Attachment 9

Air Quality Assessment

BROMELTON NORTH QUARRY - AIR QUALITY ASSESSMENT

Project ID: 14565

9/12/2022

Release: R2

Prepared For:

Groundwork Plus

Assured Environmental

DOCUMENT CONTROL PAGE

Project Title: BROMELTON NORTH QUARRY - AIR QUALITY ASSESSMENT

Project Reference ID: 14565

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105

Report Prepared for:

Groundwork Plus
6 Mayneview Street
Milton, QLD, 4066

M. Clifton

Author: Michelle Clifton

Reviewer: Craig Beyers

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R0	8/11/2022	M. Benham	Initial Release
R1	24/11/2022	M. Benham	Comments
R2	9/12/2022	M. Benham	Comments

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

°C	Degrees centigrade
Conversion of ppm to mg/m^3	Where R is the ideal gas constant; T, the temperature in kelvin (273.16 + T°C); and P, the pressure in mm Hg, the conversion is as follows: mg m^3 = (P/RT) x Molecular weight x (concentration in ppm) $= \frac{P \times \text{Molecular weight} \times (\text{concentration in ppm})}{62.4 \times (273.2 + T°C)}$ For the purposes of the air quality assessment all conversions were made at 0°C unless stated otherwise.
g/s	Grams per second.
g/m^2	Gram per metre square.
g/m^2/month	Gram per metre square per month.
ha	Hectares.
m	Metre.
m/s	Metres per second
mg/m^3	Milligrams (10-3) per cubic metre. Conversions from mg/m^3 to parts per volume concentrations (i.e., ppm) are calculated at 0 °C.
kg	Kilograms.
kg/annum	Kilograms per annum.
km	Kilometre
µg/m^3	Micrograms (10-6) per cubic metre. Conversions from µg/m^3 to parts per volume concentrations (i.e., ppb) are calculated at 0 °C.
ppb	Parts per billion.
ppm	Parts per million.
PM_{10}, $PM_{2.5}$, PM_1	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres, respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
TSP	Total suspended particulate.
70th percentile	The value exceeded for 70 % of the time.

ABBREVIATIONS

AHD	Australian Height Datum
DES	Department of Environment and Science
EA	Environmental Authority
EPP(Air)	Environmental Protection (Air) Policy 2019
ERA	Environmentally Relevant Activities
KRA	Key Resource Area
GLC	Ground Level Concentration
NPI	National Pollutant Inventory
SDAP	State Development Assessment Provisions
tpa	Tonnes per annum

1 INTRODUCTION

1.1 Background

The Neilsens Group (Neilsens) operate the hard rock quarry known as Bromelton North Quarry, (Subject Site). Bromelton North Quarry is operated pursuant to Consent Order for Material Change of Use – Development Permit for Extractive Industry (ref: 3448 of 2003) granted on 23 June 2004. The Consent Order allows for extraction of 400,000 tonnes per annum of material from the site.

The operation holds an Environmental Authority (EA) EPPR00054113 for the extraction and screening of between 100,000 to 1,000,000 tonnes of material per annum.

Neilsens propose to increase the extraction rate to 800,000 tonnes per annum and extend the east pit footprint. It is not proposed to change the approved hours of operation or location of fixed plant, and equipment.

1.2 Scope of Assessment

Assured Environmental (AE) was appointed by Groundwork Plus to undertake an air quality assessment for the increase in extraction and screening from 400,000 tpa to 800,000 tpa.

In undertaking the assessment, reference has also been made to the following regulations and guidelines:

- Environmental Protection Act 1994;
- Environmental Protection Regulation 2019;
- Environmental Protection (Air) Policy 2019;
- Application requirements for activities with impacts to air (DES, 2021); and
- The Bromelton State Development Area (SDA) Development Scheme.

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to assess the potential for adverse amenity and health impacts as a result of the proposed development.

1.3 This Report

This report summarises the methodology, results, and conclusions of the air quality assessment.

2 DESCRIPTION OF ENVIRONMENTAL VALUES

2.1 Location

The Subject Site is located at Sandy Creek Road, Bromelton, on Lot 1 on RP98576. The Site is approximately 5 km south west of Beaudesert and has a total site area of approximately 62.792 hectares. The site is located in the Transition Precinct of the Bromelton State Development Area, in which extractive industry is an expected land use. The Subject Site and the adjacent quarry are classified as a Key Resource Area (KRA 61), which is a planning tool designed to protect resources from being rendered inaccessible by urban expansion.

The existing setting dominated by agricultural land used for cropping and grazing purposes interspersed with clusters of rural residential land. Other non-rural activities occur within proximity of the site, including an adjacent extractive industry use to the south and energy facility to the west.

2.2 Receptors

There are 5 sensitive receptors within 1 km of the Subject Site and 20 sensitive receptors within 2 km. All receptors within 2 km of the Subject Site are listed in Table 2 and have been identified as shown in Figure 2.

The nearest sensitive receptor, R1 is a single dwelling located approximately 558 metres south west of the Subject Site boundary. The quarry workings will retain a ridgeline to the south, which will topographically screen the operations from receptors to the south-east and south-west.

Table 2: Modelled Sensitive Receptors

ID	Location (UTM Zone 56)		Elevation (m)	Land use
	Easting	Northing		
R1	492722	6903088	89	Residential
R2	492669	6902126	61	Residential
R3	492499	6902079	66	Residential
R4	492511	6902002	68	Residential
R5	492453	6901925	73	Residential
R6	492452	6901859	73	Residential
R7	492404	6901783	75	Residential
R8	492477	6901708	73	Residential
R9	492405	6901635	81	Residential
R10	492389	6901573	85	Residential
R11	493456	6901579	64	Residential
R12	493992	6901471	68	Residential
R13	495239	6901390	57	Residential
R14	495024	6902098	55	Residential
R15	495795	6902032	57	Residential
R16	496042	6902189	49	Residential
R17	495388	6902837	61	Residential
R18	495644	6903536	54	Residential
R19	494717	6904259	60	Residential
R20	493997	6904642	60	Residential

2.3 Terrain

Figure 3 illustrates the local topography, as obtained from a combination of Lidar data at 10 m resolution. The terrain of the local area is undulating to hilly varying from approximately 30 m to 170 m AHD within 1 km radius of the Subject Site.

2.4 Climatic Conditions

The climate of the Scenic Rim region of Queensland is temperate with hot summers and cool winters (due to elevation) and is cooler than the rest of the state. The average annual temperature for the region is 22°C. The summer average temperature is 25°C, in autumn and spring it is 22°C, and in winter 16°C.

Annual and seasonal average rainfall is variable, affected by local factors such as topography and vegetation, and broader scale weather patterns, such as the El Niño - Southern Oscillation. Annual average rainfall is 1,565 mm, with much occurring during summer either as heavy thunderstorms or from tropical rain depressions.

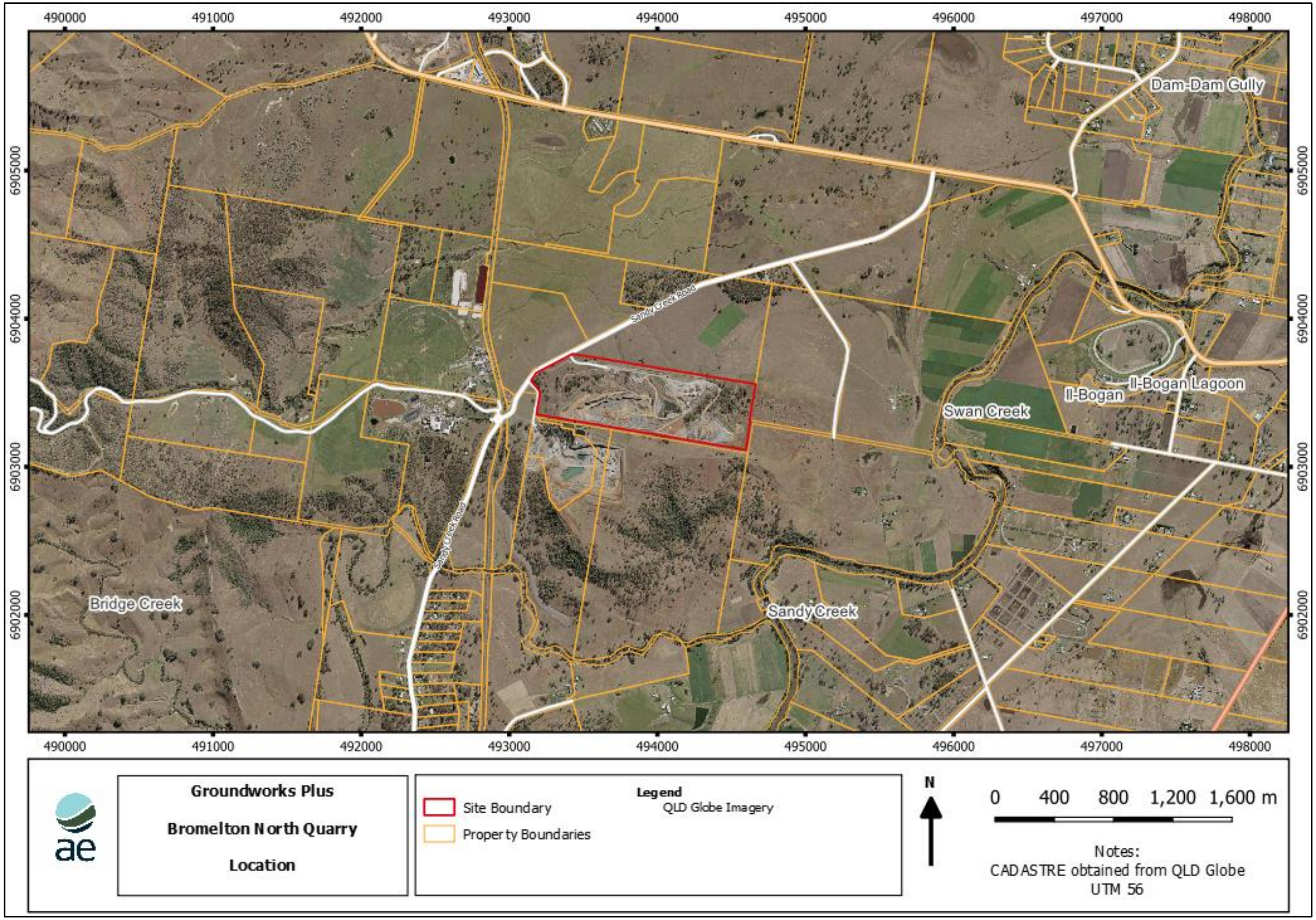


Figure 1: Site Location

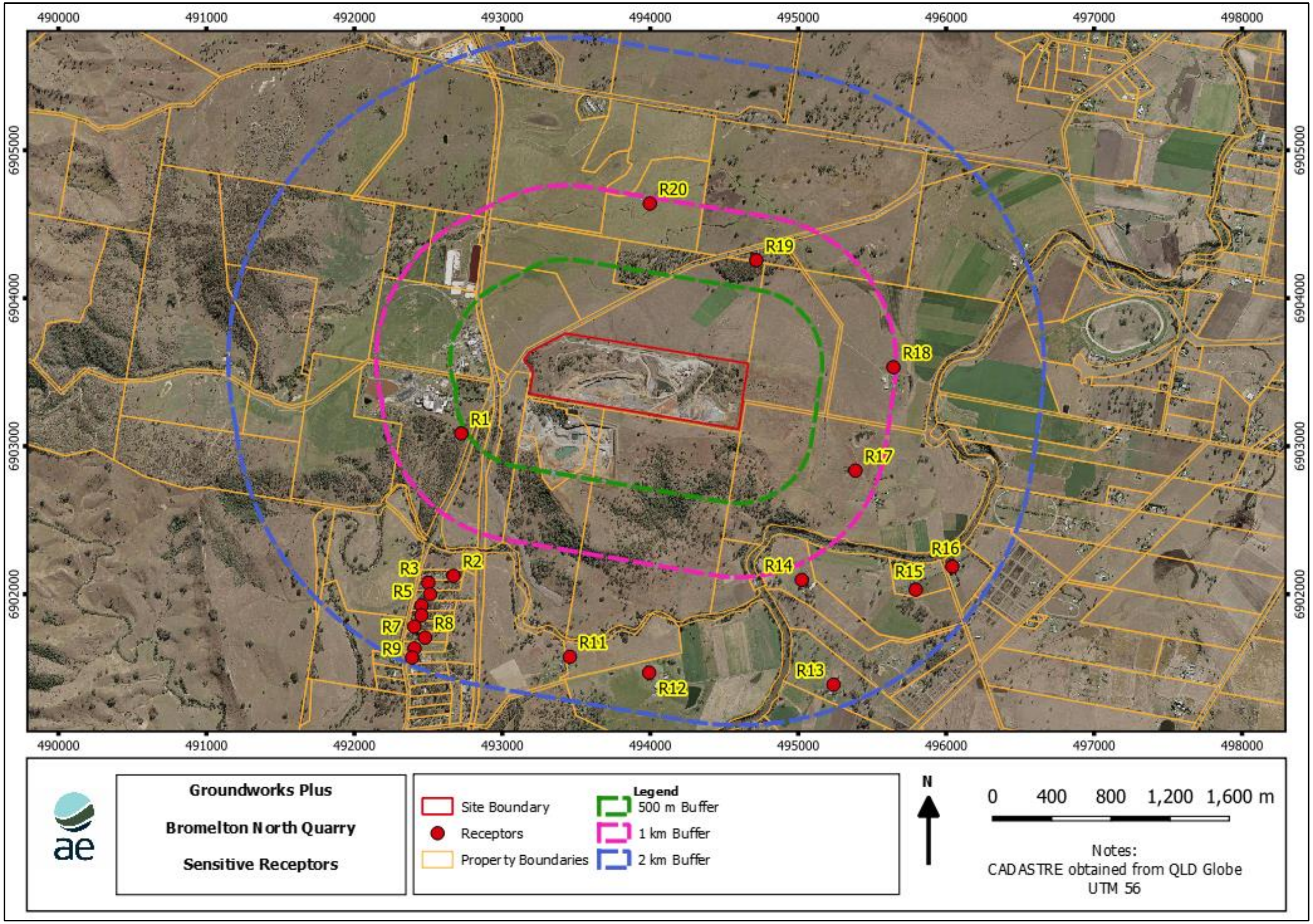


Figure 2: Sensitive Receptors

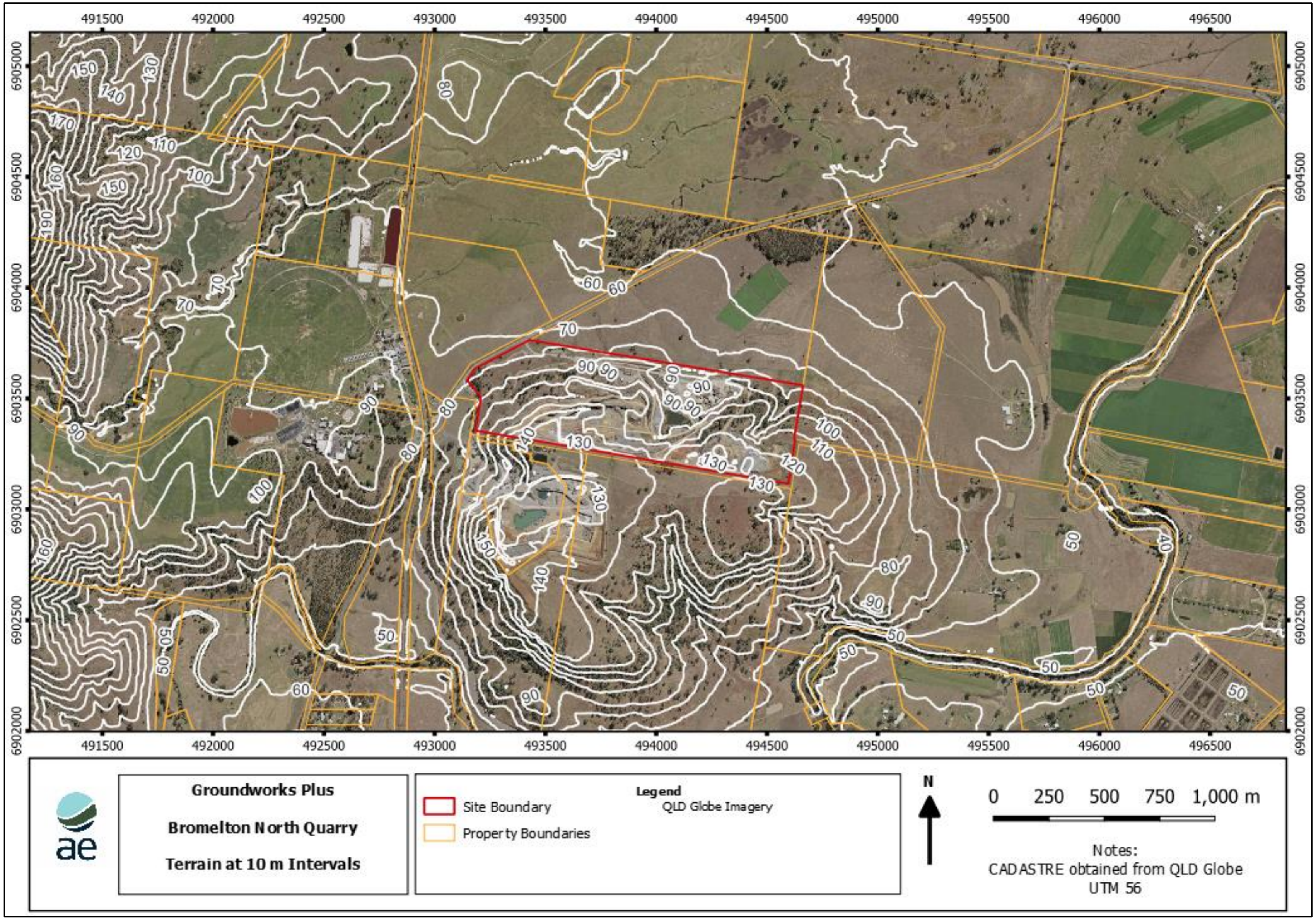


Figure 3: Surrounding Topography at 10 m Intervals (Extracted from LiDAR Data)

3 QUARRY OPERATIONS

3.1 Overview

Neilsens operate the hard rock quarry known as Bromelton North Quarry (Subject Site). The quarry operates under:

- Consent Order for Material Change of Use – Development Permit for Extractive Industry (ref: 3448 of 2003) granted on 23 June 2004;
- Environmental Authority EPPR00540113 (EA), issued by the Department of Environment and Science (DES), authorising the following Environmentally Relevant Activities (ERAs):
  - ERA Threshold 16 (2)(b) - Extractive and screening activities - extracting, other than by dredging more than 100,000 but not more than 1,000,000 tonnes of material in a year.
  - ERA Threshold (3)(b) - Extractive and screening activities - screening more than 100,000 but not more than 1,000,000 tonnes of material in a year.

