when sensitive receptors are downwind from dust sources. They could also occur during conditions of poor dispersion, typically during calm nights. Monitoring is ideally undertaken at a height of ten metres on a site meeting the requirements of AS3580.14-2014 Methods for sampling and analysis of ambient air - Meteorological monitoring for ambient air quality monitoring applications as far as practical.
2. Monitor PM_{10} concentrations at sensitive receptors where PM_{10} concentrations can potentially exceed the relevant criterion, using an Australian Standard method such as AS/NZS 3580.9.9-2006 Determination of suspended particulate matter – PM_{10} low volume sampler – Gravimetric method or AS/NZS 3580.9.11 Determination of suspended particulate matter – PM_{10} beta attenuation monitors. This monitoring should be undertaken at least every sixth day for the first year of operation and reviewed to determine the extent of future monitoring.
3. Should a non-frivolous complaint regarding dust nuisance be received, undertake dust deposition monitoring at a site representative of the complainant's dwelling according to AS/NZS 3580.10.1 2016 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method. This monitoring would be undertaken for an appropriate duration recommended by an appropriately qualified person, and the results reviewed to determine the extent of future monitoring.
4. Should a non-frivolous complaint regarding health concerns about dust be received, monitor PM_{10} concentrations at a site representative of the complainant's dwelling using an Australian Standard method such as AS/NZS 3580.9.9-2006 Determination of suspended particulate matter – PM_{10} low volume sampler – Gravimetric method or AS/NZS 3580.9.11 Determination of suspended particulate matter – PM_{10} beta attenuation monitors. This monitoring would be undertaken at least every sixth day over at least the three months of winter and reviewed to determine the extent of future monitoring.

10.6 Reporting and Corrective Actions

It is recommended the monitoring results be assessed against the relevant criteria summarised in **Table 3.4** and reported to the BSP mine management on a monthly basis. The cause of any exceedances should be investigated, and preventative measures be identified to avoid similar incidents from happening in the future. These corrective actions may include increasing water application on dust sources, reducing or ceasing specific dust-generating activities, and/or using a weather forecasting system with dispersion modelling to assist in predicting adverse conditions.

11. GREENHOUSE GAS EMISSIONS

11.1 Greenhouse Gas Regulatory Requirements

11.1.1 National Greenhouse and Energy Reporting (NGER)

The legislative framework for a national greenhouse and energy reporting system is established via:

- the National Greenhouse and Energy Reporting Act 2007 (NGER Act) as amended 12 April 2023 (Department of the Environment and Energy, 2023a)
- the National Greenhouse and Energy Reporting Regulations 2008 (NGER Regulations) as amended 1 July 2023 (Department of the Environment and Energy, 2023b)
- the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER Determination) as amended 7 October 2023 (Department of the Environment and Energy, 2023d).

The NGER Technical Guidelines (Department of the Environment and Energy, 2017) provide additional guidance and commentary to assist in estimating greenhouse gas emissions for reporting under the NGER system. The emission factors used in these guidelines are consistent with those specified in the National Greenhouse Account Factors (Department of the Environment and Energy, 2023c). The National Greenhouse Account Factors form the most appropriate standard for use in the prediction of emission for impact assessment.

The NGER Act makes reporting mandatory for corporations whose energy production, energy use, or greenhouse gas emissions meet certain specified thresholds. These thresholds are detailed in the NGER Regulations. **Section 11.1.2** summarises the reporting thresholds.

The NGER Determination provides methods for the estimation and measurement of:

(a) greenhouse gas emissions
(b) the production of energy
(c) the consumption of energy.

Greenhouse gas emissions are defined in Section 2.5 of the NGER Regulation as follows:

Emissions of greenhouse gas, in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of:

(a) an activity, or series of activities (including ancillary activities) that constitute the facility (scope 1 emissions)
(b) one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility (scope 2 emissions).

Coverage of scope 1 emission sources is given in Section 1.3 (4) of the NGER Determination by:

(a) fuel combustion, which deals with emissions released from fuel combustion
(b) fugitive emissions from fuels, which deals with emissions mainly released from the extraction, production, processing and distribution of fossil fuels
(c) industrial processes emissions, which deal with emissions released from the consumption of carbonates and the use of fuels as feedstock or as carbon reductants, and the emission of synthetic gases in particular cases
(d) waste emissions, which deal with emissions mainly released from the decomposition of organic material in landfill or other facilities, or wastewater handling facilities.

Scope 2 emissions are generally emissions that result from activities that generate power offsite for consumption onsite. The largest contributor to scope 2 emissions is consumption of electricity or steam.

Scope 3 emissions are those created downstream or upstream of the operation, specifically from the usage of the product produced by the operation, and from the manufacturing of supplies such as fuel.

11.1.2 Reporting Thresholds

This section is to determine operational requirements of the project to report scope 1 and 2 emissions. Section 13 of the NGER Act sets reporting thresholds for the operation of a facility or corporations, as per the following excerpts:

(1) A controlling corporation's group meets a threshold for a financial year if in that year:

(a) the total amount of greenhouse gases emitted from the operation of facilities under the operational control of entities that are members of the group has a carbon dioxide equivalence of: ....

(iii) 50 kilotonnes or more; or

....

(c) the total amount of energy consumed from the operation of facilities under the operational control of entities that are members of the group is:

....

(iii) 200 terajoules or more; or

(d) an entity that is a member of the group has operational control of a facility the operation of which during the year causes:

i) emission of greenhouse gases that have a carbon dioxide equivalence of 25 kilotonnes or more; or

ii) production of energy of 100 terajoules or more; or

iii) consumption of energy of 100 terajoules or more.

Note that within a corporation, incidental facilities may be reported as percentages of the total or otherwise estimated as per the NGER Regulations as updated by the National Greenhouse and Energy Reporting Amendment (Streamlining Reporting) Regulation 2013.

11.1.3 Greenhouse Gases

Gases addressed by the NGER Regulations (Department of Environment and Energy, 2023b), are the six key greenhouse gases consistent with the Kyoto Protocol. These gases differ in their capacity to trap heat and contribute to the greenhouse effect. The capacity of each gas to contribute to global warming is referred to as its Global Warming Potential (GWP) relative to that of carbon dioxide. The GWP's of the six Kyoto greenhouse gases are provided in **Table 11.1.**

Because of the variation in GWP between different gases, the emission factors used to calculate greenhouse gas emissions from the project are stated in terms of carbon dioxide equivalents (CO_2-e) and consider the various GWP's of the different greenhouse gases.

Table 11.1: Global Warming Potential of Greenhouse Gases

Greenhouse Gas	GWP (CO_2-e)
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous oxide (N_2O)	265
Hydrofluorocarbons (HFC's)	116 – 12,400
Perfluorocarbons (PFC's)	6,630 – 11,100
Sulphur hexafluoride (SF_6)	23,500

Note: Source is Department of the Environment and Energy, 2023b.

11.2 Greenhouse Gas Assessment

11.2.1 Methodology for Impact Assessment

11.2.1.1 BSP

The following data and assumptions were used in emission calculations:

- Fugitive gas emissions from coal extraction have been determined using Method 1 for fugitive gas emission calculation from the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Department of the Environment and Energy, 2023d).
- Annual ROM extracted and product coal production data used are listed in **Table 2.1**.
- Annual diesel combusted on site for mobile plant, both off-road vehicles and road vehicles, are listed in **Table 11.2**.
- The average diesel used for explosives was estimated to be 675 kL per year. The Baralaba North Mine, similarly sized to the BSP, had a diesel consumption of 273 and 49 kL in the previous 2 years. Therefore, the estimated diesel consumption for explosives at the BSP is likely to be conservative.
- Annual diesel used for the off-site haulage of product coal to the train load-out facility is as per **Table 11.3**.
- The average mains electricity consumption per year was estimated to be 3,900 kW for BSP and 128 kW for the TLO.
- The areas to be cleared of vegetation have been determined by Ecological Survey & Management as part of the ecological assessment for this project. As most of the clumps of vegetation in the project area have a crown cover of 20 per cent or more, it was assumed that all vegetation to be cleared has this crown cover.
- Emissions resulting from the combustion of petrol are assumed to be insignificant for the purposes of this assessment.
- Upset conditions may include severe weather such as flood, extreme winds, or drought leading to no water being available. Under these conditions, mining would cease and emissions would be significantly reduced.

