Tronox KZN Sands (Pty) Ltd

INTEGRATED ENVIRONMENTAL AUTHORISATION FOR THE PORT DURNFORD MINE, KWAZULU-NATAL

Air Quality Impact Assessment

FEBRUARY 2025

CONFIDENTIAL

REPORT (VERSION 02) CONFIDENTIAL

PROJECT NO. 41106008

Our Ref No. 41106008-REP-00012

DATE: FEBRUARY 2025

WSP

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Phone: +27 11 254 4800

WSP.com

QUALITY CONTROL

Issue/revision	First issue			
Remarks	Report			
Date	15 August 2024	30 October 2024	06 February 2025	
Prepared by	Z. Ebrahim	Z. Ebrahim	Z. Ebrahim	
Signature			Ebrahim, Zayd (ZAZE05418) 2025.03.25 10:00:16 +02'00'	
Checked by	K. Collett	K. Collett	K. Collett	
Signature			Collett, Kirsten (ZAKC02294) 2025.03.25 11:49:32 +02'00'	
Authorised by	K. Collett	K. Collett	K. Collett	
Signature			Collett, Kirsten (ZAKC02294) 2025.03.25 11:52:55 +02'00'	
Project number	41106008	41106008	41106008	
Report number	41106008-REP-00012			
File reference	\\corp.pbwan.net\za\Central_Data\Projects\41100xxx\41106008 - Tronox Port Dunford EIA\41 AA\01-Reports\02-Final\AQ			

ACRONYMS AND ABBREVIATIONS

µg	Micrograms
AEL	Atmospheric Emission Licence
AQIA	Air Quality Impact Assessment
CO	Carbon Monoxide
CPC	Central Processing Complex
DEM	Digital elevation model
DTMU	Dozer Trap Mining Unit
EA	Environmental authorisation
FEL	Front End Loader
ha	Hectare
HMC	Heavy Mineral Concentrate
hr	Hour
km	Kilometre
kV	Kilovolt
KZN	KwaZulu-Natal
LDV	Light duty vehicle
LOM	Life of Mine
m	Metre
m^2	Squared metre
m^3	Cubic metre
mamsl	Metres above mean sea level
m/s	Meters per second
mg	Milligram
MMIF	Mesoscale Model Interface Program
MSP	Mineral Separation Plant
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act 107 of 1998
NEMAQA	National Environmental Management: Air Quality Act 39 of 2004
NO_2	Nitrogen dioxide
NPI	National Pollution Inventory (Australian Government)
O_3	Ozone

Pb	Lead
PM_{10}	Particulate Matter with Aerodynamic Diameter less than 10-micron metres
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter less than 2.5-micron metres
PWP	Primary Wet Plant
PR	Prospecting Right
RBCAA	Richards Bay Clean Air Association
ROM	Run-of-Mine
RSF	Residue storage facility
SAAQIS	South African Air Quality Information System
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
SAWS	South African Weather Service
SO_2	Sulphur dioxide
SRTM	Shuttle Radar Topographic Mission
TiO_2	Titanium dioxide
tph	Tons per hour
Tronox	Tronox KZN Sands (Pty) Ltd
TSP	Total Suspended Particulates
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRF	Weather Research and Forecasting
WSP	WSP Group Africa (Pty) Ltd

EXECUTIVE SUMMARY

Tronox KZN Sands (Pty) Ltd (Tronox) currently holds a Prospecting Right (PR) under the Department of Mineral Resources and Energy ("currently operates the Fairbreeze Mine (Fairbreeze) which mines heavy mineral sands in the Richards Bay area. The mine is supported by a Mineral Separation Plant (MSP) and Smelter (collectively known as the Central Processing Complex (CPC)) in Empangeni. Tronox also holds a Prospecting Right for the Port Durnford mineral resource, located ~3.4 km northeast of Fairbreeze. This Prospecting Right has been renewed numerous times and Tronox now need to apply for a Mining Right.