3.2 Current Consent Conditions

Conditions of Environmental Authority EPPR00540113 (effective 12 August 2020) issued by the Department of Environment and Science provides specific requirements relating to emissions of air from the activity as summarised in Table 3.

Table 3: Conditions Relevant to Air

Condition number	Condition
Air	
A1	Dust or particulate matter that will have or is likely to have an adverse effect on people living in or using the surrounding area shall not be permitted to emanate beyond the boundaries of the premises to which this environmental authority relates.
A2	There must be no release of dust and/or particulate matter: (i) that causes dust deposition, monitored in accordance with Australian Standard AS 3580.10.1 of 1991, to exceed one hundred and twenty (120) milligrams per square meter per day beyond the boundary of the premises to which this environmental authority relates; nor (ii) that causes the concentration of particulate matter with an aerodynamic diameter less than ten (10) micrometre (µm) (PM10) suspended in the atmosphere downwind and beyond the boundary of the premises to which this environmental authority relates to exceed one hundred and fifty (150) micrograms per cubic metre over a twenty four (24) hour averaging time, when monitored in accordance with Australian Standard AS 3580.9.6 `Ambient air - Particulate matter - Determination of suspended particulate PM10 high - volume sampler with size-selective inlet - Gravimetric method" or an alternate method for PM10 permitted in the "Air Quality Sampling Manual" published by the Department of Environment first edition, November 1997, or more recent editions or supplements to that document as such become available.
A3	The holder of this environmental authority must take all reasonable and practicable measures necessary to prevent and/or minimise the release of particulate matter and dust

Condition number	Condition
	to the atmosphere from extractive operations. Reasonable and practicable measures may include but are not limited to: (i) limiting topsoil/overburden removals at any one time to that necessary while providing for effective production of quarry rock; and (ii) limiting removal of topsoil/overburden to periods of favourable weather conditions or maintaining materials in a damp state to avoid dust generation and propagation; and (iii) progressive rehabilitation during the life of the operation; and (iv) designing blast to prevent venting; and (v) installing effective dust collectors at blast hole drilling rigs; and (vi) dampening down of quarry working areas.
A4	The holder of this environmental authority must take all reasonable and practicable measures necessary to prevent and/or minimise the release of particulate matter and dust to the atmosphere from crushing, screening, and conveying equipment. Reasonable and practicable measures may include but are not limited to: (i) enclosure or shielding of conveyors; and (ii) the installation of windshields or barriers to suppress dust emissions; and (iii) keeping the material in a moist state; and (iv) use of water sprays at transfer points
A5	Stockpiles must be maintained using all reasonable and practicable measures necessary to minimise the release of windblown dust or particulate matter to the atmosphere. Reasonable and practicable measures may include but are not limited to: (i) use of water spray as required during winds likely to generate such releases; (ii) use of dust-suppressant shielding; (iii) storage in bunkers; and (iv) covering with tarpaulins.
A6	Trafficable areas must be maintained using all reasonable and practicable measures necessary to minimise the release of windblown dust or traffic generated dust to the atmosphere. Reasonable and practicable measures may include but are not limited to: (i) keeping surfaces clean; (ii) sealing with bitumen or other suitable material; (iii) using water sprays; (iv) adopting and adhering to speed limits; and (v) using dust suppressants and wind breaks.
A7	Any spillages of material onto sealed areas, as a result of delivery or handling, must be cleaned up without delay into storage bins or other suitable receptacles.
A8	The tailgates of all trucks leaving the premises to which this environmental authority relates must be securely fixed prior to loading to prevent loss of material.
A9	The holder of this environmental authority must take all reasonable and practicable measures necessary to prevent spillage and/or loss of particulate matter or windblown dust from trucks used for transporting extracted material from the premises to which this environmental authority relates. The reasonable and practicable measures may include but are not limited to: (i) wetting down the load prior to transport; and (ii) having the entire load covered with a tarpaulin or similar material for the duration of

Condition number	Condition
	transport; and (iii) clearing of spillage from side rails, tail gates and draw bars of trucks prior to departure from the premises to which this environmental authority relates and prior to departure from the premises to which this environmental authority relates to which the load has been delivered.
A10	Vehicle tyres and under bodies must be sufficiently free of dust and mud, including by being washed and/or cleaned prior to leaving the premises to which this environmental authority relates if necessary, so as to ensure that dust and/or mud is not deposited on any public road by vehicles leaving the premises to which this environmental authority relates.
A11	Notwithstanding development conditions A8, A9 or A10 if material is deposited on any public road by vehicles leaving the premises to which this environmental authority relates, clean-up of such material should occur immediately.
A12	All disturbed areas must be revegetated as soon as practicable on the completion of extraction operations.

3.3 Current Operations

The existing quarry operation provides for extraction, processing, stockpiling, ancillary operations area, and stormwater controls over 5 stages. The current operation generally aligns with the approved Stage 4 layout, avoiding mapped remnant vegetation between the east and west pits.

Material is processed using a crushing and screening plant located in the central sector of the quarry. The primary bin tipping platform is approximately 15 metres above the plant and stockpile pad whilst the remainder of the plant (screens and secondary and tertiary crushers) are located on a pad north of the primary bin tipping platform. This processing plant produces a wide range of quality quarried products.

The quarry component of the operation comprises two pits. The quarrying process begins with removal of overburden material and excavation at the quarry face and/or floor using various heavy machinery (excavators, bulldozers, and wheeled loaders).

Fragmented material is transported from the pit floor to the onsite processing area (referred to as the crushing floor) using dump trucks traversing a haul road up and out of the pit to the feeder dump point above the crushing floor.

The crushing floor comprises of an array (or train) of equipment including a feeder, crushers, and impactors as well as numerous conveyors and screens. This crushing floor is a permanent fixture and the range, and the type of material being processed, and its required sizing dictate the number of crushers, conveyors and screens used at any point in time.

It is important to note that not all crushing plant is operated simultaneously; the number of crushers and screens operating is dependent on client contracts. Once crushed and screened, the final product is then loaded again into dump trucks and transported along haul roads to stockpiles awaiting sale or further processing (i.e. aggregate coating). Upon sale, the final product is loaded at its stockpile into trucks of multiple sizes for transportation offsite.

3.4 Proposed Operations

The proposed development is for an increase to the scale and intensity of the existing hard rock extraction operation by:

- extending the eastern quarry footprint north; and
- increasing the extraction rate to 800,000 tpa.

The east pit has been designed to avoid clearing of remnant vegetation. It is not proposed to alter other aspects of the existing operation such as hours of operation or location of fixed plant and equipment. This development application is intended to replace the conditions of the Consent Order.

The fixed processing plant and associated stockpiling area will be retained in the centre of the site. No additional buildings or structures are proposed, including the site office, amenities block, parking areas, weighbridge, workshop, and truck wash down facilities.

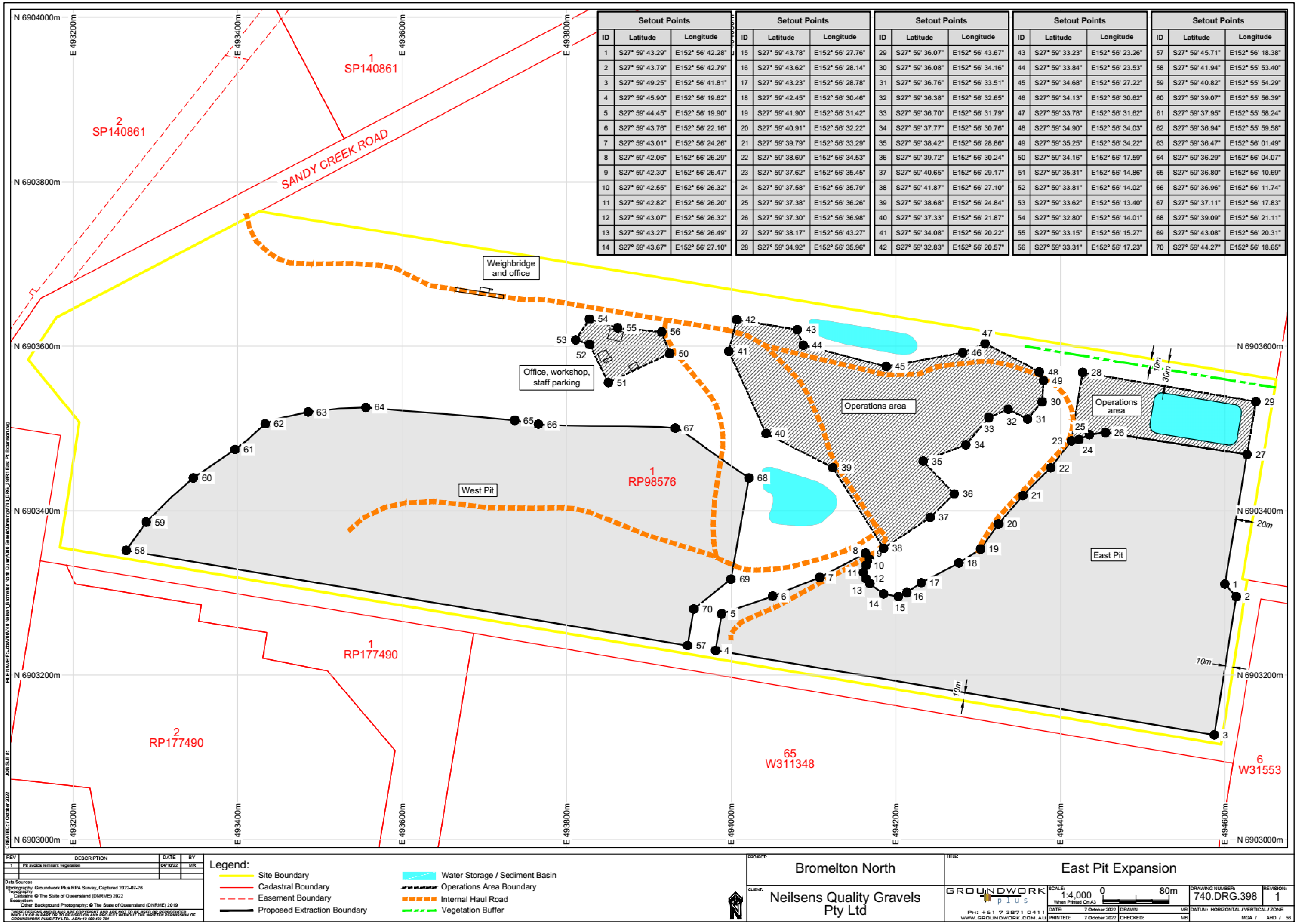
3.5 Comparison of Operations

Table 4 provides a comparison of the current approved existing activities and future proposed modification activities as part of the increase in production.

Table 4: Comparison of Activities

Aspect	Current Activities	Proposed Activities
Land Use	Approval granted for an extractive industry and associated processing and crushing and grinding.	Continued use of existing west pit and extension to east pit.
Quarry footprint	As per Figure 5 (Stage 4 of approved plans)	Primarily focused on the East Pit (80%) with some minor extraction in the West Pit (20%)
Approved Hours of operation	06:00 to 18:00 Monday to Friday. 07:00 – 17:00 Saturday No operation on Sundays or Public Holidays	N/A – no change proposed.
Production and Transportation limits	Up to 400,000 tpa from the site. Daily maximum generally 4,000 tpd	Up to 800,000 tpa from the site. No change to daily maximum
Extraction method	Extraction by blast and drill.	N/A – no change proposed.
Site infrastructure and plant	Drilling, blasting, and extraction in quarry pit	No change to the operations in the quarry pit.
	Primary, secondary, and tertiary crushing and screening facilities on crushing floor	No change to the crushing/ screening facilities on crushing floor
Product transport method and access	Via truck to Sandy Creek Road	N/A – no change proposed.
Truck Movements	Average daily truck dispatches based on current payloads (9% trucks/ 86% truck and dog and 5% B-double): • 43 truckloads per day	Average daily truck dispatches based on current payloads (9% trucks/ 86% truck and dog and 5% B-double): • 78 truckloads per day

Aspect	Current Activities	Proposed Activities
	• 85 movements per day Staff vehicles: • 10 movements per peak hour (start and end of shift)	• 156 movements per day Staff vehicles: • 10 movements per peak hour (start and end of shift)
Blasting	Typically 12 blasts per year	Expected 24 blasts per year
Blasting hours	09:00 to 17:00 Monday to Friday	N/A – no change proposed.
Equipment	Refer to Section 3.3.	N/A – no change proposed. Increased extraction and processing based on increasing efficiency



ID	Latitude	Longitude
1	S27° 59' 43.29"	E152° 56' 42.28"
2	S27° 59' 43.79"	E152° 56' 42.79"
3	S27° 59' 49.25"	E152° 56' 41.81"
4	S27° 59' 45.90"	E152° 56' 19.62"
5	S27° 59' 44.45"	E152° 56' 19.90"
6	S27° 59' 43.76"	E152° 56' 22.16"
7	S27° 59' 43.01"	E152° 56' 24.26"
8	S27° 59' 42.06"	E152° 56' 26.29"
9	S27° 59' 42.30"	E152° 56' 26.47"
10	S27° 59' 42.55"	E152° 56' 26.32"
11	S27° 59' 42.82"	E152° 56' 26.20"
12	S27° 59' 43.07"	E152° 56' 26.32"
13	S27° 59' 43.27"	E152° 56' 26.49"
14	S27° 59' 43.67"	E152° 56' 27.10"
15	S27° 59' 43.78"	E152° 56' 27.76"
16	S27° 59' 43.62"	E152° 56' 28.14"
17	S27° 59' 43.23"	E152° 56' 28.78"
18	S27° 59' 42.45"	E152° 56' 30.46"
19	S27° 59' 41.90"	E152° 56' 31.42"
20	S27° 59' 40.91"	E152° 56' 32.22"
21	S27° 59' 39.79"	E152° 56' 33.29"
22	S27° 59' 38.69"	E152° 56' 34.53"
23	S27° 59' 37.62"	E152° 56' 35.45"
24	S27° 59' 37.58"	E152° 56' 35.79"
25	S27° 59' 37.38"	E152° 56' 36.26"
26	S27° 59' 37.30"	E152° 56' 36.98"
27	S27° 59' 38.17"	E152° 56' 43.27"
28	S27° 59' 34.92"	E152° 56' 35.96"
29	S27° 59' 36.07"	E152° 56' 43.67"
30	S27° 59' 36.08"	E152° 56' 34.16"
31	S27° 59' 36.76"	E152° 56' 33.51"
32	S27° 59' 36.38"	E152° 56' 32.65"
33	S27° 59' 36.70"	E152° 56' 31.79"
34	S27° 59' 37.77"	E152° 56' 30.76"
35	S27° 59' 38.42"	E152° 56' 28.86"
36	S27° 59' 39.72"	E152° 56' 30.24"
37	S27° 59' 40.65"	E152° 56' 29.17"
38	S27° 59' 41.87"	E152° 56' 27.10"
39	S27° 59' 38.68"	E152° 56' 24.84"
40	S27° 59' 37.33"	E152° 56' 21.87"
41	S27° 59' 34.08"	E152° 56' 20.22"
42	S27° 59' 32.83"	E152° 56' 20.57"
43	S27° 59' 33.23"	E152° 56' 23.26"
44	S27° 59' 33.84"	E152° 56' 23.53"
45	S27° 59' 34.68"	E152° 56' 27.22"
46	S27° 59' 34.13"	E152° 56' 30.62"
47	S27° 59' 33.78"	E152° 56' 31.62"
48	S27° 59' 34.90"	E152° 56' 34.03"
49	S27° 59' 35.25"	E152° 56' 34.22"
50	S27° 59' 34.16"	E152° 56' 17.59"
51	S27° 59' 35.31"	E152° 56' 14.86"
52	S27° 59' 33.81"	E152° 56' 14.02"
53	S27° 59' 33.62"	E152° 56' 13.40"
54	S27° 59' 32.80"	E152° 56' 14.01"
55	S27° 59' 33.15"	E152° 56' 15.27"
56	S27° 59' 33.31"	E152° 56' 17.23"
57	S27° 59' 45.71"	E152° 56' 18.38"
58	S27° 59' 41.94"	E152° 55' 53.40"
59	S27° 59' 40.82"	E152° 55' 54.29"
60	S27° 59' 39.07"	E152° 55' 56.39"
61	S27° 59' 37.95"	E152° 55' 58.24"
62	S27° 59' 36.94"	E152° 55' 59.58"
63	S27° 59' 36.47"	E152° 56' 01.49"
64	S27° 59' 36.29"	E152° 56' 04.07"
65	S27° 59' 36.80"	E152° 56' 10.69"
66	S27° 59' 36.96"	E152° 56' 11.74"
67	S27° 59' 37.11"	E152° 56' 17.83"
68	S27° 59' 39.09"	E152° 56' 21.11"
69	S27° 59' 43.08"	E152° 56' 20.31"
70	S27° 59' 44.27"	E152° 56' 18.65"