The mobile equipment anticipated to utilise diesel fuel are summarised in **Table 11.2**.

Table 11.2: Estimated Diesel Consumption of Mobile Plant

Year	Excavators (L/year)	Mine haul trucks (L/year)	Ancillary equipment (L/year)	Small/Medium Vehicles and Service Trucks (L/year)	Small Engines (L/year)	Total (L/year)
1	7,307,515	24,784,642	5,401,057	545,638	554,800	38,593,653
2	8,941,638	17,705,814	6,020,590	630,864	554,800	33,853,707
3	9,074,209	23,076,252	6,525,258	665,604	554,800	39,896,122
4	8,642,116	25,762,732	6,471,147	675,564	556,320	42,107,879
5	9,074,957	25,095,290	6,674,882	677,101	554,800	42,077,030
6	9,029,099	26,155,925	6,663,331	677,731	554,800	43,080,885
7	6,674,962	14,011,268	5,041,733	596,240	537,280	26,861,484
8	6,674,962	13,179,913	4,975,071	592,308	538,752	25,961,007
9	6,674,962	17,943,805	5,334,110	618,749	537,280	31,108,907
10	6,693,250	18,670,033	5,431,002	625,735	537,280	31,957,301
11	6,674,962	20,762,276	5,528,060	633,681	537,280	34,136,259
12	6,674,962	11,877,536	4,876,298	584,703	538,752	24,552,252
13	6,674,962	12,180,107	4,906,403	585,821	537,280	24,884,574
14	6,685,763	16,979,571	5,285,694	614,772	537,280	30,103,081
15	6,674,962	20,303,267	5,573,962	637,215	537,280	33,726,686
16	6,674,962	21,784,632	5,638,299	643,368	538,752	35,280,014
17	6,674,962	15,088,035	5,118,286	602,134	537,280	28,020,697
18	6,693,250	19,055,902	5,446,994	626,967	537,280	32,360,392
19	6,674,962	14,335,152	5,056,919	597,409	537,280	27,201,723
20	6,674,962	16,917,852	5,264,816	614,614	538,752	30,010,996
21	6,088,538	20,871,583	5,234,059	628,589	537,280	33,360,049
22	3,835,463	8,866,314	2,997,885	523,904	502,240	16,725,806

Year	Excavators (L/year)	Mine haul trucks (L/year)	Ancillary equipment (L/year)	Small/Medium Vehicles and Service Trucks (L/year)	Small Engines (L/year)	Total (L/year)
23	1,466,805	5,054,177	1,718,373	481,608	537,280	9,258,242
24	0	0	451,584	4,843	292,800	749,227
25	0	0	451,584	4,843	292,000	748,427
26	0	0	447,808	4,828	292,000	744,635
27	0	0	0	3,000	292,000	295,000
28	0	0	0	3,000	292,800	295,800
29	0	0	0	3,000	292,000	295,000
30	0	0	0	3,000	292,000	295,000
Total	**156,957,190**	**410,462,079**	**122,535,205**	**14,106,833**	**14,480,528**	**718,541,835**

Table 11.3: Estimated Diesel Consumption for the Off-site Haulage of Product Coal

Year	Product (t)	Number of Trips	Diesel (L/year)
1	947,374	9,023	613,538
2	1,578,896	15,037	1,022,523
3	1,469,714	13,997	951,815
4	1,548,821	14,751	1,003,046
5	1,608,699	15,321	1,041,824
6	1,694,116	16,134	1,097,142
7	1,769,800	16,855	1,146,156
8	1,789,793	17,046	1,159,104
9	1,806,014	17,200	1,169,609
10	1,666,441	15,871	1,079,219
11	1,662,594	15,834	1,076,728
12	1,618,978	15,419	1,048,481
13	1,620,640	15,435	1,049,557
14	1,595,225	15,193	1,033,098
15	1,750,293	16,669	1,133,523
16	1,833,437	17,461	1,187,369
17	1,848,062	17,601	1,196,840
18	1,613,811	15,370	1,045,135
19	1,528,349	14,556	989,788
20	1,489,877	14,189	964,872
21	1,579,192	15,040	1,022,715
22	942,255	8,974	610,222
23	563,484	5,367	364,923
Total	**35,525,865**	**338,342**	**23,007,227**

11.2.1.2 TLO

The estimated diesel fuel usage for the handling of product coal from Baralaba South at the TLO is summarised in **Table 11.4.**

Table 11.4: Diesel Consumption for the TLO

Year	Dozers (L/year)	Other Mobile Equipment (L/year)	Stationary Engines (<450 kW) (L/year)	Total (L/year)
1	59,844	3,067	999	63,909
2	99,735	5,111	1,664	106,511
3	92,839	4,758	1,549	99,146
4	97,836	5,014	1,632	104,482
5	101,618	5,208	1,696	108,521
6	107,014	5,484	1,786	114,283
7	111,794	5,729	1,865	119,389
8	113,057	5,794	1,886	120,738
9	114,082	5,847	1,904	121,832
10	105,265	5,395	1,756	112,417
11	105,022	5,382	1,752	112,157
12	102,267	5,241	1,706	109,215
13	102,372	5,246	1,708	109,327
14	100,767	5,164	1,681	107,612
15	110,562	5,666	1,845	118,073
16	115,814	5,935	1,932	123,682
17	116,738	5,983	1,948	124,669
18	101,941	5,224	1,701	108,866
19	96,542	4,948	1,611	103,101
20	94,112	4,823	1,570	100,506
21	99,754	5,112	1,664	106,531
22	59,520	3,050	993	63,564
23	35,594	1,824	594	38,012
Total	**2,244,091**	**115,006**	**37,444**	**2,396,542**

11.2.2 Emissions from Vegetation Clearing

Emissions from vegetation clearing were calculated using the Plot module of the FullCAM software v6.20.03.0827 (Department of the Environment and Energy 2020). Only vegetation with cover greater than 20 percent need to be assessed under the NGER Scheme, a threshold specified by Department of the Environment and Energy (2020).

Spatial data (rainfall, evaporation, temperature, local tree species) was downloaded for latitude -24.265°2′ longitude 149.860°59′, a location within the BSP mining lease.

Each of the areas and vegetation types listed in **Table 11.5** were entered into FullCAM as a plot. The default biomass values were used. The fate of cleared timber has not yet been decided so the worst-case scenario was assumed being that all branches were placed in windrows and burned with no product recovery. Bark, leaves and grass are assumed to be mixed with topsoil and placed back on the land as part of rehabilitation.

Table 11.5: Vegetation in the Study Area with a Crown Cover >20%

Regional ecosystem type	Vegetation type	Modelled as	Area to be cleared (ha)
Regional Ecosystem			
11.3.25	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines	Eucalyptus Open Woodland	0.4
11.5.9	Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces	Eucalyptus Open Woodland	8.7
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Rainforest and Vine Thickets	1.1
High Value Regrowth			
11.3.3a	Eucalyptus coolabah woodland on alluvial plains	Eucalyptus Open Woodland	0.1
11.4.9a	Acacia harpophylla shrubby woodland with Terminalia oblongata on Cainozoic clay plains	Acacia Open Woodland	7.6
11.5.9	Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces	Eucalyptus Open Woodland	4.6
Threatened Ecological Communities			
Brigalow	-	Acacia Open Woodland	10.8
Total	**-**	**-**	**33.3**

Notes: Source: Ecological Survey & Management (2023)

Additionally, 1246 ha of grass will be cleared during the construction and operation of the mine, and for the purpose of this assessment, it has been modelled as Mitchell grass.

Progressive rehabilitation of the waste emplacements will start from year 2 of mining operations and will offset incremental land clearance over the life of the Project. It was assumed that Mitchell grass would be used to revegetate these areas.

The decay or combustion of vegetation will emit both CO_2 and, in anaerobic conditions, CH_4. Literature provided by Department of Environment and Energy and its predecessors, provide some factors for the proportion of non-CO_2 gases released by combustion, but not by decay. Therefore, this assessment assumes that the carbon is released as CO_2.

The results of the model simulation are shown in **Table 11.7**. Applying a conversion factor of 44 / 12 / 1000 converts these predicted values to kilotonnes CO_2-e. For the purpose of this assessment, a period of 50 years from the start of mining operations was selected.