Tronox will initially develop a very low-rate mining only operation as Phase 1. Phase 1 will operate at approximately 100 tons per hour (tph) producing Run-of-Mine (ROM) to be sent to Fairbreeze mine for primary beneficiation, for approximately 10 years from 2025 to 2035. It is anticipated that the mining operations will increase in throughput after 2036 when the Project enters Phase 2 (Full Scale), an operation with a planned mining rate of 3,000 tph, 24 hours a day for 365 days per year, to provide the continued feed of heavy mineral concentrate (HMC) to the KwaZulu-Natal (KZN) Mineral Separation Plant in Empangeni for 34 years. To obtain a mining right, environmental authorisation (EA) for the proposed expansion Project (i.e. the Port Durnford Project) is required. As part of the EA process, Tronox has requested WSP Group Africa (Pty) Ltd (WSP) to undertake an Air Quality Impact Assessment (AQIA) for the Port Durnford Project.

Importantly, an AQIA was undertaken in 2012, but such an assessment is outdated (as more than five years to date has lapsed and due to the change in the land use conditions to date), in accordance with the Regulations Regarding Air Dispersion Modelling (hereafter referred to as the Modelling Regulations). As such, a new AQIA (this report) has been undertaken.

This report presents the findings from the AQIA, using a Level two dispersion model (AERMOD) to predict the potential air quality impacts associated with the proposed Project. Included in this report is a description of the Project background; a discussion on the associated atmospheric emissions and relevant air quality legislation; a description of the methodology utilised in the study; identification of representative sensitive receptors; dispersion modelling predictions as well as an assessment of the related impacts.

Given that the proposed operations involve mining operations, only particulate related pollutants are of concern, and therefore assessed in this AQIA, namely Particulate Matter (PM as PM_{10}, $PM_{2.5}$ and dust fallout [calculated as Total Suspended Particulates (TSP)]).

To assess the existing air quality in the area surrounding the proposed Project site, ambient monitoring data was obtained from the nearest monitoring stations. Particulate matter monitoring is measured at the nearby South African Weather Service (SAWS) Mtunzini monitoring station, located ~9 km from the Port Durnford site. However, the station data was poor with low data recovery and could not be used for assessment purposes. As such, ambient measured PM_{10} concentrations were sourced from the Richards Bay Clean Air Association (RBCAA) eSikhaleni station and from the South African Air Quality Information System (SAAQIS) eSikhawini monitoring station, which are the closest stations to the site with suitable data recovery (both located ~6 km from the Port Durnford site.

Measured PM_{10} concentrations for the period January 2020 – December 2022 were assessed. For this period, two exceedances of the 24-hour National Ambient Air Quality Standard (NAAQS)

(75 µg/m^3) were recorded at the eSikhaleni monitoring station, occurring in June 2021 and July 2021, remaining compliant as four exceedances of the standard are permitted per calendar year. Two exceedances of the 24-hour NAAQS were recorded in June 2021 and July 2021 at the eSikhawini monitoring station, remaining compliant as four exceedances of the standard are permitted per calendar year.

An emissions inventory was developed to identify all potential sources of particulate emissions associated with the proposed Project. The ambient impacts of the proposed operational phase were then assessed using the AERMOD dispersion model. It is noted due to the erratic and transient nature of the construction and decommissioning phases, a quantitative assessment of ambient impacts was not undertaken, but rather a qualitative discussion thereof.