Figure 4: Proposed East Pit Extension

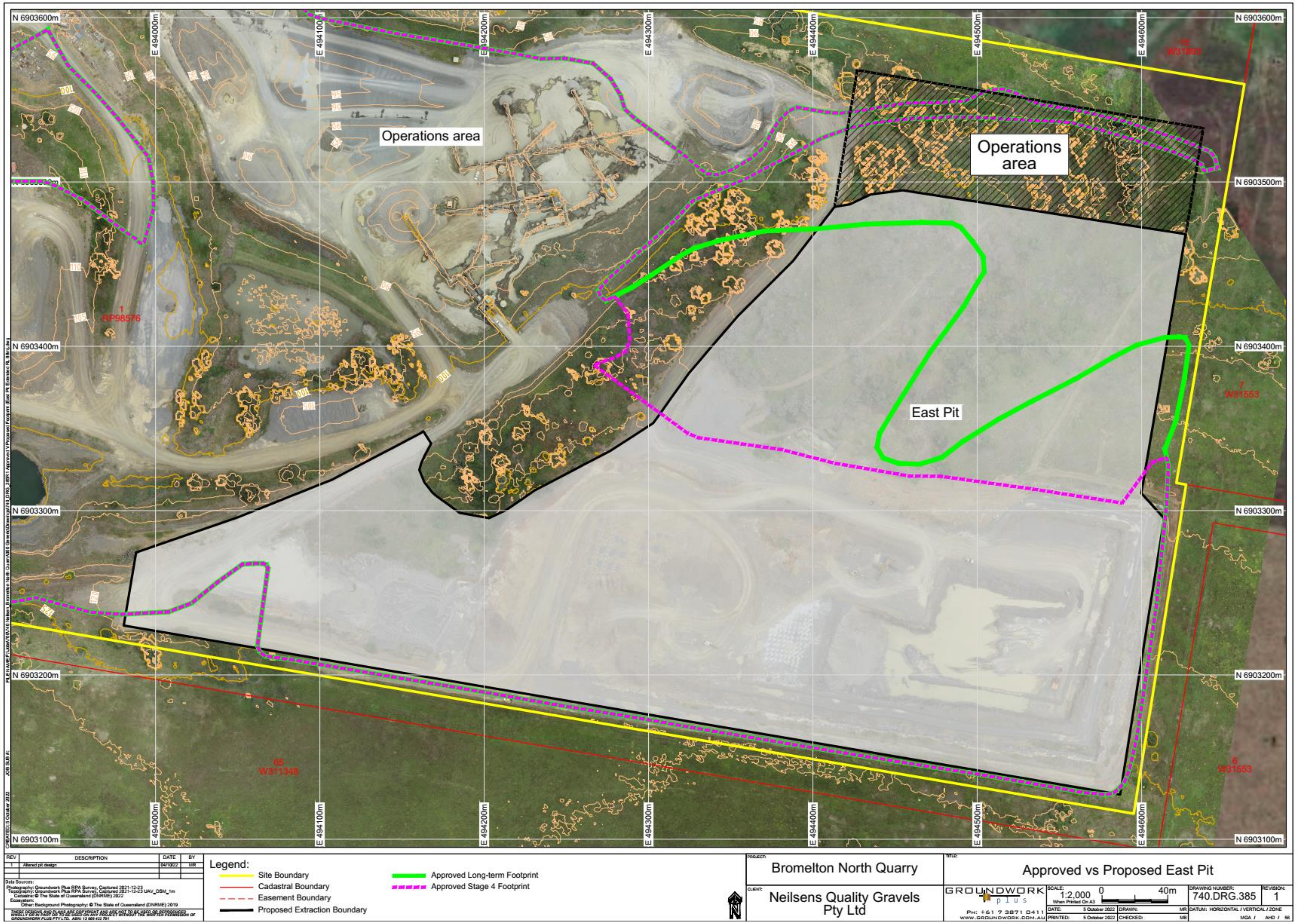


Figure 5: Approved and Proposed Footprint of East Pit

4 REGULATORY REQUIREMENTS

4.1 Overview

This Section reviews the applicable criteria taking into consideration the following:

- Scenic Rim Regional Council Planning Scheme;
- State Development Code 22;
- Bromelton State Development Area Development Scheme; and
- Environmental Protection (Air Quality) Policy 2019.

4.2 Scenic Rim Regional Council

The site is located within the Scenic Rim Regional Council Area. The Scenic Rim Planning Scheme includes assessment benchmarks relating to air quality within the Extractive Industry Code (PO13) as provided in Table 5.

Table 5: Scenic Rim Regional Council Extractive Industry Code Acceptable Outcomes

Performance Outcomes	Acceptance Outcomes
Environmental management requirements for the Extractive industry are properly identified in an Environmental Management Plan prepared by a suitably qualified person and submitted to Council that demonstrates appropriate management practices to protect environmental standards, by addressing the following: (1) Air quality; (2) Stormwater; (3) Noise; (4) Waste; (5) Water quality including, erosion and sedimentation control; (6) Stream bed and bank stability; (7) Landscape and rehabilitation; (8) Workplace procedures; (9) Emergency and hazard procedures; (10) Flora and fauna protection; and (11) Auditing and review.	AO13 No acceptable outcome is prescribed.

4.3 State Development Assessment Provisions (SDAP) Code 22

The purpose of State Code 22 is to ensure that Environmentally Relevant Activities (ERAs):

- are located and designed to avoid or mitigate environmental harm on environmental values of the natural environment, adjacent sensitive land uses and sensitive receptors;
- are designed and located to avoid impacts or, where the matters of state environmental significance cannot be reasonably avoided, impacts are reasonably minimised and mitigated;

- do not result in a significant residual impact on a matter of state environmental significance unless the significant residual impact is acceptable, and an offset is provided.

Table 6 provides the Acceptable Outcomes for air as detailed in State Code 22.

Table 6: SDAP Code 22 Acceptable Outcomes

Performance Outcomes	Acceptance Outcomes
PO2 Development is suitably located and designed to avoid or mitigate environmental harm to the air environment.	AO2.1 Development meets the air quality objectives of the Environmental Protection (Air) Policy 2019

4.4 Bromelton SDA Development Scheme

The Subject Site is located within the Transition Precinct of the Bromelton State Development Area. Section 2.5.4 Emissions details the requirements a development within the SDA area must achieve:

> (1) Development is designed to avoid or minimise:
>
> > (a) adverse impacts from air, noise and other emissions that will affect the health and safety, wellbeing and amenity of communities and individuals and
> >
> > (b) conflicts arising from (but not limited to), spray drift, odour, noise, dust, light spill, smoke, or ash emissions with sensitive and/or incompatible land uses
>
> (2) Development supports the achievement of the relevant acoustic and air quality objectives of the Environmental Protection (Noise) Policy 2008 and the Environmental Protection (Air) Policy 2008.
>
> (3) Development with high levels of emissions is to, in accordance with current best practice, avoid adverse impacts on the cumulative air quality1 of the Bromelton air shed.

The Environmental Protection (Air) Policy 2008 has been superseded by Environmental Protection (Air) Policy 2019.

4.5 Environmental Protection (Air Quality) Policy

The Environmental Protection (Air Quality) Policy 2019 (EPP (Air)) provides air quality objectives for a range of compounds with the potential to impact on the health and well-being and aesthetics of the environment. Specifically, the objectives are intended to enhance or protect the following environmental values:

> *(a) the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and*
>
> *(b) the qualities of the air environment that are conducive to human health and wellbeing; and*

(c) the qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures, and other property; and

(d) the qualities of the air environment that are conducive to protecting agricultural use of the environment.

Table 7 presents a summary of the air quality objectives applicable to the assessment.

Table 7: Schedule 1 Air Quality Objectives

Indicator	Environmental value	Air quality objectives ($\mu g/m^3$ except where noted)	Period
$PM_{2.5}$	Health and wellbeing	25	24 hours
		8	1 year
PM_{10}	Health and wellbeing	50	24 hours
		25	1 year
Total Suspended Particles	Health and wellbeing	90	1 year

5 EXISTING AIR ENVIRONMENT

5.1 Introduction

The quantification of cumulative air pollution concentrations requires an ambient background concentration of each relevant air pollutant, which is representative of the likely concentrations experienced in the region. The background concentration is added to the predicted concentrations associated with the proposed development. This is known as a cumulative assessment and demonstrates that the capacity of the airshed is sufficient to deal with the proposed development.

Background concentrations can be determined from onsite measurements or selected from representative data. The representative background concentration is added to the predicted concentrations from proposed activities and assessed for compliance against the relevant air quality objectives and guidelines.

This section summarises the existing industries in the region surrounding the subject site that are sources of dust emissions, the nearest monitoring data collected by Department of Environment and Science (DES) and monitoring data from monitoring at sensitive receptors around the quarry.

5.2 Ambient Monitoring

5.2.1 Department of Environment and Science

To assess cumulative impacts, daily background air quality data has been obtained from the DES website. DES monitoring station at Josephville is located within 1 km of the Subject Site, but only measures weather parameters.

Background concentrations can be assessed using two methods:

- Contemporaneous hourly data for the same meteorological year assessed; and
- Review of the most recent three years of data as percentile values. These values are typically 70th percentile for hourly and daily time periods and annual average

5.2.1.1 Monitoring Stations

The nearest and most representative monitoring stations have been reviewed for this assessment. There are no monitoring stations near Beaudesert; the nearest monitoring station is North Maclean monitoring station, which is approximately 28 km from the Subject Site. PM_{10} and $PM_{2.5}$ are not measured at North Maclean or Mutdapilly (located 38 km from the Subject Site). Table 8 provides an overview of pollutants measured at the nearest monitoring stations from 2015 until 2021.

Table 8: Measured Pollutants by Monitoring Station

Compound	Monitoring Station (2015 – 2021)				
	Flinders View	North Maclean	Mutdapilly	South Brisbane	Southwood
PM_{10}	Yes	-	-	Yes	Yes
$PM_{2.5}$	From Feb 2021	-	-	Yes	Yes

5.2.1.2 Contemporaneous Review

To assess cumulative impacts, ambient monitoring data has been obtained from the Department of Environment and Science (DES) for 2015 from Flinders View, Southwood and South Brisbane as identified in Table 8, as this is the same year as the meteorological dataset utilised in this assessment.

Table 8 provides the statistics for the hourly background concentrations for particulates and gaseous compounds for 2015 from Flinders View, Southwood, and South Brisbane.

Table 9: Background Concentrations for 2015

Compound	Time Period	1-hour Concentration (µg/m³)			Annual Average (µg/m³)	Station
		Max	90th Percentile	70th Percentile		
PM_{10}	24-hour	44.5	21.6	16.0	14.6	Flinders View

The *Queensland Air Monitoring 2015 (National Environment Protection (Ambient Air Quality) Measure Report* (DES, 2016) confirms that there was no exceedences of the PM_{10} 24-hour objective at Flinders View. The 24-hour average concentrations for PM_{10} is presented in Figure 6.

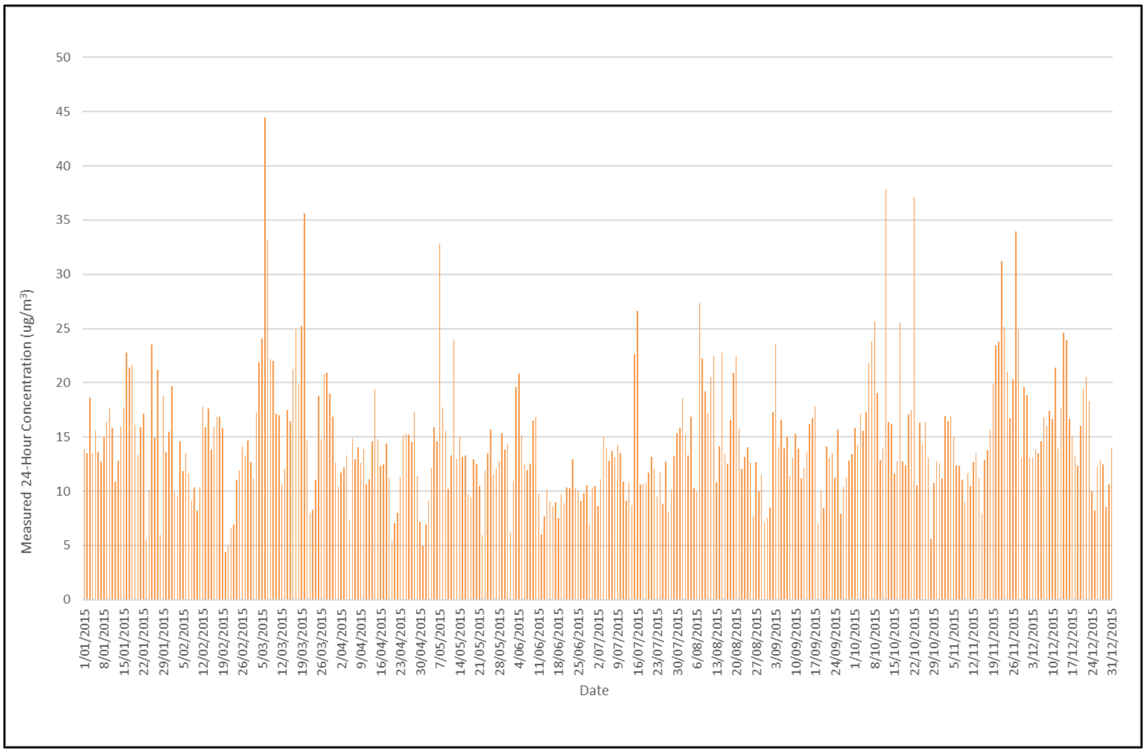


Figure 6: Hourly PM_{10} Concentrations at Flinders View for 2015

5.2.1.3 Three Year Review

It can be seen from Table 8 that $PM_{2.5}$ is only measured at Springwood for the entire period and commenced at Flinders View in February 2021. When using background monitoring data, the monitoring location should be representative of the Subject Site area; with this in mind, Springwood (and other $PM_{2.5}$ monitoring stations) are not considered representative as they're located in heavily urban areas or adjacent to motorways.

A review of the Queensland Air Monitoring National Environmental Protection (Ambient Air Quality) Measure Reports for 2019 – 2021 has identified the following in relation to PM_{10} monitoring:

- Bushfires in 2019 caused regional-wide exceedences of PM_{10}; at Flinders View, 21 exceedences of the PM_{10} 24-hour criterion were determined based on bushfires and dust events.

- There were four exceedences of the 24-hour criteria at Flinders View in 2020, with all of these events attributed to dust events. These dates were:

    - 20 February with concentration of 53.6 µg/m^3 (caused by region wide dust event);
    - 20 July with concentration of 86.2 µg/m^3 (caused by local dust event);
    - 20 August with concentration of 96.2 µg/m^3 (caused by region wide dust event); and
    - 22 August with concentration of 78.6 µg/m^3 (caused by region wide dust event);

- A single exceedence of the PM_{10} was recorded in 2021 Flinders View on 15 October with a concentration of 59.3 µg/m^3 which was the result of a region wide dust event.

Table 10 presents the percentile monitoring data from Flinders View and South Brisbane stations for 2019-2021 as well as 2015.

Table 10: Background Concentrations as Percentiles

Compound	Averaging Period	Parameter	Concentration (µg/m^3)		
			2019	2020	2021
PM_{10} (Flinders View)	1 day	70th percentile	24.7 [a)]	19.3 [a)]	16.4
	1 year	Average	24.3 [a)]	17.0	14.5
$PM_{2.5}$ (Flinders View)	1 day	70th percentile	-	-	6.5
	1 year	Average	-	-	5.9

a) PM_{10} and $PM_{2.5}$ monitoring data influenced by bushfires or dust events.

5.2.1.4 Other Pollutants

The nearest station that records total suspended particles (TSP) is located at Cannon Hill. In lieu of this, research indicates that in rural areas, PM_{10} typically represents 49% of total TSP, therefore, TSP concentrations have been estimated based on the application of this ratio[a].

5.2.2 Local Monitoring

Dust deposition monitoring is undertaken at two locations on a monthly basis (Figure 7). Based on this data, the annual average deposition rate at NBDG5 is 44 mg/m^2/day, which is considered representative of background locations. It is considered that deposition rates at NBDG7 could be attributed to activities occurring at both Bromelton North Quarry and Bromelton Quarry.