Although the cleared area is larger than the revegetated area, the net emissions from clearing and rehabilitation are negative. This is due to the higher carbon storage of Mitchell grass compared to open woodlands, presumably because of the dense growth and root network. Moreover, when an area is cleared, the carbon is stored in the soil and released slowly over many years, whereas when it is replanted, there is a surge in carbon absorbed from the atmosphere.

Table 11.6: Summary of Disturbed and Revegetated Areas

Year	Eucalyptus Open Woodland (ha)	Acacia Open Woodland (ha)	Rainforest and Vine Thickets (ha)	Mitchell Grass (ha)	Revegetated Area (ha)
1	3.4	4.5	0.3	306	0
2	0.7	1.0	0.1	67	33
3	0.7	1.0	0.1	67	0
4	0.7	1.0	0.1	67	0
5	0.7	1.0	0.1	67	0
6	0.7	1.0	0.1	67	0
7	0.7	1.0	0.1	67	31
8	0.7	1.0	0.1	67	31
9	0.7	1.0	0.1	67	32
10	0.7	1.0	0.1	67	32
11	0.7	1.0	0.1	67	32
12	0.7	1.0	0.1	67	36
13	0.7	1.0	0.1	67	36
14	0.7	1.0	0.1	67	36
15	0.7	1.0	0.1	67	47
16	0	0	0	0	47
17	0	0	0	0	11
18	0	0	0	0	11
19	0	0	0	0	11
20	0	0	0	0	9
21	0	0	0	0	9
22	0	0	0	0	9
23	0	0	0	0	10
24	0	0	0	0	22
25	0	0	0	0	124
26	0	0	0	0	123
27	0	0	0	0	124
28	0	0	0	0	124
29	0	0	0	0	111
Total	**13.8**	**18.5**	**1.1**	**1,246**	**1,091**

Table 11.7: Net Carbon Emissions from Vegetation Clearing and Revegetation Sink

Year	Eucalyptus Open Woodland (tC)	Acacia Open Woodland (tC)	Rainforest and Vine Thickets (tC)	Mitchell Grass (tC)	Revegetation (tC)	Clearing Emission (kilotonnes CO_2-e)	Revegetation Sink (kilotonnes CO_2-e)
1	212	284	16.2	710	0	4.5	0.0
2	92	124	7.1	454	-1,040	2.5	-3.8
3	92	123	7.1	407	-323	2.3	-1.2
4	93	125	7.2	441	-53	2.4	-0.2
5	94	126	7.3	475	0	2.6	0.0
6	95	128	7.4	508	0	2.7	0.0
7	97	130	7.5	541	-977	2.8	-3.6
8	98	131	7.6	572	-1,280	3.0	-4.7
9	99	133	7.7	603	-1,362	3.1	-5.0
10	100	134	7.8	632	-1,372	3.2	-5.0
11	101	136	7.9	661	-1,373	3.3	-5.0
12	102	137	8.0	688	-1,499	3.4	-5.5
13	103	139	8.0	715	-1,538	3.5	-5.6
14	104	140	8.1	742	-1,545	3.6	-5.7
15	105	141	8.2	767	-1,891	3.7	-6.9
16	59	80	4.7	636	-1,999	2.9	-7.3
17	50	67	3.9	595	-883	2.6	-3.2
18	43	58	3.4	578	-530	2.5	-1.9
19	37	50	2.9	562	-472	2.4	-1.7
20	33	44	2.6	546	-409	2.3	-1.5
21	29	39	2.3	531	-389	2.2	-1.4
22	26	35	2.1	517	-386	2.1	-1.4
23	24	32	1.8	503	-418	2.1	-1.5
24	21	29	1.7	489	-806	2.0	-3.0
25	19	26	1.5	476	-4,138	1.9	-15.2
26	18	24	1.4	464	-5,125	1.9	-18.8
27	16	22	1.3	452	-5,312	1.8	-19.5
28	15	20	1.2	441	-5,320	1.8	-19.5
29	14	19	1.1	430	-4,912	1.7	-18.0
30	13	18	1.0	420	-1,287	1.7	-4.7
31	12	17	1.0	410	-179	1.6	-0.7
32	12	16	0.9	400	0	1.6	0.0
33	11	15	0.9	391	0	1.5	0.0
34	10	14	0.8	383	0	1.5	0.0
35	10	13	0.8	375	0	1.5	0.0
36	9	12	0.7	367	0	1.4	0.0

Year	Eucalyptus Open Woodland (tC)	Acacia Open Woodland (tC)	Rainforest and Vine Thickets (tC)	Mitchell Grass (tC)	Revegetation (tC)	Clearing Emission (kilotonnes CO_2-e)	Revegetation Sink (kilotonnes CO_2-e)
37	9	12	0.7	359	0	1.4	0.0
38	8	11	0.6	352	0	1.4	0.0
39	8	11	0.6	345	0	1.3	0.0
40	7	10	0.6	338	0	1.3	0.0
41	7	10	0.6	332	0	1.3	0.0
42	7	9	0.5	326	0	1.3	0.0
43	7	9	0.5	320	0	1.2	0.0
44	6	8	0.5	314	0	1.2	0.0
45	6	8	0.5	309	0	1.2	0.0
46	6	8	0.5	304	0	1.2	0.0
47	6	8	0.4	299	0	1.1	0.0
48	5	7	0.4	294	0	1.1	0.0
49	5	7	0.4	289	0	1.1	0.0
50	5	7	0.4	285	0	1.1	0.0
Total	**2,166**	**2,902**	**168**	**23,348**	**-46,820**	**105**	**-172**

Note: tC defined as net carbon mass in tonnes.

11.2.3 Fugitive Gas Emissions

Fugitive gas emissions from coal extraction have been determined using Method 1 for calculating fugitive gas emissions for open cut coal mines as presented in the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Department of the Environment and Energy, 2023d). The formula for Method 1 calculation is presented below:

$$E_j = Q \times EF_j$$

Where:

E_j is the fugitive emissions of methane (j) that results from the extraction of coal from the mine during the year measured in CO_2-e tonnes.

Q is the quantity of run-of-mine coal extracted from the mine during the year measured in tonnes.

EF_j is the emission factor for methane (j), measured in CO_2-e tonnes per tonne of run-of-mine coal extracted from the mine, taken to be the following:

(a) for a mine in Queensland – 0.031

Based on the Method 1 formula, the emission factor for Queensland and the annual quantity of run-of-mine coal to be extracted, **Table 11.8** presents the greenhouse gas emissions from fugitive gas for each year of mining operation.

Table 11.8: Fugitive Gas Emissions from Coal Extraction at BSP

Year	ROM Extracted (t)	Fugitive Emissions of Methane (kt CO_2-e)
1	1,251,073	39
2	2,141,756	66
3	2,030,053	63
4	2,100,000	65
5	2,200,000	68
6	2,300,000	71
7	2,400,000	74
8	2,500,000	77
9	2,500,000	77
10	2,317,103	72
11	2,250,000	70
12	2,250,000	70
13	2,250,000	70
14	2,189,267	68
15	2,416,509	75
16	2,500,000	77
17	2,500,000	77
18	2,182,084	68
19	2,100,000	65
20	2,019,095	63
21	2,142,522	66
22	1,309,976	41
23	750,948	23
Total	**48,600,387**	**1,507**

Fugitive gas emissions from the stockpiling of product coal at the TLO will be insubstantial for the following reasons:

- Methane accumulates in underground coal seams over the geological timeframes in which coal is formed. When the coal is mined, that methane is released in substantial quantities as accounted for above. There is no substantial additional methane formed during stockpiling of coal.
- Nitrous oxide and other combustion products are potentially released from stockpiles if spontaneous combustion occurs. Trains are expected to take coal from the TLO site daily with no long-term stockpiling. Hence, spontaneous combustion is unlikely.

11.2.4 Liquid Fuel Emissions

Diesel fuel will be used primarily by mining equipment, light vehicles, fixed plant such as lighting rigs, pumps in the coal handling processing plant, and power generators.

Greenhouse emission factors for liquid fuel consumption are shown in **Table 11.9**. Note that the emission factors are per kilolitre of fuel.