Given that the proposed active operational period of Phase 1 operations will be intermittent (active mining will take place five days a week per month, for twelve hours a day) and for the purpose of this report, emissions from this scenario have been quantified, however, the emission sources have not been modelled. For Phase 2, mining is expected to progress across the site (from 2036 – 2069) and as such, the modelling scenarios have been split into key periods (based on location of emission sources) for ease of assessment. For the dispersion modelling, the following scenarios were considered (operational years are indicated in brackets):

- Phase 2 Scenario 1 (3,000 tph) Operations (2036 – 2047)
- Phase 2 Scenario 2 (3,000 tph) Operations (2048 – 2053)
- Phase 2 Scenario 3 (3,000 tph) Operations (2054 – 2069)

For Phase 2 (all scenarios), $PM_{2.5}$ and PM_{10} concentrations are predicted to be well below the relevant NAAQS for the proposed Phase 2 operations. Notably, the maximum fenceline concentrations predicted for Phase 2 are well below the NAAQS. Highest predicted concentrations are in close proximity to the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

For Phase 2 (all scenarios), dust fallout rates are predicted to exceed the National Dust Control Regulations residential standard at representative receptors in close proximity (within 1 km) of the site boundary. Notably, the maximum fenceline concentrations exceed the non-residential standard. The predicted exceedances extend up to 500 m north-northwest and south-southwest of the proposed boundary. The nearest sources contributing to the exceedances beyond the site boundary include the sand stockpiles. Notably, Tronox propose to rehabilitate and vegetate legacy stockpiles and backfilled areas during the operational phase.

Based on dust fallout results, impacts of the Phase 2 operations are predicted and dust-related complaints from receptors are anticipated. Notably the highest predicted fallout rates occur in proximity to the PWP and DTMU's. It is recommended that the proposed mitigation methods are adhered to, and various additional mitigation recommendations are provided in this report. It is, however, recommended that a dust fallout monitoring network is established after commissioning of Phase 2 operations to establish dust fallout levels in the surrounding communities and identify the need for additional mitigation. If elevated air pollution levels are detected, then further mitigation measures will need to be considered.

All impacts of the proposed Project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the nature, significance, consequence, extent, reversibility, duration and probability of occurrence. Based on the results of this Air Quality Impact Assessment, the significance of air pollution-related impacts is rated as "low" for the construction, operational and decommissioning phases of the Project, provided mitigation measures are set in place during the operational phase.

From an air quality perspective, it is therefore advised that the Port Durnford Project be authorised, provided mitigation measures are kept in place and dust fallout monitoring is conducted monthly during Phase 2.

DETAILS AND DECLARATION OF THE SPECIALIST

DETAILS OF THE SPECIALISTS

Task	Develop Air Quality Impact Assessment
Full Name	Zayd Ebrahim
Title/Position	Senior Consultant
Qualification	BSc Environmental and Geographical Sciences & Geology
Professional Affiliations	SACNASP

DECLARATION OF INDEPENDENCE BY SPECIALIST

I, Zayd Ebrahim, a duly authorised representative of WSP (Pty) Ltd, declare that I –

- Act as the independent specialist in this application.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed.
- Do not have nor will have a vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Tronox currently operates the Fairbreeze Mine (Fairbreeze) which mines heavy mineral sands in the Richards Bay area. The mine is supported by a Mineral Separation Plant (MSP) and Smelter (collectively known as the Central Processing Complex (CPC)) in Empangeni. Tronox also holds a Prospecting Right for the Port Durnford mineral resource, located ~3.4 km northeast of Fairbreeze. This Prospecting Right has been renewed numerous times and Tronox now need to apply for a Mining Right.

Fairbreeze mine will conclude its life of mine in 2037 and it is intended that the Port Durnford mining activities will facilitate the continuation of Tronox mining operations in the area. To achieve this, the existing PR for the Port Dunford mineral resource needs to be converted into a mining right. Initially, it is intended to develop as Phase 1, a low-rate operation at approximately 100 tph for approximately 10 years from 2025 to 2035. It is anticipated that the mining operations will increase in throughput after 2036 when the Project enters Phase 2 (Full Scale), an operation with a planned mining rate of 3,000 tph, 24 hours a day for 365 days per year, to provide the continued feed of HMC to the KZN Mineral Separation Plant in Empangeni for 34 years. Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion.