[a] Air Noise Environment Pty Ltd (1999) 'Fine dust and the implications for the coal industry', ACARP Project C7009

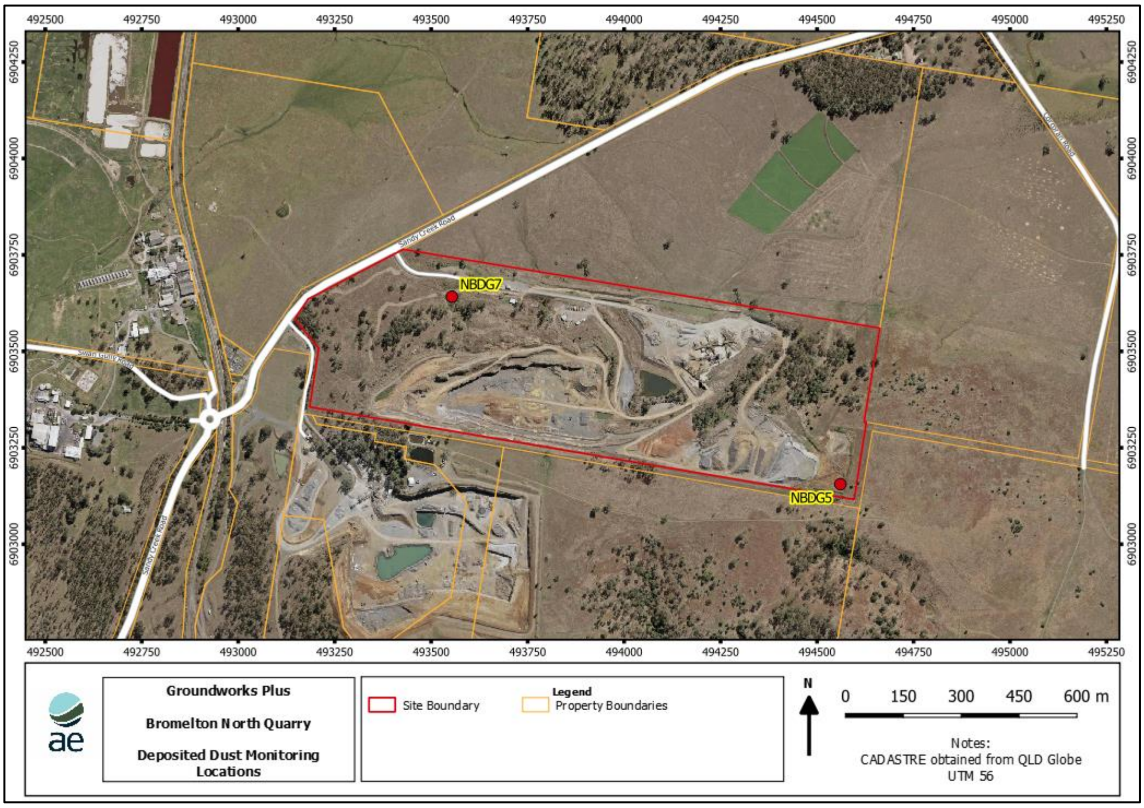


Figure 7: Deposited Dust Monitoring Locations

5.3 Applied Background Concentrations for this Assessment

Following the review of the background monitoring data, Table 11 presents the adopted background monitoring data for this assessment and justification:

- Contemporaneous data for 2015 from Flinders View for PM_{10}. This approach is applied as the PM_{10} data is heavily influenced by bushfires or dust events in recent years; and
- Percentile data for $PM_{2.5}$ for 2021 for Flinders View as this is the only monitoring site which is considered representative, and the only time period measured at this location.

Table 11: Adopted Background Monitoring Data for TSP and Deposited Dust

Pollutant	Time Period	Concentration	Source
TSP	Annual	29.0 µg/m^3	Calculated from PM_{10} for 2015
Deposited Dust	Month	44 mg/m^2/day	Average from NBDG5 Monitoring data from Table 9
PM_{10}	24-hour	Refer to Table 8 and Figure 6	Flinders View for 2015
	Annual		
$PM_{2.5}$	24-hour	6.5 µg/m^3	Flinders View for 2021
	Annual	5.9 µg/m^3	

5.4 Surrounding Industries

5.4.1 National Pollutant Inventory Database

The National Pollutant Inventory (NPI) is an initiative of the Australian Government that provides the community, industry, and government with information about emissions of pollutants to air, water, and land from industrial facilities across Australia. It has emissions estimates for 93 substances and the source and location of these emissions. Industrial facility operators are obliged to submit annual reports of their facilities emissions to the environment, if certain threshold criteria are exceeded.

A review of the NPI database has identified there are two facilities nearby which emit the same pollutants:

- Bromelton Generation Site; and
- Bromelton Quarry.

Since 2018, Bromelton Generation site has only reported NPI in 2020/2021. The reported emissions were for total volatile organic compounds (TVOCs), which were reported as 2,500 kg per annum. TVOCs are not cumulative to the Subject Site and therefore have not been considered in this assessment.

5.4.2 Bromelton Quarry

The Bromelton Quarry operates pursuant to a Planning Permit and Environmental Authority. Conditions on the Planning Permit for not regulate noise and dust emissions, however, do limit the activity to 1.5 Mpta. The Environmental Authority (Ref: EPPR00473413), authorises extraction and screening activities above 1 Mtpa

In order to carry out a cumulative assessment, a review of the NPI database was undertaken and the emissions for 2020/2021 were obtained as shown in Table 12. Based on experience, it is suspected that the particulate emission rates are under-reported and as such a full assessment will be undertaken.

No production rate date relating to the current Bromelton Quarry operations, equipment or mitigation measures is publicly available. As such, emissions from Bromelton Quarry have been calculated using the calculation methodologies in Section 7.3 and Appendix B adopting the maximum extraction rate.

Table 12: NPI Reported Emissions Data for Bromelton Quarry 2020/2021

Substance	Air Fugitive (kg)	Air Point (kg)	Total (kg)	Emission Rate (g/sec)
PM_{10}	10810	-	10810	0.34
$PM_{2.5}$	627	-	627	0.02

Table 13 presents the emission rates for Bromelton Quarry operations. Without any publicly available documents, the following assumptions have been made:

- Operating hours: same as Bromelton North Quarry;
- Production rate: 1.5 Mtpa based on average production as no daily peak production data available;

- Drill and blast every 33,000 tonnes;
- Haul road watering – Level 1 (50%);
- Crushing plant and mobile crushing plant do not have any dust controls;
- Paved internal road from Sandy Creek Road to weighbridge. All other roads are unpaved;
- Future concrete batching plant is included and operating at 90,000 m^3;
- Mobile fleet and haul trucks are ratioed to Bromelton North Quarry for the purpose of combustion emissions.

Table 13 lists the emission rates for Bromelton Quarry. No mitigation except watering of haul roads and concrete plant loading of trucks have been applied.

Table 13: Summary of Emission Rates from Bromelton Quarry

Activity	Emission Rate (g/sec)		
	TSP	PM_{10}	$PM_{2.5}$
Concrete (material transfers and silos)	0.00054	0.00021	1.55×10^{-5}
Drill and Blast	0.060	0.031	0.002
Material Transfers	0.447	0.211	0.032
Crushing and Screening	5.887	2.027	0.14
Paved Roads	1.110	0.213	0.05
Unpaved Roads	10.51	2.87	0.451
Wind erosion area stockpiles	1.14	0.57	0.04
Wind erosion from exposed area	4.16	2.08	0.16
Total	**19.16**	**5.93**	**0.72**

6 MODELLING METHODOLOGY

6.1 TAPM Predictions

Atmospheric dispersion modelling involves the mathematical simulation of the dispersion of air contaminants in the environment. The modelling utilises a range of information to estimate the dispersion of pollutants released from a source, including:

- Meteorological data for surface and upper air winds, temperature, and pressure profiles, as well as humidity, rainfall, cloud cover and ceiling height information;
- Emissions parameters including source, location, and height, source dimensions and physical parameters (e.g. exit velocity and temperature) along with pollutant mass emission rates;
- Terrain elevations and land use both at the source and throughout the surrounding region; and
- The location, height, and width of any obstructions (such as buildings or other structures) that could significantly impact on the dispersion of the plume.

For the purpose of the assessment, meteorological modelling has been undertaken using TAPM (The Air Pollution Model) and CALMET to predict localised meteorological conditions. The meteorological data derived from these models have been used as an input for the CALPUFF dispersion modelling.

A site-specific meteorological dataset has been determined using the prognostic model TAPM. Prognostic models, such as TAPM, permit the development of localised meteorological datasets, based on synoptic weather conditions. The model predicts the regional flows important to dispersion, such as sea breezes and terrain induced flows, against a background of larger-scale meteorology provided by synoptic analyses.

The output of this model, when used with a diagnostic meteorological model, such as CALMET, provides a meteorological dataset suitable for introduction into the wind field results. This methodology is the recommended approach for the modelling of contaminant concentrations using CALMET[b].

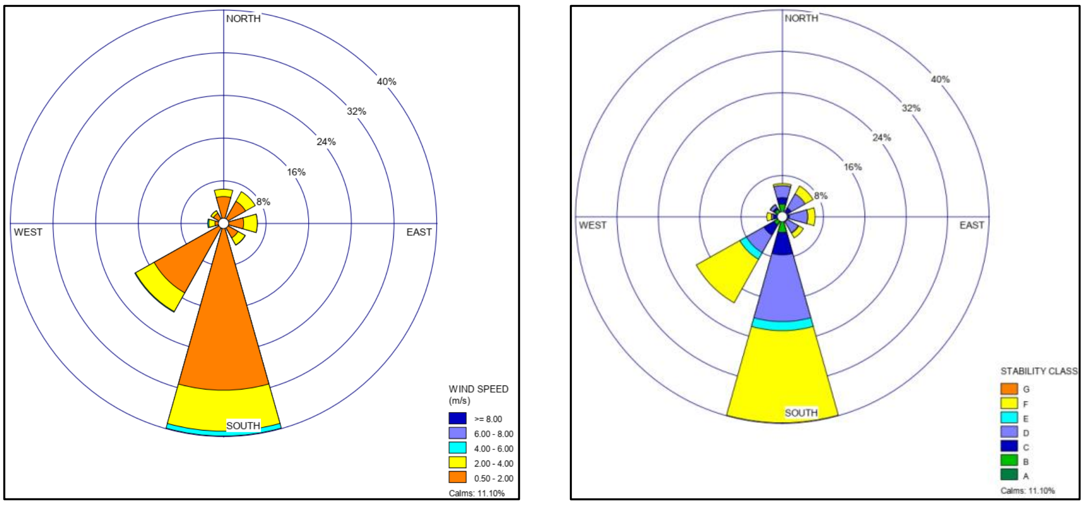
---

[b] TRC Environmental Corporation (March 2011) 'Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia' prepared on behalf of the NSW Office of Environment and Heritage

Table 14: Summary of Meteorological Modelling Parameter

Model	Aspect	Assigned Parameter
TAPM (v4.04)	Year Modelled	One full year - 2015 which is compared to long-term observations to demonstrate suitability. Hourly data from BOM Beaudesert and DES Josephville was assimilated into TAPM.
	Coordinates	Latitude: -27°59.5 / Longitude: 152°56.0
	Domain Grids	25 x 25 x 25 grid points
	Nesting Spacing	30 km, 10 km, 3 km, and 1 km.
CALMET (v 7.1)	Databases	Default databases for sea temperature, terrain and land cover applied
	Model Domain	20-km x 20-km grid (200 m grid intervals)
	Terrain Data	Nasa Shuttle Radar Topography Mission (SRTM) 1-second (approximately 30 m) digital elevation model
	Land Use	Default from USGS for 1 km spacing. Review of the land use was undertaken and updated based on recent aerial imagery
	Vertical Layers	12 Layers - 20 m, 50 m, 75 m, 150 m, 200 m, 500 m, 750 m, 1,000 m, 1,500 m, 2,000 m, 3,000 m, and 4,000 m

Figure 8 presents the annual wind rose for the Subject Site during 2015. Detailed meteorological analysis of the dataset is presented in Appendix A.



Wind Rose   Stability Class Rose

Figure 8: Predicted Annual Wind and Stability Class Roses at Subject Site for 2015

6.2 CALPUFF Dispersion Modelling

The CALPUFF modelling system treats emissions as a series of puffs. These puffs are then dispersed throughout the modelling area and allowed to grow and bend with spatial variations in meteorology. In doing so, the model can retain a memory of the plume's movement throughout a single hour and from one hour to the next while continuing to better approximate the effects of complex air flows.

CALPUFF utilises the meteorological processing and prediction model CALMET to provide three-dimensional wind field predictions for the area of interest. The final wind field developed by the model (for consideration by CALPUFF) includes an approximation of the effects of local topography, the effects of varying surface temperatures (as is observed in land and sea bodies) and surface roughness (resulting from varied land uses and vegetation cover in an area). The CALPUFF model can resolve complex terrain influences on local wind fields including consideration of katabatic flows and terrain blocking.

Post processing of modelled emissions is undertaken using the CALPOST package. This allows the rigorous analysis of pollutant predictions generated by the CALPUFF system. CALPOST is able to provide an analysis of predicted pollutant concentrations for a range of averaging periods from 1 hour to 1 year.

6.3 Receptors

A computational grid of 6 km by 5 km at 100 m spacing has been modelled. Two separate grids covering the two quarries were modelled as follows:

- Grid 1: Centre co-ordinates 494262, 6903472 for a distance of 700 m at 50 m spacing; and
- Grid 2: Centre co-ordinates 493200, 6903300 for a distance of 400 m at 50 m spacing.

In addition, existing receptors were modelled as shown in Figure 2 and receptors were placed at 20 m intervals along the boundary of the Subject Site.

6.4 Other Settings

For the purposes of the assessment, the air dispersion modelling has utilised the following settings for CALPUFF:

- three-dimensional mode using meteorological data file from CALMET;
- ISC rural wind speed profile;
- no chemical transformation;
- no gaseous deposition;
- transitional plume rise;
- stack tip downwash for point sources;
- partial plume penetration for point sources;
- dispersion coefficients using Pasquill–Gifford coefficients or turbulence calculated from micro-meteorology;
- no adjustment of dispersion curves for roughness;
- partial plume path adjustment method for terrain using default coefficients;
- no building wakes were modelled; and
- pit retention was applied to west pit activities only.

7 AIR EMISSION ESTIMATION

7.1 Overview

Emissions from the quarrying operations are typically particulates (TSP, PM_{10}, and $PM_{2.5}$) associated with extraction, material transfers, crushing and screening and vehicle movements. Table 15 presents a summary of the sources and types of emissions from the Project.

Table 15: Summary of Potential Emissions

Element	Activity	Potential Emissions
Quarrying	Vehicle movements on unpaved roads	Particulates
	Blasting and drilling	Particulates
	Rock extraction	Particulates
	Material transfers	Particulates
	Wind erosion from stockpiles	Particulates
	Wind erosion from exposed areas	Particulates
Haul road	Heavy truck movements on unpaved roads	Particulates and gaseous compounds
Processing	Emissions from crushing/screening material transfers	Particulates

7.2 Scenario Assessed

For the purposes of the assessment, only one scenario (future operations) will be assessed. The sources of emissions for this scenario is presented in Table 16.

Table 16: Scenario Assessed

Scenario	Activity
Future Operations (800,000 tonnes per annum) based on operational information in Table 4	Drilling and Blasting
	Processing (screening, primary and tertiary crushing)
	Material transfers (loading / unloading / miscellaneous)
	Vehicle movements (light and heavy) on internal haul roads
	Wind erosion from stockpiles and exposed areas

7.3 Sources of Emissions

7.3.1 Quarrying Operations

Emission estimates for the above activities have been derived based on the USEPA AP-42: Compilation of Air Emission Factors (US Environmental Protection Agency, Various Dates) and National Pollution Inventory (NPI) Emission Estimation Technique Manual for Mining (2012).

Emission factors within these documents are used to estimate emissions of TSP, PM_{10} and $PM_{2.5}$ to the air from various sources. Emission factors relate to the quantity of a substance emitted from a source to some measure of activity associated with the source. Emission factors used to estimate a facility's emissions based on activity rates and control measures are presented in Appendix B.

Table 17 present the emission rates for future operations. The emission rates have been modelled as operational hours and are based on maximum throughput of 1,200,000 tpa which is equivalent to the daily peak production of 4,000 tpd (which is a conservative assessment as the site will be limited to 800,000 tpa). The emission rates for the facility based on the operational information detailed in Appendix B.

Table 17: Summary of Emission Rates for Daily Peak Operations

Activity	Emission Rate (g/sec)		
	TSP	PM_{10}	$PM_{2.5}$
Drill and Blast	0.04	0.02	0.00
Material Transfers	0.45	0.21	0.03
Crushing and Screening	4.70	1.62	0.11
Unpaved Roads	15.18	3.40	0.76
Wind erosion area stockpiles	1.68	0.84	0.06
Wind erosion from exposed area	5.76	2.88	0.22
Total	**22.05**	**6.09**	**0.96**

Figure 9 present the location of existing sources.