Table 11.9: Liquid Fuel Greenhouse Emission Factors

Fuel Type	Energy Content (GJ/kL) [1]	Scope 1 Emission Factor (kg CO_2-e/GJ) [1, 2]	GHG Emission Factor (t CO_2-e/ kL) [3]
Diesel oil (stationary energy purposes)	38.6	70.2	2.71
Diesel in ANFO	38.6	70.2	2.71
Diesel oil (transport)	38.6	70.4	2.72

Notes: 1. Energy content of fuel is sourced from Schedule 1 Part 3 and 4 of Department of the Environment and Energy (2023d).

2. Emission factors include contributions from CO_2, CH_4 and N_2O.

3. GHG Emission Factor is the Energy Content multiplied by Scope 1 Emission Factor converted to tonnes.

The greenhouse gas emission from fuel usage is calculated by multiplying the fuel consumption by the emission factor from the last column in **Table 11.9**. **Table 11.10** presents the resultant emissions from on-site fuel combustion, with a total greenhouse gas emission of 1,989 kt CO_2-e.

Table 11.10: On-site Fuel Combustion Emission Summary

Year	Diesel (transport energy purposes) (kL) [1]	Diesel (transport energy purposes) (kt CO_2-e)[1]	Diesel (stationary energy purposes) [2] (kL)	Diesel (stationary energy purposes) [2] (kt CO_2-e)	Diesel in ANFO (kL) [2]	Diesel in ANFO (kt CO_2-e)[2]	Diesel at TLO (kL)	Diesel at TLO (kt CO_2-e)	Total Emissions (kt CO_2-e)
1	546	1.5	38,048	103	675	1.8	64	0.2	107
2	631	1.7	33,223	90	675	1.8	107	0.3	94
3	666	1.8	39,231	106	675	1.8	99	0.3	110
4	676	1.8	41,432	112	675	1.8	104	0.3	116
5	677	1.8	41,400	112	675	1.8	109	0.3	116
6	678	1.8	42,403	115	675	1.8	114	0.3	119
7	596	1.6	26,265	71	675	1.8	119	0.3	75
8	592	1.6	25,369	69	675	1.8	121	0.3	73
9	619	1.7	30,490	83	675	1.8	122	0.3	86
10	626	1.7	31,332	85	675	1.8	112	0.3	89
11	634	1.7	33,503	91	675	1.8	112	0.3	95
12	585	1.6	23,968	65	675	1.8	109	0.3	69
13	586	1.6	24,299	66	675	1.8	109	0.3	70
14	615	1.7	29,488	80	675	1.8	108	0.3	84
15	637	1.7	33,089	90	675	1.8	118	0.3	94
16	643	1.7	34,637	94	675	1.8	124	0.3	98
17	602	1.6	27,419	74	675	1.8	125	0.3	78
18	627	1.7	31,733	86	675	1.8	109	0.3	90
19	597	1.6	26,604	72	675	1.8	103	0.3	76
20	615	1.7	29,396	80	675	1.8	101	0.3	83
21	629	1.7	32,731	89	675	1.8	107	0.3	93

Year	Diesel (transport energy purposes) (kL) [1]	Diesel (transport energy purposes) (kt CO_2-e)[1]	Diesel (stationary energy purposes) [2] (kL)	Diesel (stationary energy purposes) [2] (kt CO_2-e)	Diesel in ANFO (kL) [2]	Diesel in ANFO (kt CO_2-e)[2]	Diesel at TLO (kL)	Diesel at TLO (kt CO_2-e)	Total Emissions (kt CO_2-e)
22	524	1.4	16,202	44	675	1.8	64	0.2	47
23	482	1.3	8,777	24	675	1.8	38	0.1	27
24	5	0	744	2	0	0	0	0	2
25	5	0	744	2	0	0	0	0	2
26	5	0	740	2	0	0	0	0	2
27	3	0	292	1	0	0	0	0	1
28	3	0	293	1	0	0	0	0	1
29	3	0	292	1	0	0	0	0	1
30	3	0	292	1	0	0	0	0	1
Total	**14,107**	**38**	**704,435**	**1,909**	**15,525**	**42**	**2,397**	**6**	**1,996**

Notes: 1. Transport energy purposes, as defined in Department of the Environment and Energy (2022): purposes for which fuel is combusted that consist of any of the following:

(a) transport by vehicles registered for road use;

(b) rail transport;

(c) marine navigation;

(d) air transport.

2. Stationary energy purposes, as defined in Department of the Environment and Energy (2022): purposes for which fuel is combusted that do not involve transport energy purposes. These include stationary engines, diesel in explosives and mobile plant on-site not registered for road use.

The diesel consumption for off-site haulage of product coal to the train load-out facility was calculated based on product coal mined per year and 105 tonnes payload of trucks. A fuel consumption rate of 85 L/100 km was used (ATA, 2018). **Table 11.11** presents the total fuel consumption and the resultant emissions from off-site product haulage, with a total greenhouse gas emission of 63 kt CO_{2-e}.

Table 11.11: Off-site Product Transport Fuel Combustion Emission Summary

Year	Product (t)	Number of Trips	Fuel (L)	Total Emissions (kt CO_2-e)
1	947,374	9,023	613,538	1.7
2	1,578,896	15,037	1,022,523	2.8
3	1,469,714	13,997	951,815	2.6
4	1,548,821	14,751	1,003,046	2.7
5	1,608,699	15,321	1,041,824	2.8
6	1,694,116	16,134	1,097,142	3.0
7	1,769,800	16,855	1,146,156	3.1
8	1,789,793	17,046	1,159,104	3.2
9	1,806,014	17,200	1,169,609	3.2
10	1,666,441	15,871	1,079,219	2.9
11	1,662,594	15,834	1,076,728	2.9
12	1,618,978	15,419	1,048,481	2.9
13	1,620,640	15,435	1,049,557	2.9
14	1,595,225	15,193	1,033,098	2.8
15	1,750,293	16,669	1,133,523	3.1
16	1,833,437	17,461	1,187,369	3.2
17	1,848,062	17,601	1,196,840	3.3
18	1,613,811	15,370	1,045,135	2.8
19	1,528,349	14,556	989,788	2.7
20	1,489,877	14,189	964,872	2.6
21	1,579,192	15,040	1,022,715	2.8
22	942,255	8,974	610,222	1.7
23	563,484	5,367	364,923	1.0
Total	**35,525,865**	**338,342**	**23,007,227**	**63**

11.2.5 Scope 2 Emissions

Emission factors associated with the annual consumption of purchased electricity are shown in **Table 11.12**.

Table 11.12: Purchased Electricity (Scope 2) Emission Summary

Total Electricity Consumed (kWh)	Emission factor (kg CO_2-e / kWh)[1]	Total Emissions (kt CO_2-e)[2]
34,164,000 (mine) + 1,124,255 (TLO)	0.73	25.8

Note: 1. Source is Schedule 1, Part 6 of Department of the Environment (2022).
2. Annual emissions.

11.2.6 Scope 3 Emissions

Scope 3 emissions are indirect emissions that occur outside the site boundary as a result of actions by the organization. These emissions include upstream emissions, such as those generated during the extraction and production of fossil fuels used by the organisation, as well as downstream emissions from the transportation of the final product to customers or emissions from outsourced activities.

Scope 3 emissions are attributable to the location where the coal is consumed. Therefore, scope 3 are not attributable to the BSP and do not need to be reported under the NGER scheme.

For this assessment, the following Scope 3 emissions were considered:

- Upstream emissions generated during the extraction and production of the diesel used on-site
- Downstream emissions generated by the transportation of product coal by rail and maritime bulk carriers
- Downstream emissions generated by the combustion of product coal by the customers

For calculating upstream emissions related to on-site diesel usage, the Scope 3 emission factor, which is presented as Supply Emission Factor in **Table 11.13** was used. Conversely, when assessing downstream emissions resulting from the combustion of diesel and fuel oil during product coal transportation and coal combustion by the costumer, the direct emissions factors, presented as Combustion Emission Factors in **Table 11.13** were used. These direct emission factors are associated with Scope 1 emissions for the organisation responsible for causing these emissions, but for the BSP they fall under Scope 3.