To obtain a mining right for the proposed Port Durnford site, EA for the Project is required. As part of the EA process, Tronox has requested WSP Group Africa (Pty) Ltd (WSP) to undertake an AQIA for the Port Durnford Project.

This report presents the findings from the AQIA, using a Level two dispersion model (AERMOD) to predict the potential air quality impacts associated with the proposed Project. Included in this report is a description of the Project background; a discussion on the associated atmospheric emissions and relevant air quality legislation; a description of the methodology utilised in the study; identification of representative sensitive receptors; dispersion modelling predictions as well as an assessment of the related impacts.

1.1 TERMS OF REFERENCE

The terms of reference, designed to best meet the Project requirements are summarised below:

- Identification of representative sensitive receptors in the vicinity of the proposed site.
- A baseline assessment of the current ambient air quality situation in the vicinity of the proposed site.
- Compilation of a comprehensive air emissions inventory to account for all sources of air pollution during the operational phase of the Project.
- An air dispersion modelling investigation to determine the impact of the emissions associated with the operational phase of the proposed Project.
- Submission of an Air Quality Impact Assessment report (this report), detailing all findings from the baseline assessment, air emissions inventory and air dispersion modelling simulations.
- Provide recommendations on the scope of any mitigation measures that may be applied to reduce air pollution associated with the proposed Project, if necessary.

2 PROJECT BACKGROUND

2.1 PROJECT LOCATION

The study area is situated in the uMlalazi and uMhlathuze Local Municipalities which are part of the King Cetshwayo District Municipality in the KwaZulu-Natal Province. It is located approximately 15km south-west of Richards Bay and is adjacent to the following settlements/towns at different points along the boundary:

- Mtunzini – 200 m southwest.
- Port Dunford – 60 m south-southeast.
- eSikhawini – 200 m southeast.
- Gobandlovu – 200 m northeast.

The N2 highway as well as the R102 traverse the length of the orebody (refer to **Figure 2-1**); the R102 being located to the northwest and the N2 running through the centre. There is also a railway line just south of the N2 that also traverses the mining right area. The proposed mining right area is approximately 4,734 ha, however, only 1,152 ha are earmarked for development and mining.

The predominant land use in the Project development area is agriculture, with commercial timber plantations and forestry. The largest portion of the Project area is currently used for commercial Eucalyptus plantations. Endemic vegetation in the form of swamp forests, wetlands and small portions of coastal dune forests, occurs in the drainage channels and streams between the plantations (Zanokhule, 2008). Other land uses in the area include mining, commercial sugarcane farming, aqua-ponic exotic fish farming, organic flower farming, tea-tree cultivation, fruit farming, university, rural and urban settlements, Umlalazi Nature Reserve, industry, roads and railways (Snyman, 2008). General infrastructure in the Project development area includes electric power lines, which cross the area in an east to west direction, as well as a railway line that transects the eastern portion of the area.

2.2 TOPOGRAPHY

The surrounding topography is characterised by a gently undulating coastal plain with low lying areas approximately 0.5 metres above mean sea level (mamsl) surrounded by a gently sloping topography with elevation changes above 400 mamsl. Low lying plains are located to the south and south-east and steep slopes are predominantly located to the north-east of the proposed boundary. Terrain influences dispersion of pollutants, especially during periods of stable conditions (refer to **Figure 2-2**).