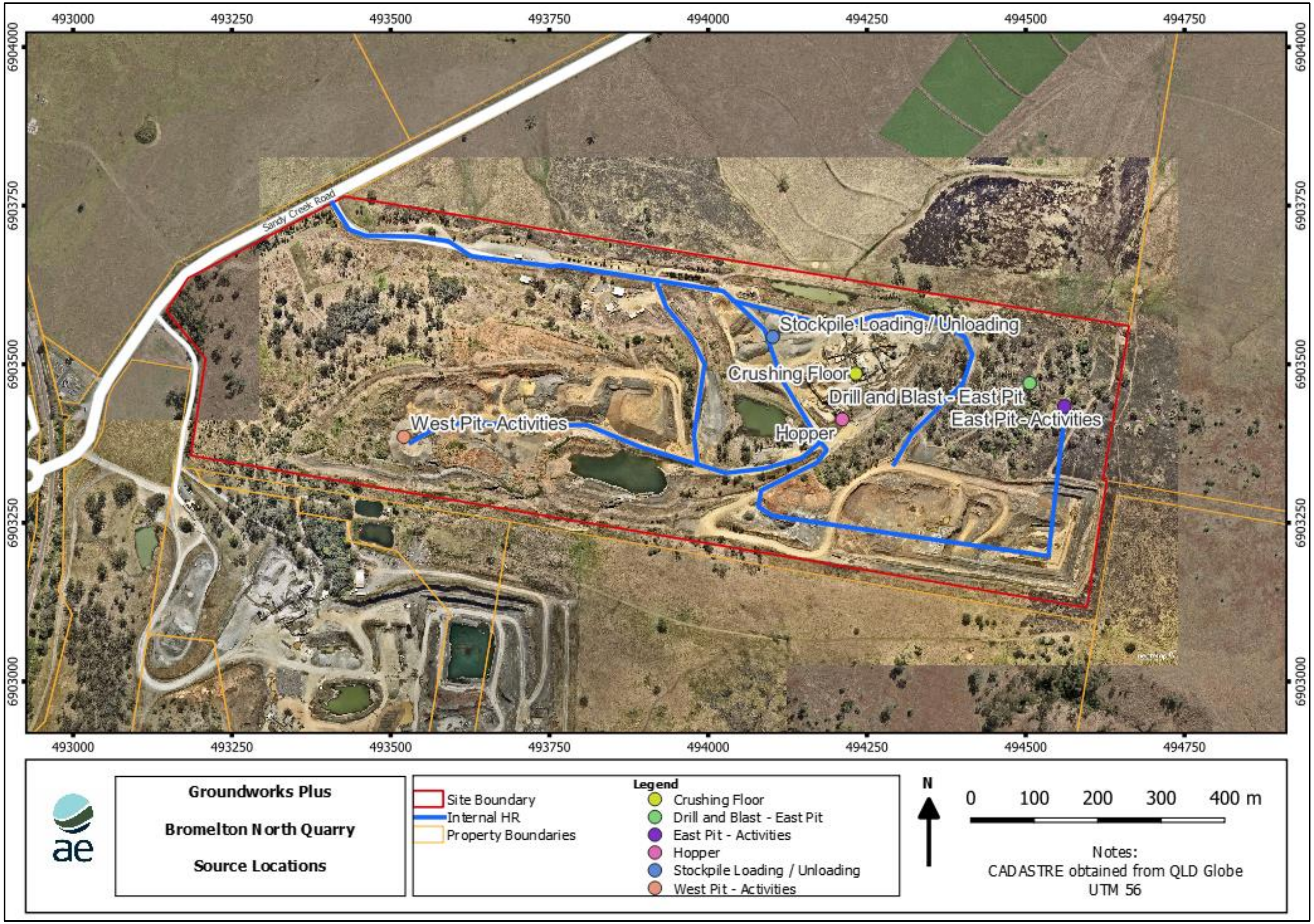


Figure 9: Source Locations

7.4 Source Parameters

Source parameters adopted in the preparation of the model are presented in Table 18 with the location of sources as modelled presented in Figure 9.

Table 18: Source Parameters

Activity	Source Type	Source Parameters			
		Area (m^2)	Effective Height (m)	σY (m)	σZ (m)
Drill and blast	Volume	N/A	10	8.4	2.3
Pit Activities	Volume	N/A	5.0	11.6	1.16
Unpaved Roads	Line volume	N/A	3.0	N/A	1.0
ROM	Volume	N/A	15	1.4	3.5
Crushing Plant	Volume	N/A	10	14.0	2.3
Stockpile Loading/Unloading	Volume	N/A	5.0	3.86	1.16
Wind erosion from stockpiles	Area	Refer to App B	5.0	N/A	2.0
Wind erosion from exposed areas			1.0	N/A	1.0

8 REDICTED GROUND LEVEL CONCENTRATIONS

8.1 Overview

The results in this Section are presented as follows:

- Predicted concentrations from the Subject Site operations of the future expansion in isolation for daily peak production (Table 17); and
- Predicted concentrations from the Subject Site operations of the future expansion in isolation for average production and the adjacent Bromelton Quarry (Table 13) and background concentrations, predicted concentrations (Table 11).

The predicted isopleths presented in Appendix C are for the total predicted concentrations from all cumulative activities and background concentrations.

8.2 Site Only Predicted Results

In accordance with the EPP(Air Quality), the maximum predicted concentrations at the discrete receptors identified in Table 19 for the future Subject Site operations in isolation.

Table 19 presents a summary of the maximum predicted ground level concentrations at the sensitive receptors. It can be seen that the predicted concentrations comply at all sensitive receptors and at the site boundary for all pollutants and time periods.

Table 19: Summary of Maximum Predicted Ground Level Concentrations at Sensitive Receptors from Subject Site Only

Pollutant	Averaging Period	Maximum Predicted GLC at Sensitive Receptors ($\mu g/m^3$)	Criteria ($\mu g/m^3$)
TSP	Annual	3.3	90
PM_{10}	24 hours	19.0	50
	Annual	3.6	25
$PM_{2.5}$	24 hours	2.5	25
	Annual	0.5	8
Deposited Dust	Month	42.6	120 $mg/m^2/day$

8.3 Cumulative Predicted Results

Table 20 presents the results from the Subject Site during future daily peak operations and the adjacent Bromelton Quarry and background concentrations. The results show that the predicted concentrations comply at all sensitive receptors for all pollutants and time period.

The maximum predicted PM_{10} 24-hour concentration is predicted to be 49.8 $\mu g/m^3$ at Receptor R20, which is located to the north of the Bromelton North Quarry. A review of the particulate contributions identifies the crushing operations are dominating the results, which was visible at site when the wind was blowing particulates from the crushing area towards this receptor.

It can be seen from the isopleths in Appendix C and D that the terrain contributes with constraining dispersion from most pit activities, with the exception of the crushing plant and stockpiling activities.

Table 20: Summary of Maximum Predicted Ground Level Concentrations at Sensitive Receptors from Subject Site, Bromelton Quarry and Background Concentrations

Pollutant	Averaging Period	Maximum Predicted GLC at Sensitive Receptors (µg/m^3)	Criteria (µg/m^3)
TSP	Annual	32.8	90
PM_{10}	24 hours	49.8	50
	Annual	19.2	25
$PM_{2.5}$	24 hours	9.7	25
	Annual	6.4	8
Deposited Dust	Month	109.0	120 mg/m^2/day

Overall, the emissions from the Subject Site are not expected to result in significant adverse impacts on the health and wellbeing of the air environment for the surrounding receptors where the control measures detailed in Section 9 are implemented.

The predicted isopleths are presented in Appendix C.

Table 21: Predicted Cumulative Pollutant Concentrations at Sensitive Receptors including Background Concentrations (Particulates)

Receptor	Maximum Predicted Ground Level Concentration at Receptor (µg/m³)					
	TSP	PM_{10}		$PM_{2.5}$		Deposited Dust
	1 year	24 hours	1 year	24 hours	1 year	Monthly
R1	32.8	47.7	18.8	9.1	6.3	109.0
R2	30.2	48.8	16.2	8.4	6.1	62.9
R3	29.8	47.0	15.7	8.1	6.0	57.5
R4	29.8	47.2	15.6	8.1	6.0	56.8
R5	29.7	46.7	15.4	8.2	6.0	54.9
R6	29.6	46.7	15.3	8.3	6.0	54.3
R7	29.5	46.4	15.2	8.5	6.0	53.0
R8	29.5	46.8	15.3	8.9	6.0	53.6
R9	29.5	46.3	15.2	8.9	6.0	52.1
R10	29.4	46.2	15.1	9.0	6.0	51.5
R11	29.8	48.5	15.7	8.3	6.0	57.6
R12	29.5	46.5	15.3	8.7	6.0	52.5
R13	29.2	44.5	14.6	7.7	5.9	46.6
R14	29.4	44.8	14.9	7.9	6.0	49.7
R15	29.1	44.3	14.5	7.9	5.9	46.7
R16	29.1	44.3	14.5	7.7	5.9	46.3
R17	29.3	44.3	14.9	7.6	6.0	50.1
R18	29.3	44.3	14.8	8.2	6.0	52.5
R19	32.4	46.4	18.1	9.1	6.4	88.7
R20	32.4	49.8	19.2	9.7	6.4	89.1
Max	32.8	49.8	19.2	9.7	6.4	109.0
Criteria	90 µg/m³	50 µg/m³	25 µg/m³	25 µg/m³	8 µg/m³	120 mg/m²/day
Compliant?	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

9 MITIGATION MEASURES

The Environment Protection (Air) Policy management hierarchy gives priority to avoiding emissions where reasonable to do so. Where this is not possible, emissions reduction and management currently at the quarry are best practice.

The operations of the quarry aim to reduce emissions of dust and other pollutants by implementing the following control measures as listed in Table 22.

Table 22: Mitigation Controls by Activity

Activity	Mitigation Measure
Work Areas / Trafficable Area	▪ Limit high dust generating activities (vehicle movements) to periods of favourable weather conditions. ▪ The dry stacking will have a high moisture content which will minimise emissions; if visual surveillance indicates dust generation water the dry stacking where operations are occurring. ▪ Dampen down (approx. rate of 2 litres/m²/hour) the internal haul roads by water spraying when visual surveillance indicates excessive dust generation. ▪ Restrict vehicle movements to designated routes to the extent practicable. ▪ Enforce speed limits on internal roads. ▪ Maintain road surfaces in good condition. ▪ Prevent and clean up any spillages or dust accumulation on driveways or sealed roads.
Processing Plant	▪ Use shielding and/or windbreaks where possible. ▪ Maintain equipment in accordance with the original equipment manufacturers' specifications. ▪ Water or use foam-based products when dust from the crushing area is visibly dispersing towards the north.
Stockpiles	▪ Limit the height of any stockpiles to <6m, where practicable. ▪ Regularly water stockpiles to keep down dust emissions if visual surveillance indicates excessive dust generation.

10 CONCLUSIONS

Neilsens propose to increase the extraction rate to 800,000 tonnes per annum and extend the east pit footprint. It is not proposed to change the approved hours of operation or location of fixed plant, and equipment.

An air quality impact assessment has been undertaken to demonstrate the expansion of the quarry will not have adverse effects on surrounding receptors. The assessment has been conducted in accordance with Department of Environment & Science (DES) *Guideline - Application requirements for activities with impacts to air* (2019).

The detailed air quality modelling and assessment of the proposed quarry activities demonstrates that compliance with the air quality objectives prescribed in the Queensland Environmental Protection (Air) Policy 2019 can be achieved at all sensitive receptors with the provision of the control measures detailed in Appendix B, and the general environmental duty of care is adhered to.

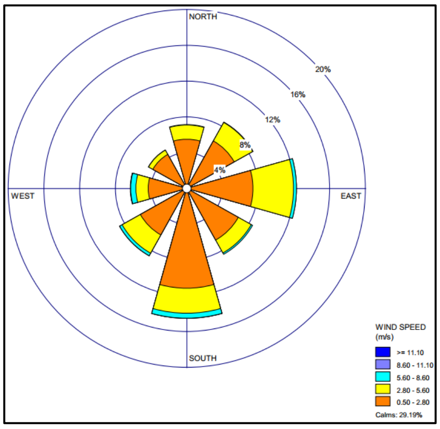
A cumulative assessment of the adjacent Bromelton Quarry has identified a single exceedences of the PM_{10} 24-hour criterion at receptor R1 for one day. A review of the contributions has shown that the Subject Site's contribution is less than the background concentration and the concentration from Bromelton Quarry.

It is recommended that mitigation measures are implemented as per Section 9 of this report to minimise the likelihood of exceedences occurring.

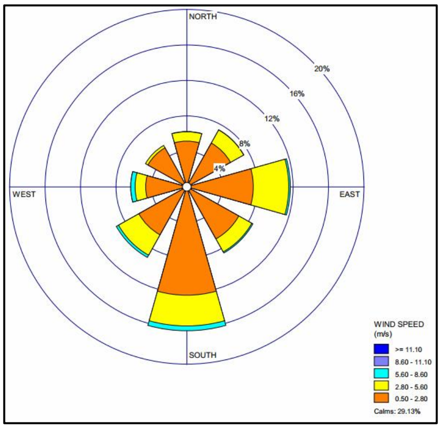
APPENDIX A: METEOROLOGICAL REVIEW

Section of Representative Year

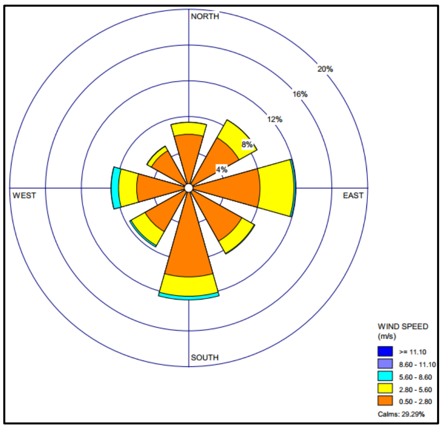
To determine the most representative meteorological year to utilise in the modelling, seven years (2012 - 2019) of meteorological observations from BOM Beaudesert (station number 040983) were reviewed. The Figure below presents the wind roses for 2012 – 2019.



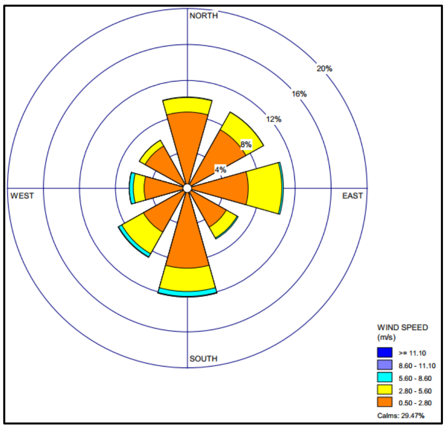
Annual 2012 - 2019



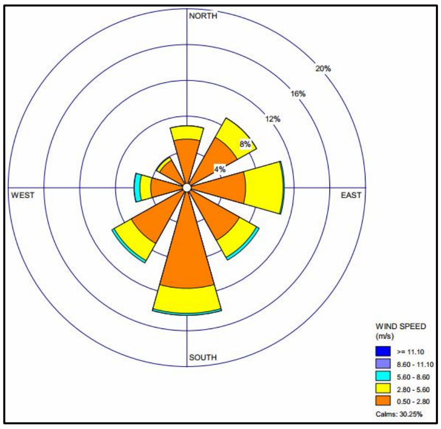
Annual 2015



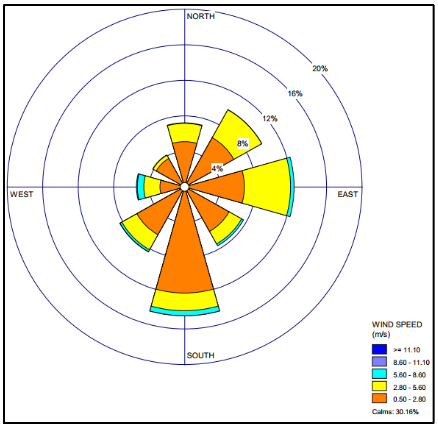
Annual 2016



Annual 2017



Annual 2018



Annual 2019

Long-term Wind Roses from BOM Beaudesert (2012 - 2019)

Figure in this section present the observed annual and seasonal wind roses for BOM Warwick. The following is noted:

- The annual wind roses for all years are very similar in wind direction and wind speed to the seven-year wind roses.
- 2015 and 2018 are the closest representative wind roses of the past five years.

Table 23 presents a yearly comparison of various meteorological parameters against the seven-year dataset. It can be seen form the Table that 2015 is the most representative year based on the percentage of calm conditions and the strongest correlation for relative humidity, temperature, and wind speed by month.

Table 23: Data Analysis

Parameter		Year					
		2012 - 2019	2015	2016	2017	2018	2019
Wind Conditions	Data Availability	99.86	99.92	99.87	99.98	99.98	99.63
	Calm Conditions (%)	29.19	29.13	29.29	29.47	30.25	30.16
	Ave. Wind Speed (m/s)	1.50	1.44	1.43	1.44	1.44	1.55
Rainfall	Data Availability	99.81	99.92	99.8	99.81	99.98	99.63
	Rainfall (mm)	792	868	714	1212	774	392
	Average Hourly Rainfall (mm/hour)	0.09	0.10	0.08	0.14	0.09	0.04
Correlations of Datasets by Month	RH (%)		0.88	0.60	0.65	0.51	0.32
	Temperature (°C)		0.99	0.99	0.97	0.99	0.61
	Wind Speed (m/s)		0.87	0.91	0.66	0.72	0.67

a) Based on long-term data from BOM website

As such, 2015 is considered the most representative year for locations close to Beaudesert.

Validation of Model Performance

Monitoring data from BOM Beaudesert and DES Josephville were assimilated into the modelling. As DES Josephville is <1 km from the site boundary, a detailed comparison has been made to this station instead of BOM Beaudesert.

An evaluation of the performance of the meteorological model is presented in this section. The evaluation compares the observed meteorological data from DES Josephville with the output from CALMET, which included data assimilation in TAPM.