Table 11.13: Scope 3 Emission Factors

Year	Energy Content (GJ/unit of fuel)[1]	Combustion Emission Factor (kg CO_2-e/GJ)[1,2]	Supply Emission Factor (kg CO_2-e/GJ)[1,2]	GHG Emission Factor (tonnes CO_2-e/unit of fuel)[3]
Coking Coal	30.0 GJ/t	92.03	-	2.76 tonnes CO_2-e/t
Diesel (mobile plant on-site)	38.6 GJ/kL	-	17.3	0.67 tonnes CO_2-e/kL
Diesel (product transportation by rail)	38.6 GJ/kL	70.4	-	2.72 tonnes CO_2-e/kL
Fuel Oil	39.7	73.84	-	2.93 tonnes CO_2-e/kL

Notes: 1. Energy content of fuel and emission factors are sourced from Department of the Environment and Energy (2022).
2. Emission factors include contributions from CO_2, CH_4 and N_2O.
3. GHG Emission Factor is the Energy Content multiplied by Scope 3 Emission Factor.

The following data and assumptions were used in emission calculations of Scope 3 emissions:

- loaded coal train gross weight of 14,144 tonnes (Connell Hatch, 2009)
- unloaded coal train gross weight of 2,666 tonnes (Connell Hatch, 2009)
- maximum coal hauled per trip of 11,019 tonnes (Connell Hatch, 2009)
- train trip distance (one way) of 151 km
- fuel efficiency of 0.0029 and 0.0077 L/t/km for loaded and unloaded trains, respectively (Connell Hatch, 2009)
- product coal conservatively assumed shipped to Japan
- bulk carrier capacity of 275,000 ton
- bulk carrier trip distance of 4,057 nautical miles, at 10 knots, for a total of 16.9 days at sea
- bulk carrier fuel consumption of 37.5 t/day
- heavy fuel oil density of 1010 kg/kL

Table 11.14 presents the calculated Scope 3 emissions.

Table 11.14: Scope 3 Emission Summary

Year	Combustion Emissions from Rail Transportation ($kt\ CO_2$-e)	Combustion Emissions from Bulk Carriers ($kt\ CO_2$-e)	Combustion Emissions from Coal Final Use ($kt\ CO_2$-e)	Upstream Scope 3 Emissions from Diesel Used On-site ($kt\ CO_2$-e)	Total Emissions ($kt\ CO_2$-e)
1	2.2	13	2,615	27	2,656
2	3.6	21	4,358	24	4,406
3	3.4	20	4,056	28	4,107
4	3.6	21	4,275	29	4,328
5	3.7	22	4,440	29	4,495
6	3.9	23	4,676	30	4,732
7	4.1	24	4,885	19	4,932
8	4.1	24	4,940	19	4,987
9	4.1	24	4,985	22	5,035
10	3.8	22	4,599	23	4,648
11	3.8	22	4,589	24	4,639
12	3.7	22	4,468	18	4,511
13	3.7	22	4,473	18	4,516
14	3.7	21	4,403	21	4,449
15	4.0	23	4,831	24	4,882
16	4.2	25	5,060	25	5,114
17	4.2	25	5,101	20	5,150
18	3.7	22	4,454	23	4,502
19	3.5	20	4,218	19	4,262
20	3.4	20	4,112	21	4,157
21	3.6	21	4,359	24	4,407

Year	Combustion Emissions from Rail Transportation (kt CO_2-e)	Combustion Emissions from Bulk Carriers (kt CO_2-e)	Combustion Emissions from Coal Final Use (kt CO_2-e)	Upstream Scope 3 Emissions from Diesel Used On-site (kt CO_2-e)	Total Emissions (kt CO_2-e)
22	2.2	13	2,601	12	2,628
23	1.3	8	1,555	7	1,571
24	0	0	0	1	1
25	0	0	0	1	1
26	0	0	0	0	0
Total	**82**	**475**	**98,051**	**508**	**99,116**

11.2.7 Summary of Greenhouse Gas Emissions

Based on the emission calculations, the major sources of greenhouse gas emissions are diesel fuel combustion due to mining equipment and fugitive seam gas. The highest annual scope 1 emissions from the BSP are estimated to be 196 kilotonnes CO_2-e and scope 2 emissions 26 kilotonnes CO_2-e. A summary of the emissions breakdown is presented in **Table 11.15**.

The total scope 1 and scope 2 greenhouse gas emissions in 2021 - 2022 from Australian corporations that had to report to NGER was 394 megatonnes CO_2-e (Clean Energy Regulator, 2023). The total emissions in 2021 from Queensland under the Kyoto Protocol Accounting Framework were 140 megatonnes CO_2-e (Department of Environment and Energy, 2021). Based on the sum of the totals from each activity, the worst-case year in terms of emissions from the mine operation would be year 6, with a total of 222 kilotonnes CO_2-e or 0.056% of Australian NGER emissions and 0.16% of Queensland emissions.

Table 11.15: Greenhouse Gas Emissions

Year	Scope 1 Vegetation Clearing & Rehab (kt CO_2-e)	Scope 1 Fugitive Gas Emissions (kt CO_2-e)	Scope 1 Fuel Combustion On-site (Mine) (kt CO_2-e)	Scope 1 Fuel Combustion On-site (TLO) (kt CO2-e	Scope 1 Fuel Combustion Off-site (kt CO_{2-e})	Total Scope 1 Emissions (kt CO_{2-e})	Scope 2 Grid Electricity Consumption (kt CO_2-e)	Total Annual Emissions (kt CO_2-e)
1	4.5	39	106	0.2	1.7	152	26	177
2	-1	66	94	0.3	2.8	162	26	187
3	1	63	110	0.3	2.6	177	26	203
4	2.3	65	116	0.3	2.7	186	26	212
5	2.6	68	116	0.3	2.8	190	26	216
6	2.7	71	119	0.3	3.0	196	26	222
7	-0.7	74	75	0.3	3.1	152	26	178
8	-1.7	77	72	0.3	3.2	151	26	177
9	-1.9	77	86	0.3	3.2	165	26	191
10	-1.8	72	88	0.3	2.9	162	26	187
11	-1.7	70	94	0.3	2.9	166	26	191
12	-2.1	70	68	0.3	2.9	139	26	165
13	-2.1	70	69	0.3	2.9	140	26	166
14	-2.0	68	83	0.3	2.8	152	26	178
15	-3.2	75	93	0.3	3.1	168	26	194
16	-4.5	77	97	0.3	3.2	174	26	200
17	-0.6	77	78	0.3	3.3	158	26	184
18	0.6	68	90	0.3	2.8	161	26	187
19	0.7	65	76	0.3	2.7	144	26	170
20	0.8	63	83	0.3	2.6	149	26	175
21	0.8	66	92	0.3	2.8	163	26	188

Year	Scope 1 Vegetation Clearing & Rehab (kt CO_2-e)	Scope 1 Fugitive Gas Emissions (kt CO_2-e)	Scope 1 Fuel Combustion On-site (Mine) (kt CO_2-e)	Scope 1 Fuel Combustion On-site (TLO) (kt CO2-e	Scope 1 Fuel Combustion Off-site (kt CO_2-e)	Total Scope 1 Emissions (kt CO_2-e)	Scope 2 Grid Electricity Consumption (kt CO_2-e)	Total Annual Emissions (kt CO_2-e)
22	0.7	41	47	0.2	1.7	90	26	116
23	0.5	23	27	0.1	1.0	52	26	78
24	-1.0	0	2	0	0	1	0	1
25	-13	0	2	0	0	-11	0	-11
26	-17	0	2	0	0	-15	0	-15
27	-18	0	1	0	0	-17	0	-17
28	-18	0	1	0	0	-17	0	-17
29	-16	0	1	0	0	-16	0	-16
30	-3.1	0	1	0	0	-2	0	-2
31	1.0	0	0	0	0	1	0	1
32	1.6	0	0	0	0	2	0	2
33	1.5	0	0	0	0	2	0	2
34	1.5	0	0	0	0	2	0	2
35	1.5	0	0	0	0	1	0	1
36	1.4	0	0	0	0	1	0	1
37	1.4	0	0	0	0	1	0	1
38	1.4	0	0	0	0	1	0	1
39	1.3	0	0	0	0	1	0	1
40	1.3	0	0	0	0	1	0	1
41	1.3	0	0	0	0	1	0	1
42	1.3	0	0	0	0	1	0	1
43	1.2	0	0	0	0	1	0	1