Figure 10 presents a comparison of the 9 am, 3 pm and annual 2015 predicted and observed wind roses at DES Josephville monitoring station. Comparison of the DES site observed wind roses with predicted wind roses indicate that whilst the model has more wind flows from the southeast at 9 am and east at 3 pm, the prediction model

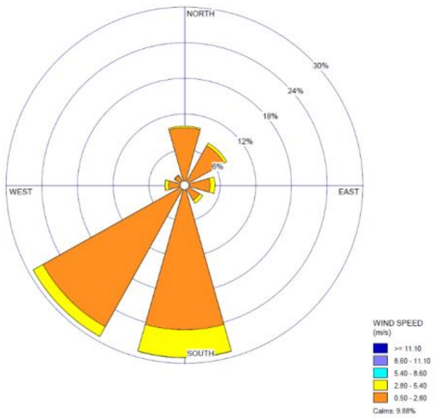
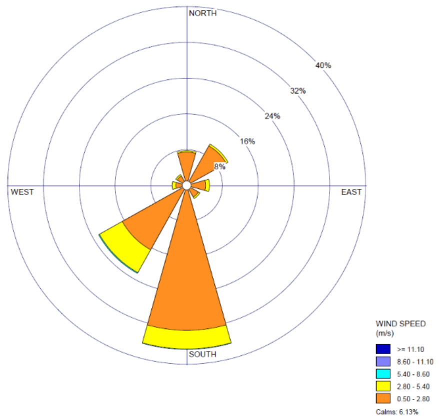
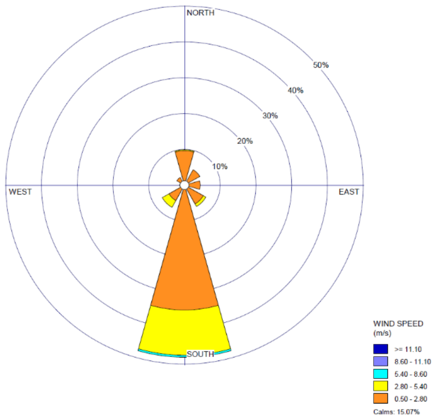
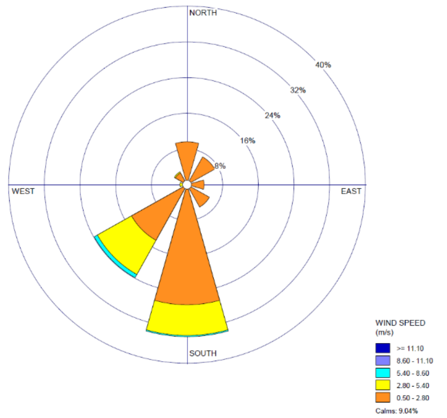
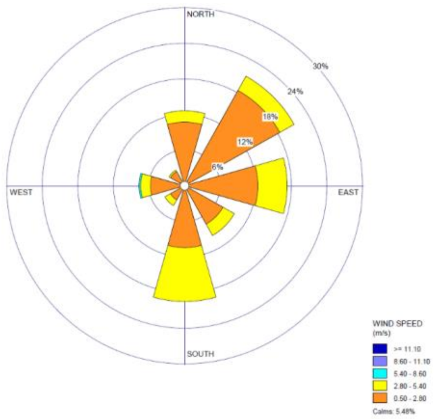
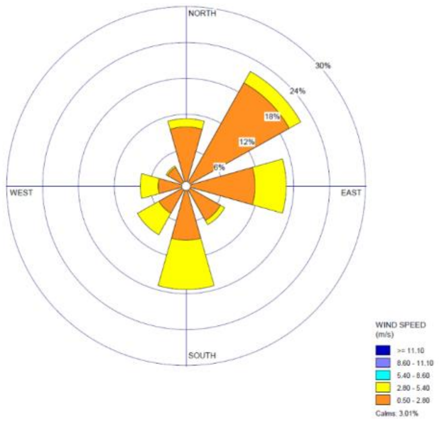
Period	DES Josephville Predicted (2015)	DES Josephville Observed (2015)
Annual		
0900		
1500		

Figure 10: Comparison of Predicted (2015) and BOM Observed Wind Roses (2015) at DES Josephville

Figure 11 shows the probability density functions that graphically compare statistical distributions of individual meteorological parameters between TAPM/CALMET output and observational data, as extracted from the DES Josephville location.

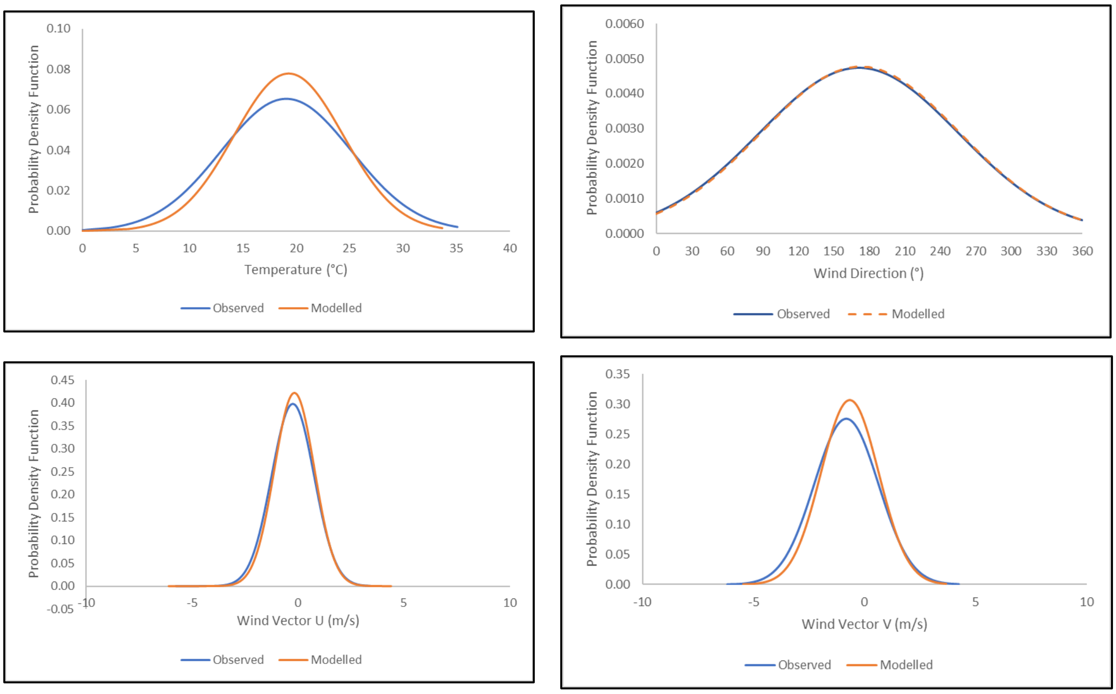


Figure 11: Probability Density Functions (pdf) Comparing Observational and Modelled Data at DES Josephville

Review of the data has identified that the modelled and observed datasets are very similar, with the following noted:

- The modelled temperatures are more likely to be higher than those observed;
- The modelled wind vector V (south/north component) is slightly different to the observed.
- The modelled wind speed and wind vector U (east/ west component) are very similar to those observed with the wind vector U modelled values matching the observed values.

On this basis, the prognostic dataset is considered suitable for the purposes of the assessment.

Prognostic Dataset Review at Subject Site

This section provides an analysis of the prognostic meteorological dataset extracted from the CALMET model for 2015 at the Subject Site.

Predicted Atmospheric Stability

The amount of turbulence in the ambient air has a major effect upon the rise and dispersion of emissions. In particular, the amount of turbulence in the atmosphere plays a key role in diffusion of an emitted plume in the air with stronger turbulence (increased instability) increasing the rate of diffusion. Where the atmosphere exhibits weak turbulence (increased stability), downwind contaminant concentrations can be expected to increase due to the limited diffusion.

Figure 12 presents the diurnal variability in atmospheric stability identified in the predicted meteorological dataset. As can be seen, atmospheric instability increased during the day where the influence of solar energy drives convection in the atmosphere. Conversely, increased stability can be seen during night periods where stable conditions are predicted for more than 90% of the time.

Monin-Obukhov Length

The Monin-Obukhov Length represents a parameter (with dimension of length) which provides a relationship between parameters characterising dynamic, thermal, and buoyant processes. The parameter, first described by Obukhov in 1946, is the characteristic height scale of the dynamic sub-layer of the atmosphere and is positive for stable stratifications and negative for unstable stratifications.

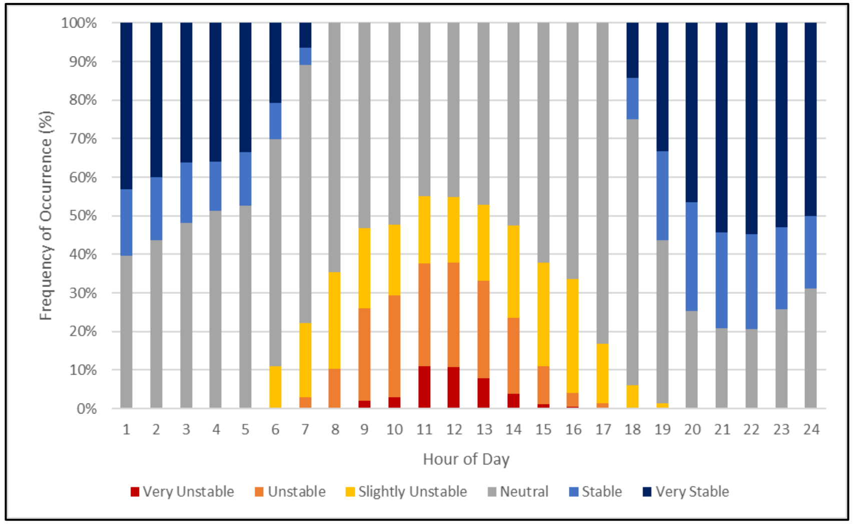
Figure 12 presents a graphical representation of the reciprocal of the Monin-Obukhov length (1/L) for the 2015 prognostic (CALMET) dataset. In this figure, neutral stability conditions have the 1/L value of zero (0), stable conditions have positive values of 1/L and unstable conditions have negative values of 1/L. The more positive 1/L value, the more stable the atmosphere is assumed to be by the model. Similarly, the more negative 1/L becomes, the more unstable the atmosphere is assumed to be by the model.

Predicted Atmospheric Mixing Height

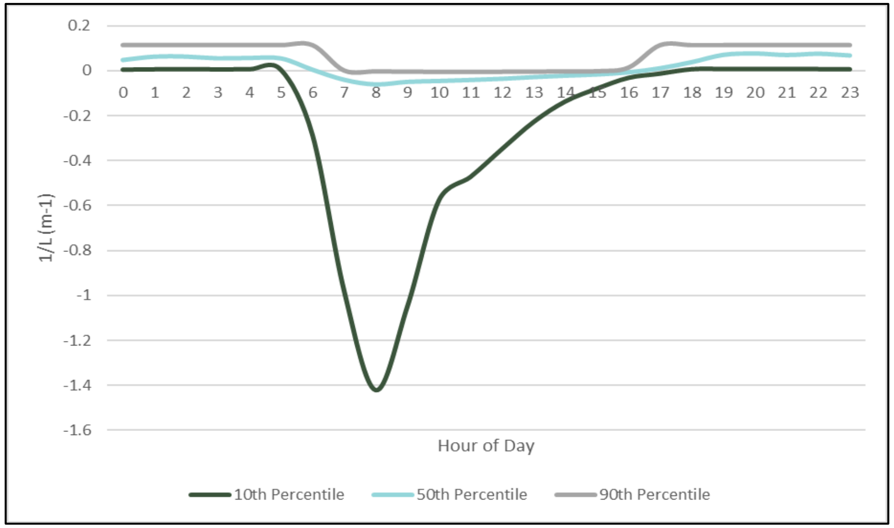
Figure 12 presents an illustration of diurnal variations in maximum and average mixing heights predicted by CALMET at the Subject Site across the 2015 prognostic meteorological dataset. As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights generally occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer. The highest maximum mixing height for the Subject Site occurs during the late afternoon period.

Temperature

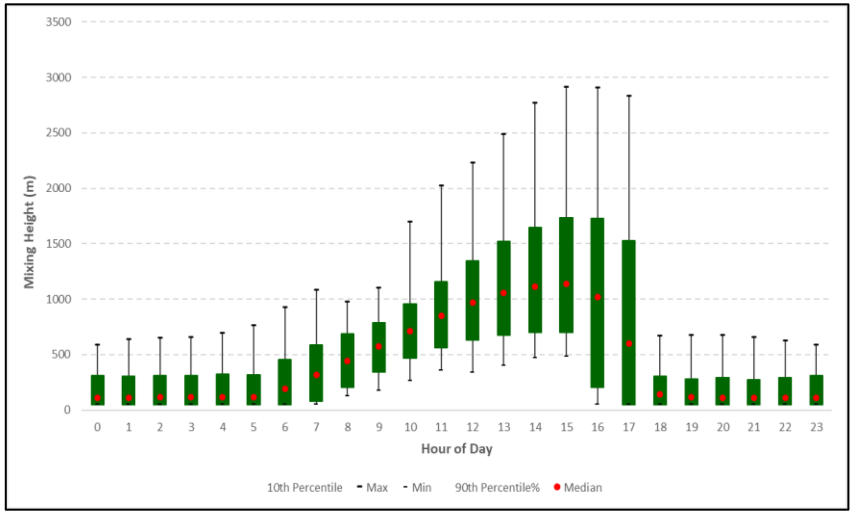
Figure 12 presents an illustration of diurnal variations in maximum and average temperatures predicted by CALMET at the Subject Site across the 2015 prognostic meteorological dataset.



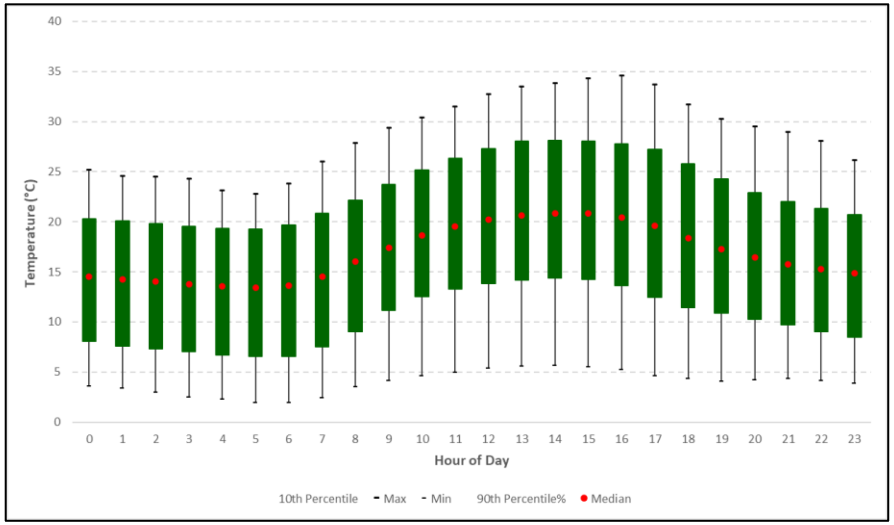
Annual Atmospheric Stability by Hour



Annual Variability of Monin-Obukhov Length by Hour



Atmospheric Mixing Height by Hour



Temperature by Hour

Figure 12: Meteorological Analysis at Subject Site

APPENDIX B: EMISSION ESTIMATION

Emission factors shown in Table 24 and operational information listed in Table 25 can be used to estimate emissions of TSP, PM_{10} and $PM_{2.5}$ to the air from various sources associated with the site.

Table 24: Emission Factor by Activity

Activity	Units	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Source
Wind Erosion for exposed areas	t/ha/hr	0.85 x (365-RD)/365	TSP x 0.5	PM_{10} x 0.075	NPI Mining
Wind Erosion from active stockpiles	kg/ha/ hr	1.8 x U x (365-RD)/365	TSP x 0.5	PM10 x 0.075	NPI for Mining
Loading / unloading trucks from stockpiles	kg/t	$0.74\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.35\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.053\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	NPI for Mining / AP-42 13.2.4
Wheel generated particulates on unpaved roads (light vehicles)	kg/VKT	$1.69\ x\ \frac{((s/12)x(S/48))^{0.3}}{(M/0.5)^{0.3}} - 0.0013$	$0.51\ x\ \frac{((s/12)x(S/48))^{0.5}}{(M/0.5)^{0.2}} - 0.0013$	TSP x 0.105	NPI for Mining
Wheel generated particulates on unpaved roads (heavy vehicles)	kg/VKT	$\frac{0.4536}{1.6093}x4.9\ x\left(\frac{s}{12}\right)^{0.7}\ x\left(\frac{Wx1.1023}{3}\right)^{0.45}$	$\frac{0.4536}{1.6093}x1.5\ x\left(\frac{s}{12}\right)^{0.9}\ x\left(\frac{Wx1.1023}{3}\right)^{0.45}$	$\frac{0.4536}{1.6093}x0.15\ x\left(\frac{s}{12}\right)^{0.9}\ x\left(\frac{Wx1.1023}{3}\right)^{0.45}$	NPI for Mining / AP-42 13.2.2
Material transfer	kg/t per transfer point	$0.74\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.35\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.053\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	NPI for Mining / AP-42 13.2.4
Truck Loading / Unloading using FEL	kg/t	$0.74\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.35\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	$0.053\ x\ 0.0016\ x\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$	NPI for Mining
Tertiary Crushing - Controlled	kg/t	0.0027	0.0012	0.00022	NPI Mining
Screening - Controlled	kg/t	0.01250	0.00430	0.00029	NPI Mining
Conveyor Transfer Point	kg/t	0.00150	0.00055	0.00016	NPI Mining

Where:

WS = wind speed (m/s)
WS_O = threshold for particulate matter lift-off (6.5 m/s)
M = material moisture content (%)
S = material silt content (or surface content in unpaved roads) (%)
U = wind speed (m/s)
W = mean vehicle weight (tonnes)
S = mean vehicle speed (km/h)

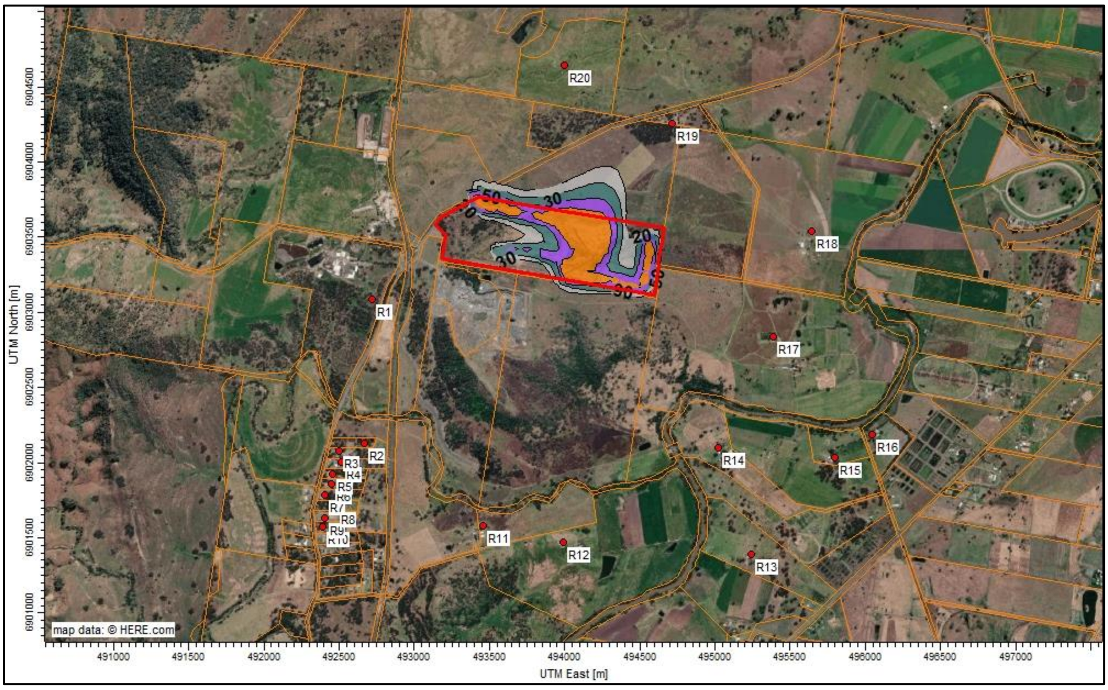
Table 25: List of Activity Data and Assumptions for Nielsen's Quarry

Parameter	Units	Proposed
Operating Times		
Operating hours	hrs per day	11
Operating days	day / year	300
Operating days	days	Mon to Sat
Volumes / Areas		
Annual Production (Average)	tonnes/yr	800,000
Annual Production (Maximum)	tonnes/yr	1,200,000
Exposed Areas	ha	16.5
Exposed stockpiles	ha	2.4
Rehabilitated Area	ha	-
Material Transfer		
Trucks Loading in Pit	tonnes/yr	1,200,000
Truck Unloading at Screening Plant	tonnes/yr	1,200,000
Screening	tonnes/yr	4,881,000
Crushing	tonnes/yr	4,080,000
Stockpile Loading	tonnes/yr	1,200,000
Trucks Loading from Stockpile	tonnes/yr	1,200,000
FEL in Materials Stockpile Area	tonnes/yr	1,200,000
Access Road Haulage	tonnes/yr	800,000
Internal Road Haulage	tonnes/yr	1,200,000
Product Truck Weight (unladen)	tonnes	32
Product Truck Weight (laden)	tonnes	61
Raw Materials Truck (unladen)	tonnes	45
Raw Materials Truck (laden)	tonnes	83
Access Road (Unpaved)	km / VKT	0.53 / 22,484
Internal Haul Roads (Unpaved)	km / VKT	2.36 / 100,232
Drilling and Blasting		
Number of Holes	per blast	255
Area per Blast	m^2	1,600
Number of Blasts per Year	-	24
Weather		
Mean wind speed (Warwick)	m/s	1.8
Rainfall >0.25 mm	Days per yr	78
Material Characteristics		
Raw material moisture content	%	2
Silt content of unpaved road	%	7.1
Emission Controls		
Material transfers (loading stockpiles)	%	0
Material transfers (processing)	%	0

Parameter	Units	Proposed
Material transfers (loading trucks)	%	0
Unpaved roads (water truck)	%	50
Wind erosion of stockpile	%	0
In pit retention	%	TSP – 50% PM_{10} – 5%

APPENDIX C: PREDICTED POLLUTANT GLC ISOPLETHS: SUBJECT SITE ONLY

This Appendix presents the predicted ground level concentrations from daily peak production rates. Due to the interpolation of the gridded results, there may be slight discrepancies with the discrete receptors.



Pollutant:	Period:	Percentile:	Criteria:
TSP	1 Year	100^{th}	90 µg/m^3

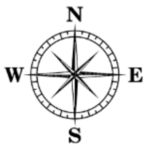
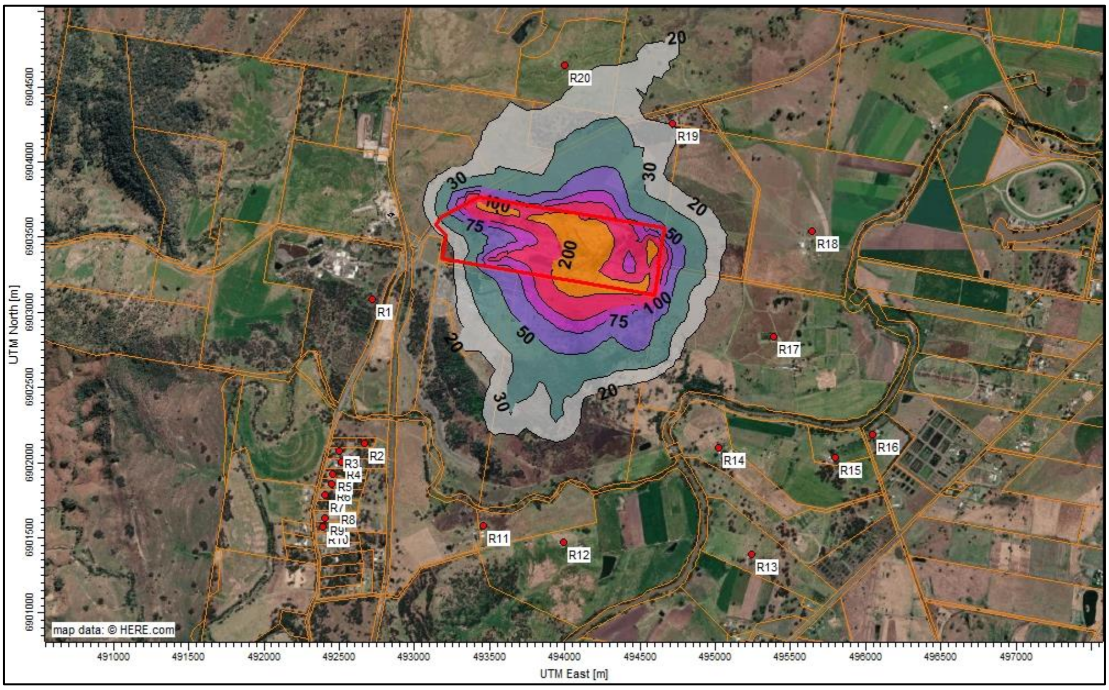
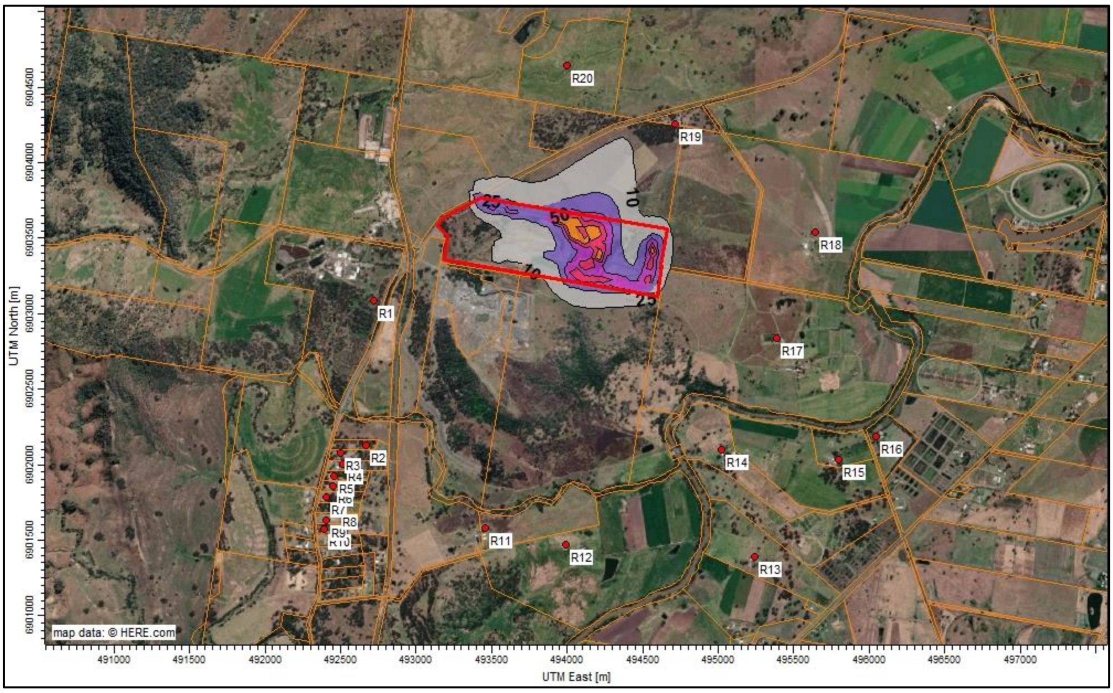


Figure 13: Predicted TSP GLCs for Daily Peak Operations from Subject Site Only



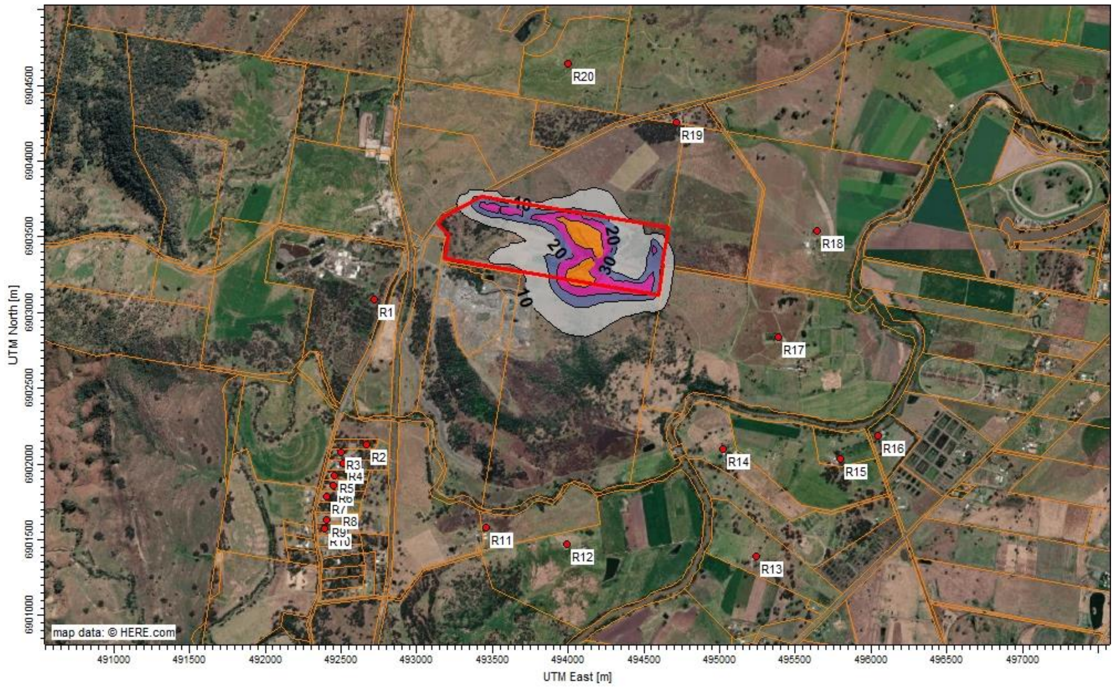
Pollutant:	Period:	Percentile:	Criteria:
PM_{10}	24 Hour	100th	50 µg/m^3

Figure 14: Predicted PM_{10} 24-hour GLCs for Daily Peak Operations from Subject Site Only



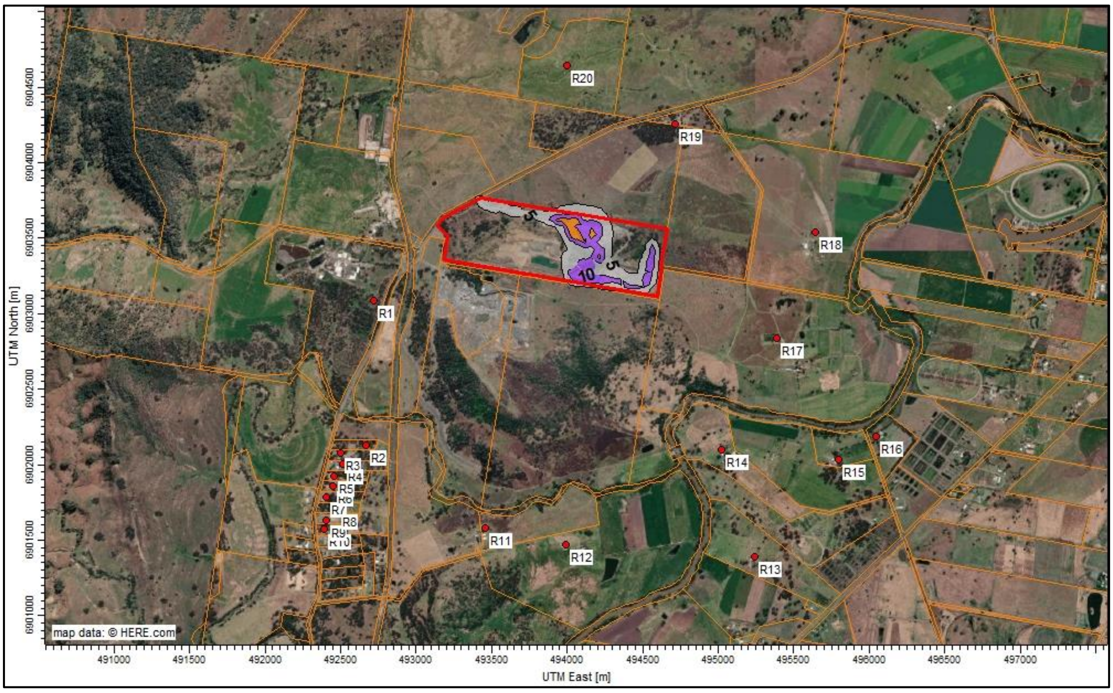
Pollutant:	Period:	Percentile:	Criteria:
PM_{10}	1 Year	100th	25 µg/m^3

Figure 15: Predicted PM_{10} annual GLCs for Daily Peak Operations from Subject Site Only



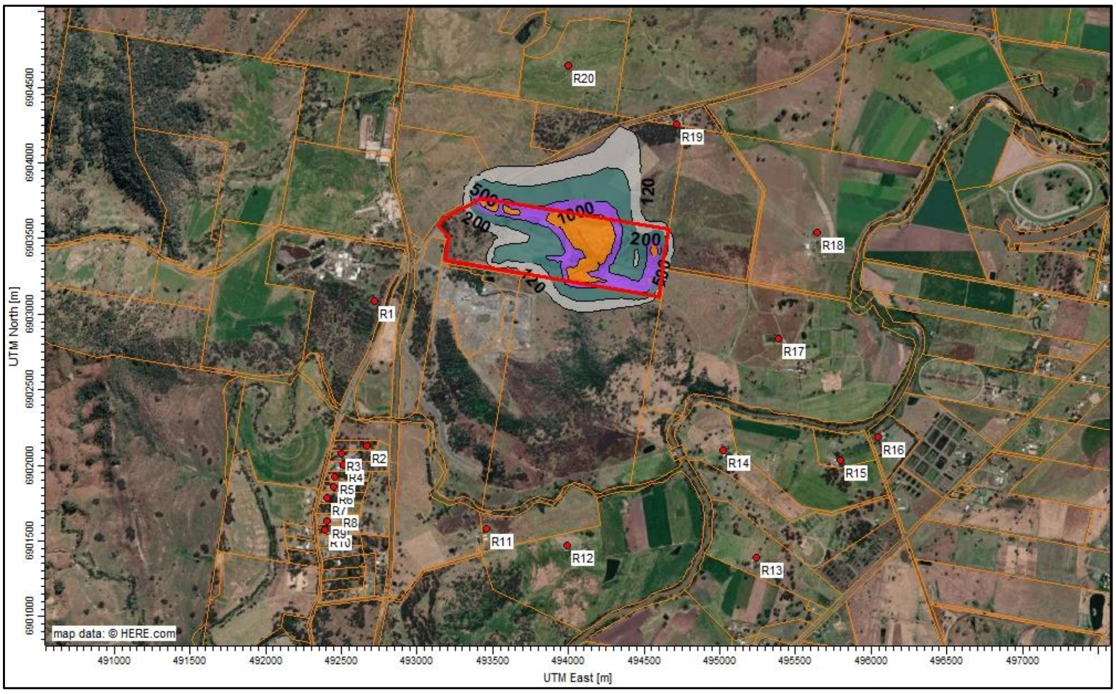
Pollutant:	Period:	Percentile:	Criteria:
$PM_{2.5}$	24 hours	100th	25 µg/m³