Year	Scope 1 Vegetation Clearing & Rehab (kt CO_2-e)	Scope 1 Fugitive Gas Emissions (kt CO_2-e)	Scope 1 Fuel Combustion On-site (Mine) (kt CO_2-e)	Scope 1 Fuel Combustion On-site (TLO) (kt CO2-e	Scope 1 Fuel Combustion Off-site (kt CO_{2-e})	Total Scope 1 Emissions (kt CO_{2-e})	Scope 2 Grid Electricity Consumption (kt CO_2-e)	Total Annual Emissions (kt CO_2-e)
44	1.2	0	0	0	0	1	0	1
45	1.2	0	0	0	0	1	0	1
46	1.2	0	0	0	0	1	0	1
47	1.1	0	0	0	0	1	0	1
48	1.1	0	0	0	0	1	0	1
49	1.1	0	0	0	0	1	0	1
50	1.1	0	0	0	0	1	0	1
Total	**-66**	**1,507**	**1,989**	**6**	**63**	**3,499**	**592**	**4,091**
Average	**-1**	**30**	**40**	**0.1**	**1**	**70**	**12**	**82**
Life of Mine Average	**-0.3**	**66**	**86**	**0.3**	**2.7**	**154**	**26**	**180**
Decommissioning Average	**-12**	**0**	**1.3**	**0**	**0.0**	**-11**	**0**	**-11**
Maximum	**4.5**	**77**	**119**	**0.3**	**3.3**	**196**	**26**	**222**

11.3 Recommendations for Mitigation Measures

Potential measures to minimise greenhouse gas emissions from the BSP are outlined in the following subsections. These are based on typical industry best practices and are presented as recommendations only. A detailed decarbonisation plan will be included as part of the EIS application.

11.3.1 Equipment and Energy Efficiency

(1) Include energy efficiency as a criterion when selecting diesel and electric-powered motors and other equipment for purchase, for example, variable speed drive pumps. This has the potential for substantial reductions in electricity demand.

(2) Install energy-efficient lighting and controls where practical. This has the potential for small reductions in electricity demand.

11.3.2 Mine Planning

(3) Minimise vegetation clearing. This has the potential for small reductions in emissions due to the decay of vegetation.

(4) Where practical reuse vegetation that has to be cleared as timber product or mulch for rehabilitation. This has the potential for small reductions in emissions due to the decay of vegetation.

(5) Rehabilitate the land as soon as practical. The subsequent growth of vegetation would provide an offset sink for CO_2.

11.3.3 Mine Operations

(6) Use production monitoring systems to minimise fuel burn rates and reduce the time trucks idle.

(7) Maintain electrical equipment to retain energy efficiency. This has the potential for reductions in electricity demand.

(8) Maintain haul roads to minimise rolling resistance. This has the potential for reductions in diesel consumption.

(9) Recycle water in the processing operations to reduce off-site pumping requirements.

(10) Provide training for mobile plant operators in how to minimise fuel consumption, including no unnecessary idling.

(11) Where suitable, use local personnel to reduce transport emissions. This has the potential for reductions in transport fuel consumption.

(12) As far as practical, obtain construction materials and ongoing consumables from local suppliers to reduce fuel consumption.

11.3.4 New Technology

(13) Consider using solar energy and other clean energy sources, including solar panels, to extend battery life at workshops, diesel lighting plants, and remote monitoring and control stations.

11.3.5 Management Systems

(14) Following completion of annual reporting, undertake an internal energy audit and energy mass balance to ensure that the activities use best practices to minimise energy consumption.

(15) Minimise stockpile retention times on the TLO stockpiles to prevent heat build-up and spontaneous combustion.

12. CONCLUSION

12.1 Air Quality

An air quality assessment has been conducted for the proposed Baralaba South Project. Potential for health impacts is addressed using criteria for TSP, PM_{10} and $PM_{2.5}$. Potential for amenity impacts is addressed using the dust deposition criterion.

The results and recommendations of the assessment are as follows:

- The dust control measures recommended in **Section 10.4.4.2** are to be implemented and maintained. It is worth noting that these control measures are based on achieving compliance at all receptor locations outside of the MLA. However, if one or more of these receptors were not to be considered (e.g. by purchase/agreement), the dust control measures may be able to be reduced, subject to further evaluation. A different combination of control measures to those recommended in **Section 10.4.4.2** may also be acceptable as long as compliance with the air quality criteria is assessed and achieved at sensitive receptor locations.
- There is low to negligible chance of exceedances of all indicators (dust deposition, annual average TSP, 24-hour average PM_{10}, annual average PM_{10}, 24-hour average $PM_{2.5}$ and annual average $PM_{2.5}$) at receptors outside the MLA boundary. It is recommended compliance monitoring be conducted as described in **Section 10.5**.

12.2 Greenhouse Emissions

A greenhouse gas emissions assessment has been conducted for the proposed BSP and TLO. The BSP and TLO are estimated to contribute up to a maximum of 222 kilotonnes of scope 1 and 2 CO_2-e per year with an average of 180 kilotonnes CO_2-e during the 23 year life of the mine. This operation exceeds the 25 kilotonne threshold (discussed in **Section 11.1.2**), requiring Baralaba Coal Company Pty Ltd to report to the NGER system.

Emissions from the mine operation will be 0.056% of Australian NGER emissions for the modelled worst-case year. This represents a small contribution to Australia's emission inventory. It is recommended that all practical measures to reduce these emissions, as described in **Section 11.3**, be implemented.

It is recommended that Method 2 calculation of fugitive gas emissions be undertaken for the purpose of NGER reporting.

REFERENCES

ACARP (1999), Fine Dust and the Implications for the Coal Industry, Report C7009.

Anderson, A., Rezamand, P., & Skibiel, A. L. (2022). Effects of wildfire smoke exposure on innate immunity, metabolism, and milk production in lactating dairy cows. Journal of Dairy Science, 105, 7047-7060. doi:10.3168/jds.2022-22135.

Andrews A. & Skriskandarajah, N (1992), Coal Mine Dust & Dairy Farming – The Answers, New South Wales Coal Association, and Australian Co-operative Foods, cited in Katestone Environmental (2013) Air Quality Assessment of the Mackenzie North Project.

AS/NZS 3580.9.9-2006 Determination of suspended particulate matter – PM10 low volume sampler – Gravimetric method.

AS/NZS 3580.9.11-2016: Methods for sampling and analysis of ambient air – Determination of particulate matter – PM10 beta attenuation monitors .

AS/NZS 3580.10.1-2016: Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method .

AS3580.14-2014 Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications .

ATA (2018), Truck impact chart: Technical Advisory Procedure, 2.2 edition, developed by Australian Trucking Association Industry Technical Council, March 2018.

Aurizon. Coal Dust Management Plan. 13 March 2020. https://www.aurizon.com.au/sustainability/environmental-management/dust, accessed 2/2/2021.

Aurizon Network. Public Quarterly Performance Report: 3rd Quarter 2018/19, January – March 2019. https://www.aurizon.com.au/what-we-deliver/network/network-downloads, accessed 2/2/2021.

Aurizon Network. Public Quarterly Performance Report: 4th Quarter 2018/19, April - June 2019. https://www.aurizon.com.au/what-we-deliver/network/network-downloads, accessed 2/2/2021.

Aurizon Network. Public Quarterly Performance Report: 1st Quarter 2019/20, July - September 2019. https://www.aurizon.com.au/what-we-deliver/network/network-downloads, accessed 2/2/2021.

Aurizon Network. Public Quarterly Performance Report: 2nd Quarter 2019/20, October – December 2019. https://www.aurizon.com.au/what-we-deliver/network/network-downloads, accessed 2/2/2021.

Beaupied, B. L., Martinez, H., Martenies, S., McConnel, C. S., Pollack, I. B., Giardina, D., . . . Magzamen, S. (2022). Cows as canaries: The effects of ambient air pollution exposure on milk production and somatic cell count in dairy cows. *Environmental Research, 207*, 112197. doi:10.1016/j.envres.2021.112197.

Bureau of Meteorology (2019), Map2. Subdivisions within the key climate groups, http://www.bom.gov.au/iwk/climate_zones/map_2.shtml, accessed on 24/06/2019.

Chirinos-Peinado, D. M., & Castro-Bedriñana, J. I. (2020). Lead and cadmium blood levels and transfer to milk in cattle reared in a mining area. *Heliyon, 6*, e03579. doi:10.1016/j.heliyon.2020.e03579.

Clean Energy Regulator (2023), 2021-22 Greenhouse and Energy Information by Registered Corporation, accessed on 01/09/2023 from https://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/Data-highlights/2021-22-published-data-highlights .