Figure 16: Predicted $PM_{2.5}$ 24-hour GLCs for Daily Peak Operations from Subject Site Only



Pollutant:	Period:	Percentile:	Criteria:
$PM_{2.5}$	1 Year	100th	8 µg/m³

Figure 17: Predicted $PM_{2.5}$ annual GLCs for Daily Peak Operations from Subject Site Only

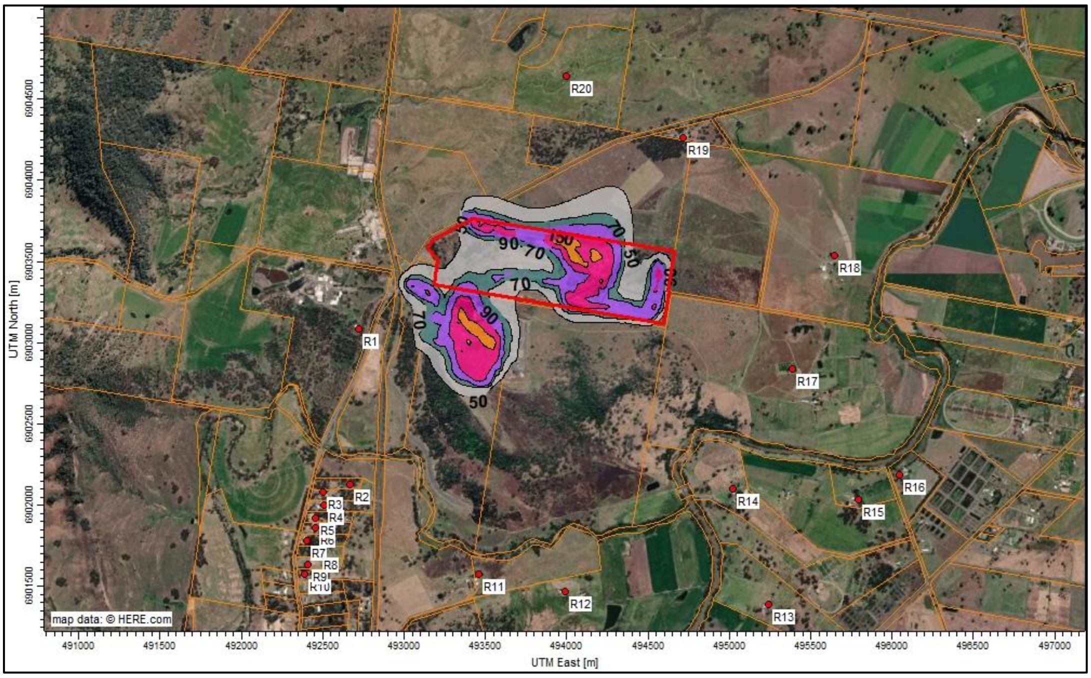


Pollutant:	Period:	Percentile:	Criteria:
Deposited Dust	1 Month	100th	120 $mg/m^2/day$

Figure 18: Predicted deposited dust GLCs for Daily Peak Operations from Subject Site Only

APPENDIX D: PREDICTED POLLUTANT GLC ISOPLETHS: CUMULATIVE

This Appendix presents the predicted ground level concentrations from peak daily production rate, adjacent BQ operations and contemporaneous background concentrations (excluding PM2.5, which are percentile background values) included. Due to the interpolation of the gridded results, there may be slight discrepancies with the discrete receptors.



Pollutant:	Period:	Percentile:	Criteria:
TSP	1 Year	100th	90 µg/m3

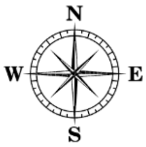
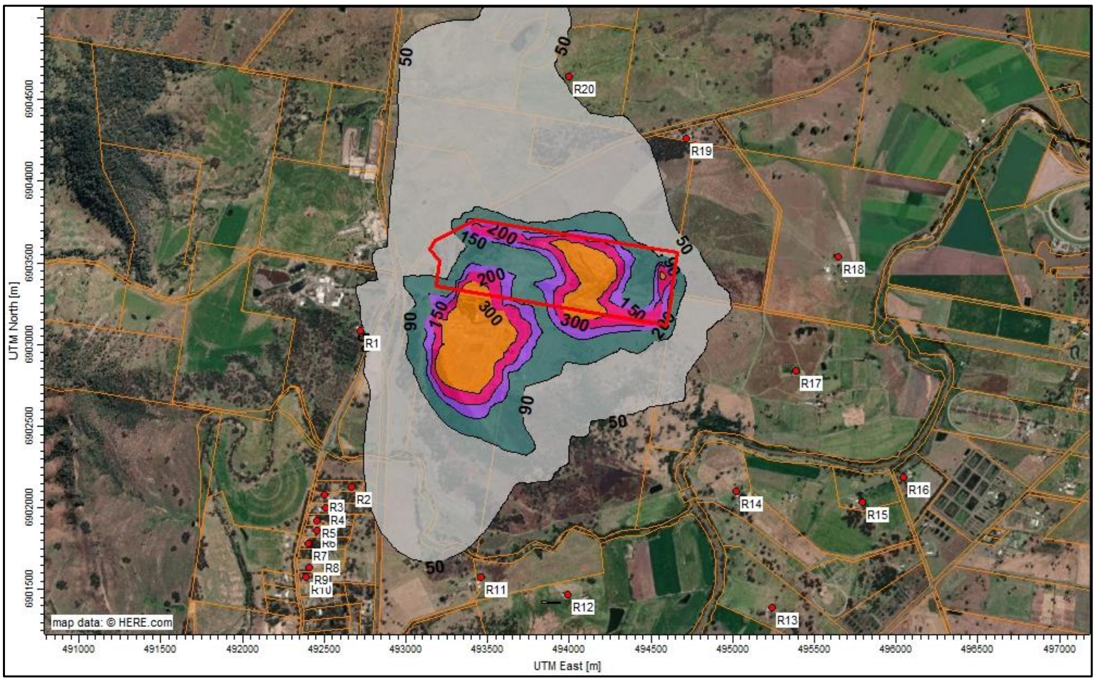
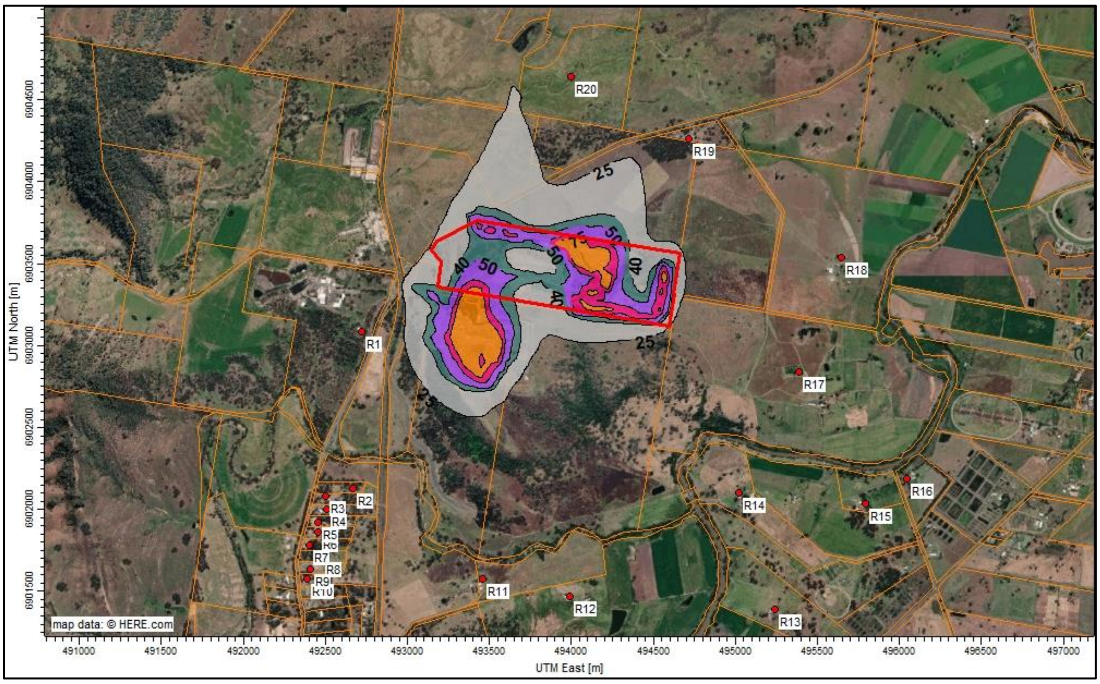


Figure 19: Predicted TSP GLCs for Cumulative Operations and Backgrounds



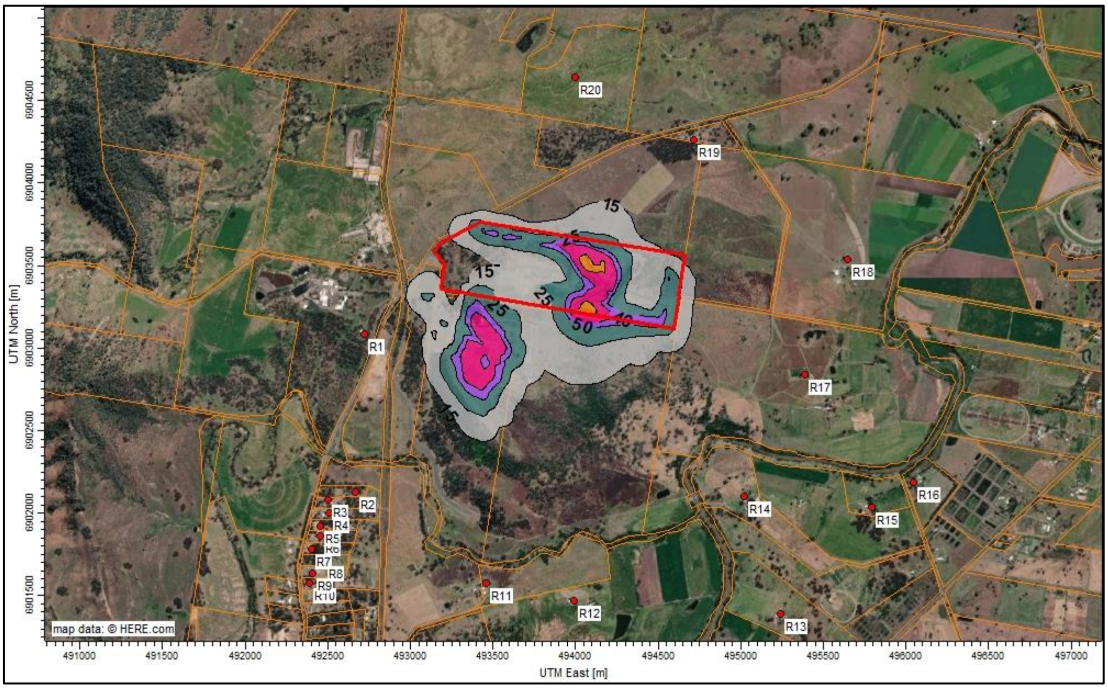
Pollutant:	Period:	Percentile:	Criteria:
PM_{10}	24 Hour	100^{th}	50 µg/m^3

Figure 20: Predicted PM_{10} 24-hour GLCs for Cumulative Operations and Backgrounds



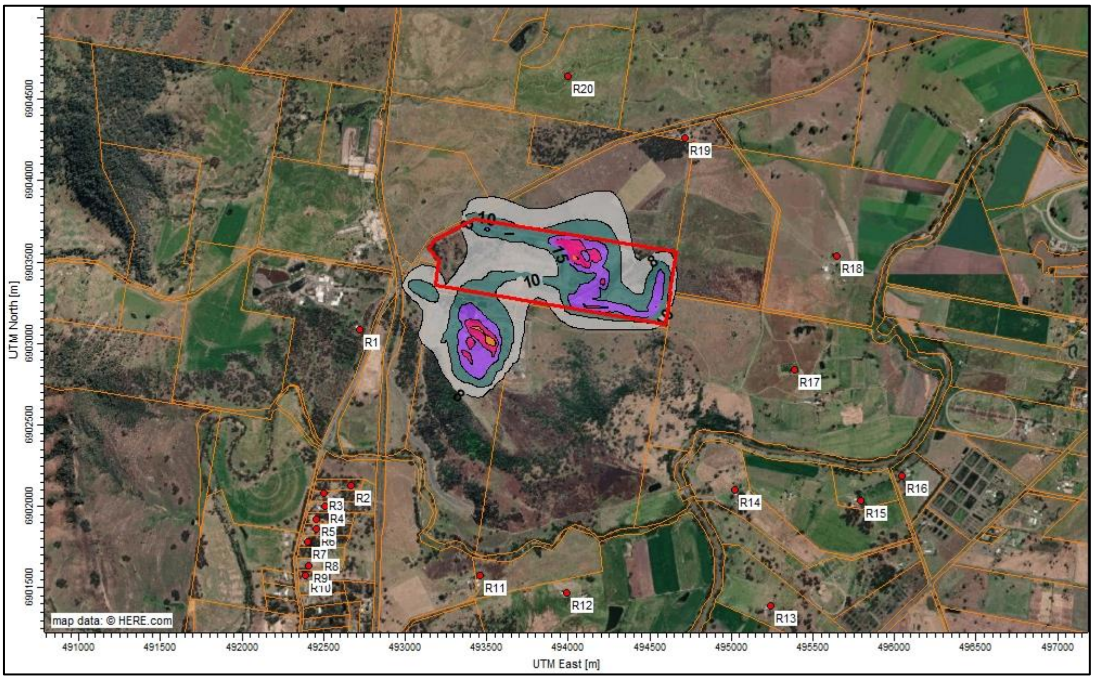
Pollutant:	Period:	Percentile:	Criteria:
PM_{10}	1 Year	100^{th}	25 µg/m^3

Figure 21: Predicted PM_{10} annual GLCs for Cumulative Operations and Backgrounds



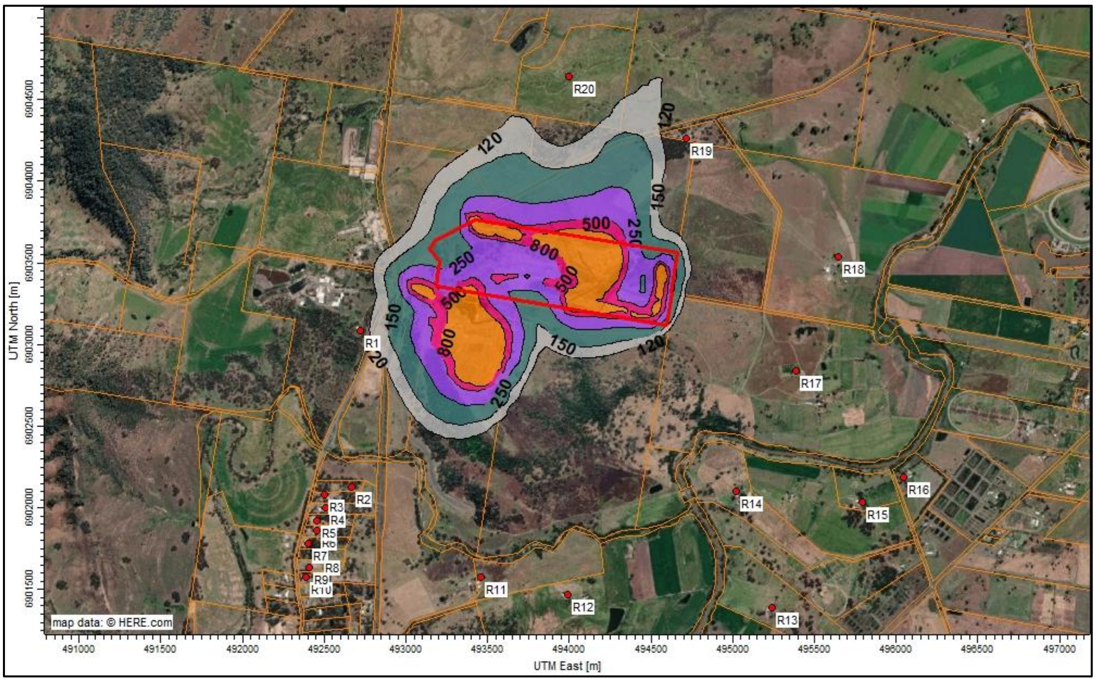
Pollutant:	Period:	Percentile:	Criteria:
$PM_{2.5}$	24 hours	100th	25 µg/m³

Figure 22: Predicted $PM_{2.5}$ 24-hour GLCs for Cumulative Operations and Backgrounds



Pollutant:	Period:	Percentile:	Criteria:
$PM_{2.5}$	1 Year	100th	8 µg/m³

Figure 23: Predicted $PM_{2.5}$ annual GLCs for Cumulative Operations and Backgrounds



Pollutant:	Period:	Percentile:	Criteria:
Deposited Dust	1 Month	100th	120 mg/m²/day

Figure 24: Predicted deposited dust GLCs for Cumulative Operations and Backgrounds