Connell Hatch (2008), Environmental Evaluation of Fugitive Coal Dust Emissions From Coal Trains: Goonyella, Blackwater and Moura Coal Rail Systems, Report H327578-N00-EE00.00 to Queensland Rail.

Connell Hatch (2009), Surat Basin Rail Project Environmental Impact Statement.

Cox J. (2014), *Mobile Sampling of Dust Emissions from Unsealed Roads*, ACARP Project C20023 Stage 2.

Cox B., Gasparrini A., Catry B., Fierens F., Vangronsveld J. & Nawrot T (2016), Ambient Air Pollution-Related Mortality in Dairy Cattle: Does it Corroborate Human Findings? in Epidemiology; 27(6): 779-786.

Department of Environment and Energy (2017), National Greenhouse and Energy Reporting Scheme Measurement Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia, October 2017, Canberra.

Department of Environment and Energy (2020), Full Carbon Accounting Model, Australian National Greenhouse Accounts, Australian Government.

Department of Environment and Energy (2021), States Greenhouse Gas Inventories 2021, https://www.greenhouseaccounts.climatechange.gov.au/, accessed on 01/09/2023.

Department of Environment and Energy (2023a), National Greenhouse and Energy Reporting Act 2007. Office of Legislative Drafting and Publishing, Attorney-General's Department, Canberra, last amended 12 April 2023.

Department of Environment and Energy (2023b), National Greenhouse and Energy Reporting Regulations 2008. Office of Legislative Drafting and Publishing, Attorney-General's Department, Canberra, last amended 1 July 2023.

Department of Environment and Energy (2023c), Australian National Greenhouse Account: National Greenhouse Accounts Factors February 2023, Australian Government.

Department of Environment and Energy (2023d), National Greenhouse and Energy Reporting (Measurement) Determination 2008. Department of Climate Change, Canberra, last amended 7 October 2023.

DES (2017), Guideline: Model mining conditions, version 6.02, Queensland Department of Environment and Science.

DES (2023), Guideline: Application requirements for activities with impacts to air, version 5.00, Queensland Department of Environment and Science.

Department of Science, Information Technology, Innovation and the Arts (2013), Western-Metropolitan Rail Systems Coal Dust Monitoring Program, https://www.qld.gov.au/__data/assets/pdf_file/0033/68775/rail-coal-dust-final-report.pdf, accessed 3/2/2021.

Egberts, V., van Schaik, G., Brunekreef, B., & Hoek, G. (2019). Short-term effects of air pollution and temperature on cattle mortality in the Netherlands. *Preventive Veterinary Medicine, 168*, 1-8. doi:10.1016/j.prevetmed.2019.03.021

Environment Australia (2012), National Pollutant Inventory Emission Estimation Technique Manual for Mining Version 3.1.

EPP(Air) (2019), Environmental Protection (Air) Policy, Queensland Government.

Graybeal, D. (2006), Relationships among Daily Mean and Maximum Wind Speeds, with Application to Data Quality Assurance, Int.J.Climatol. 26: 29-43.

Katestone (2011), NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, Katestone Environmental report KE1006953 for NSW Office of Environment and Heritage.

Lucas S.A., Coombes P.J., Planner J. and Welchman S. (2009), Rainfall harvesting and coal dust: the potential health impacts of trace elements in coal dust in rainwater, Air Quality and Climate Change Volume 43 No. 2., May 2009.

NEPM (2016), National Environment Protection (Ambient Air Quality) Measure, compilation prepared on 25 February, 2016 by Department of the Environment.

New South Wales Environment Protection Authority (2016), Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales, New South Wales Environment Protection Authority.

New Zealand Ministry for the Environment (2016), Good Practice Guide for Assessing and Managing Dust, November 2016.

NHMRC (2022) "Australian Drinking Water Guidelines Version 3.8 Updated September 2022, National Health and Medical Research Council, Canberra.

Nieckarz, Z., Pawlak, K., Baran, A., Wieczorek, J., Grzyb, J., & Plata, P. (2023). The concentration of particulate matter in the barn air and its influence on the content of heavy metals in milk. *Scientific Reports, 13*, 10626. doi:10.1038/s41598-023-37567-2.

Pacific Environment Limited (2015), Development of Australia-Specific PM10 Emission Factors for Coal Mines, ACARP Project C22027 Final Report.

Pembroke Olive Downs Pty Ltd v Sunland Cattle Co Pty Ltd (2020) QLC 27. Land Court of Queensland.

Scire J.S. & Robe F.R. (1997), Fine-Scale Application of the Calmet Meteorological Model to a Complex Terrain Site, Air and Waste Management Association's 90th Annual Meeting.

SDMIP (2018), State Development Assessment Provisions version 2.2, Department of State Development, Manufacturing, Infrastructure and Planning, March 2018.

Simtars (2008), Gladstone Airborne Coal Dust Monitoring, report oe101776f3 to QR National.

Todoroski Air Sciences (2014), Air Quality and Greenhouse Gas Assessment Baralaba North Continued Operations Project, prepared for Cockatoo Coal Limited, 10 April 2014.

TRC (2011), Generic Guidance and Optimum Model Settings for the Calpuff Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessment of Air Pollutants in NSW, Australia', prepared for NSW Office of Environment and Heritage.

United States Environmental Protection Agency (2006) AP42 Compilation of Air Pollution Emission Factors, 5th Edition, Volume 1, Chapter 13: Miscellaneous Sources, Section 2.4 Aggregate Handling and Storage Piles.

United States Environmental Protection Agency (2006) AP42 Compilation of Air Pollution Emission Factors, 5th Edition, Volume 1, Chapter 13: Miscellaneous Sources, Section 2.5 Industrial Wind Erosion.

Utah DAQ (2015), Guidelines: Emission Factors for Paved and Unpaved Haul Roads, a memorandum from Regg Olsen, Permitting Branch Manager to the Permitting Branch, State of Utah Division of Air Quality, 12 January 2015.

Victoria (2001), State Environment Protection Policy (Air Quality Management).

APPENDIX A GLOSSARY

Parameter or Term	Description
bcm	Bank Cubic Metres (volume of material in the ground prior to mining)
BSP	Baralaba South Project
CHPP	Coal Handling and Preparation Plant
CO_2	Carbon dioxide
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
Dust fallout deposition	Dust that has fallen out of the air onto a horizontal surface
EIS	Environmental impact statement
EPA	Queensland Environmental Protection Act 1994
EPP (Air)	Queensland Environmental Protection (Air) Policy 2019
$g/m^2/month$	Grams per square metre per month
GHG	Greenhouse gas
GJ	Giga joule
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
kg	Kilogram
kt	Kilotonnes
kWh	Kilowatt hours
$mg/m^2/day$	Milligrams per square metre per day
MLA	Mining Lease Application
Mt	Million tonnes
N_2O	Nitrous oxide
NGER	National Greenhouse and Energy Reporting
NPI	National Pollutant Inventory
NEPM	National Environmental Protection (Ambient Air Quality) Measure
NSW EPA	New South Wales Environment Protection Authority
NSW OEH	New South Wales Office of Environment and Heritage
$PM_{2.5}$	Particulates suspended in air with aerodynamic diameter less than 2.5 microns
PM_{10}	Particulates suspended in air with aerodynamic diameter less than 10 microns
ROM	Run of mine coal
SRTM	Shuttle Radar Topography Mission
TAPM	The Air Pollution Model developed by CSIRO and used by Trinity Consultants for meteorological modelling
TLO	Train Load-Out
ToR	Terms of Reference
TSP	Total particulates suspended in air
$\mu g/m^3$	Micrograms per cubic metre
USEPA	United States Environmental Protection Agency

APPENDIX B EMISSION INVENTORY EQUATIONS FOR PARTICULATES

Loading Overburden to Trucks by Excavator

Equation 10 of Environment Australia (2012) has been used because it provides a method of varying emission rates with wind speed.

$$E = 0.0016\,k\,\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where

- E = Emission Factor with units kg/t of overburden
- U = mean wind speed (m/s)
- M = soil moisture content (%)
- k = 0.74 for TSP
- k = 0.35 for PM_{10}

Loading Coal to Trucks by Front End Loader

Equation 12 of Environment Australia (2012) has been used.

$$E_{TSP} = \frac{0.58}{(M)^{1.2}}$$

$$E_{PM_{10}} = \frac{0.0447}{(M)^{0.9}}$$

where

- E = Emission factor with units kg/t of coal
- M = Soil moisture content (%)

Bulldozing Overburden

Equations 16 and 17 of Environment Australia (2012) have been used.

$$E_{TSP} = 2.6 \times \frac{(s)^{1.2}}{(M)^{1.3}}$$

$$E_{PM_{10}} = 0.34 \times \frac{(s)^{1.5}}{(M)^{1.4}}$$

where

- E = Emission factor with units kg/h/vehicle
- s = Material silt content (%)
- M = Soil moisture content (%)

Trucks Dumping Overburden

From equation 1 of USEPA (2006):

$$E = 0.0016\,k\,\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where

E = Emission Factor with units kg/t of overburden

U = mean wind speed (m/s)

M = soil moisture content (%)

k = 0.74 for TSP

k = 0.35 for PM_{10}

Trucks Dumping Coal

From Section A1.1.7 of Environment Australia (2012):

$E_{TSP} = 0.010$ kg/t

$E_{PM10} = 0.0042$ kg/t

Drilling

From Section A1.1.8 of Environment Australia (2012):

$E_{TSP} = 0.59$ kg/hole

$E_{PM10} = 0.31$ kg/hole

Blasting

Equation 18 of Environment Australia (2012) was used in the modelling.

$$E = 344\,k \times \frac{(A)^{0.8}}{(M)^{1.9} \times (D)^{1.8}}$$

where

E = Emission factor in units kg/blast

k = 1 for TSP

k = 0.52 for PM_{10}

A = Area blasted (m^2)

M = Soil moisture content (%)

D = Depth of the blast holes (m)

High emission of NO_x from blasting can occur under the following conditions:

- Unstable, poorly mixed, or unsensitive explosive mixtures are used.
- Explosives are used that are not appropriate for the rock type.
- Explosives that are not water-resistant are used in wet holes.
- Explosives are left in the holes for too long.
- Poor design of blast timing causes damage to unexploded holes.
- Explosives leak into fissures.

Proper management of blasting should ensure that NO_x fumes are minimised and disperse before leaving the mine site.

Wheel Dust Generation from Mine Vehicles on Unpaved Roads

The PM_{10} emission factor used in this assessment is 260 g/km, which was recommended by Pacific Environment Limited (2015), based on measurements undertaken at Australian coal mines.

The TSP emission factor was calculated using the PM_{10} emission factor of 260 g/km and the ratio of the calculated TSP and PM_{10} emissions using the below formulae (Environment Australia (2012), resulting in a TSP emission factor of 1029 g/km.

TSP

$$E = 4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} \quad \{lb/VMT\}$$

PM_{10}

$$E = 1.5 \times \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W}{3}\right)^{0.45} \quad \{lb/VMT\}$$

Where: E = Emission factor
s = Material silt content (%)
W = mean vehicle weight (tonnes)
Note – lb/VMT was converted to kg/VKT by multiplying lb/VMT by 0.2819
– vkt = vehicle kilometres travelled

Grader

From Section A1.1.14 of Environment Australia (2012):

$E = 0.0034 \times S^k$

where

E = Emission factor with units kg/vkt (vkt = vehicle kilometre travelled)

k = 2.5 for TSP

k = 2.0 for PM_{10}

S = Mean Vehicle Speed (km/h)

Loading Coal to Stockpile

From Section A1.1.15 of Environment Australia (2012):

E_{TSP} = *0.0040 kg/t*

E_{PM10} = *0.0017 kg/t*

Wind Erosion from Un-vegetated and Unsealed Surfaces

Environment Australia (2012) provides an NPI method for estimating annual emissions of dust from wind erosion based on either a default value published in 1983 or an equation published in 1998, which has several variables including number of rain days and average wind speed. However dispersion modelling is normally based on hourly time-steps and using this equation, the model will predict a small quantity of wind-blown dust every hour of the year. In reality, peak emissions of wind-blown dust will occur only during high wind speeds conditions during dry periods. During low wind speed conditions when particulates from other sources can accumulate, wind-blown dust will be negligible. Thus using the NPI equations will lead to inaccurate and un-timely contribution of wind-blown dust to the peak 24 hour predictions.

Trinity calculates variable wind-blown dust emissions from exposed surfaces based on equations 2 and 3 of USEPA (2006), which combine to become:

$E = k \times \left(58 \times (u^* - u_t^*)^2 + 25\,(u^* - u_t^*)\right)$

Where: E = Emission factor with units g/m^2/disturbance hour
k = Constant (1.0 for TSP, 0.5 for PM10 and 0.075 for PM2.5)
u^* = surface friction velocity (m/s)
u_t^* = threshold friction velocity (m/s)

The surface friction velocity can be calculated for different wind speed classes (at 10 metre anemometer height, based on Equations 13.2.5-6 and 13.2.5-7 of AP-42 (USEPA 2006) using the following three factors:

- Based on Table 13.2.5-3 the ratio of surface wind to 10 metre approach wind over a steep stockpile area ranges from 0.2 to 1.1. Parts of the stockpile where the ratio is 0.2 will likely never be eroded by wind. Parts of the stockpile where the ratio is 0.6 will trigger rarely if ever for coal only. Overburden will only trigger when the ratio reaches 1.1, which is 4% of less of the stockpile. Coal will trigger when the ratio is 0.9 to 1.1, which occurs over 15% of the stockpile.
- Using equation 13.2.5-7, the surface friction velocity is one tenth of the surface wind.
- However these calculations are based on "fastest-mile" wind speeds, which approximate the fastest 1-minute mean wind speed (Graybeal 2006). The wind speeds used in modelling are one hour means. Ratios ("G_{60}") of 1 minute means to one hour means are estimated by Ashcroft (1984) for different terrain types. For mostly open, fairly level terrain with a few buildings, G_{60} = 1.26.

Therefore for overburden, the surface friction velocity is calculated as 1.1 x 0.1 x 1.26 times the 10 metre approach wind. For coal the ratio is assumed to be 0.6 x 0.1 x 1.26 x the 10 metre approach wind.

For each wind speed category, the geometric mean surface friction velocities are shown in **Table 12.1** and **Table 12.2**.

Table 12.1 Wind Speeds and Corresponding Surface Friction Velocities (m/s) for 4% of Exposed Earth and Overburden

Pasquill Wind Speed Class	Corresponding Surface Friction Velocities	Mean Surface Friction Velocity
0 – 1.54	0 – 0.21	0.11
1.54 – 3.09	0.21 – 0.43	0.30
3.09 – 5.14	0.43 – 0.71	0.55
5.14 – 8.23	0.71 – 1.14	0.90
8.23 – 10.80	1.14 – 1.50	1.31
> 10.80	> 1.50	1.52

Table 12.2 Wind Speeds and Corresponding Surface Friction Velocities (m/s) for 15% of Exposed Coal

Pasquill Wind Speed Class	Corresponding Surface Friction Velocities	Mean Surface Friction Velocity
0 – 1.54	0 – 0.17	0.09
1.54 – 3.09	0.17 – 0.35	0.25
3.09 – 5.14	0.35 – 0.58	0.45
5.14 – 8.23	0.58 – 0.93	0.74
8.23 – 10.80	0.93 – 1.22	1.07
> 10.80	> 1.22	1.25

The threshold friction velocity (Table 13.2.5-2, USEPA 2006) for overburden is 1.02 m/s, and for fine coal dust on concrete stockpile pads is 0.54 m/s. The resultant emission rates for different Pasquill wind speed classes are given in **Table 12.3**.

Table 12.3 Wind Erosion Emission Rates for Exposed Surfaces

Source	Pasquill Wind Speed Class (m/s)	TSP (kg/ha/hour)	PM_{10} (kg/ha/hour)	$PM_{2.5}$ (kg/ha/hour)
Overburden dumps	5.15 – 8.23	0.7	0.3	0.03
Overburden dumps	8.24 – 10.80	5	2	0.2
Overburden dumps	> 10.80	10	5	0.4
ROM coal stockpile pads	3.09 – 5.14	0.8	0.4	0.03
ROM coal stockpile pads	5.15 – 8.23	11	5	0.4
ROM coal stockpile pads	8.24 – 10.80	44	22	2
ROM coal stockpile pads	> 10.80	70	35	3

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