Figure 2-1: Port Durnford locality map

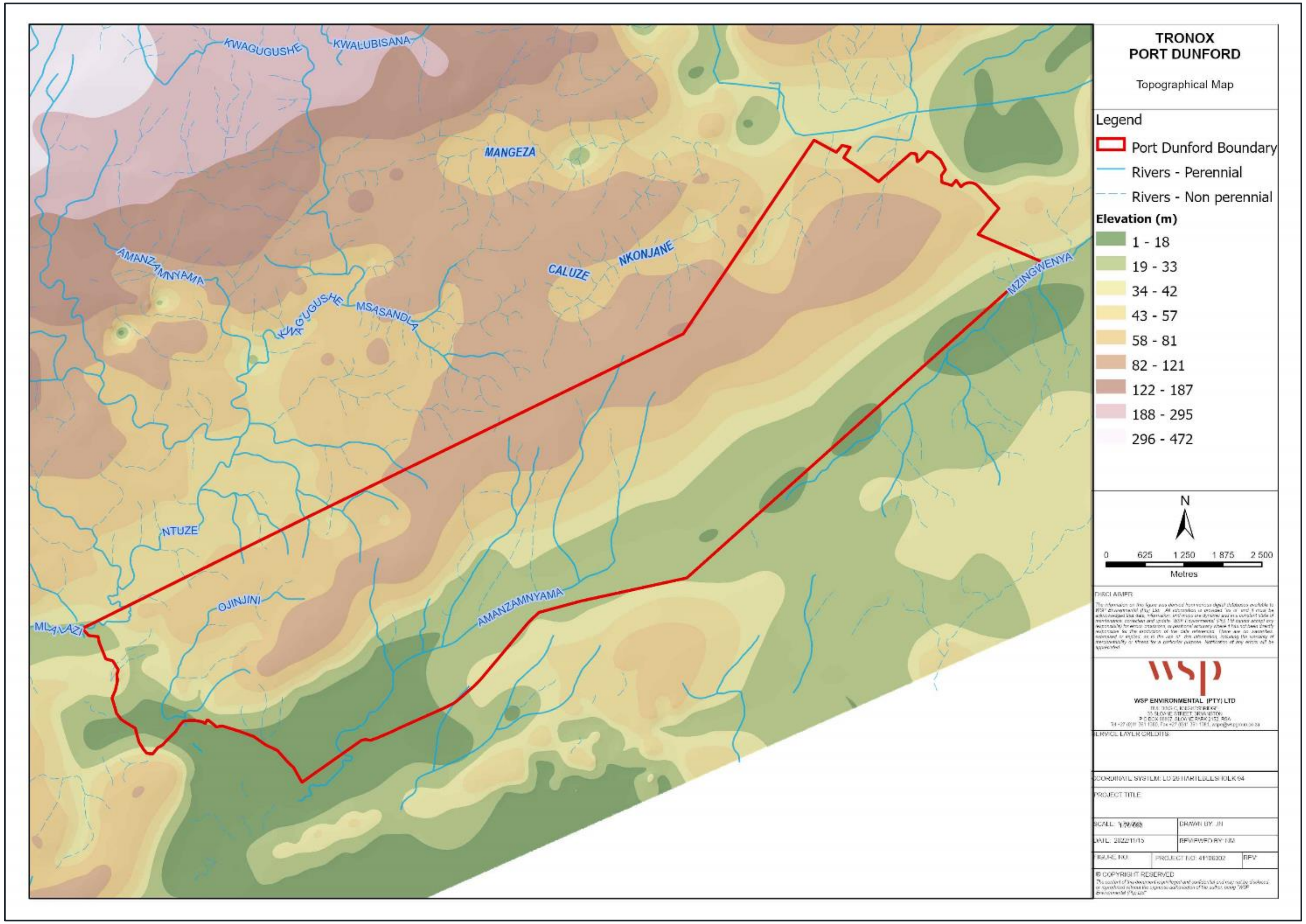


Figure 2-2: Topography map

2.3 PROCESS DESCRIPTION

PHASE 1 MINING

The low-rate (Phase 1) operation will involve Port Durnford ROM material being mined mechanically with front end loaders (FELs) and hauled via trucks to the Fairbreeze mine for stockpile and processing. No processing facilities or tailings or fines disposal facilities will be developed on the Port Durnford lease area.

At Fairbreeze mine, the ROM will be stockpiled within a mined-out portion of the orebody. The stockpiled material will then be reclaimed via hydraulic mining processes as per the current practice at Fairbreeze mine, and the material will be pumped to the Fairbreeze Primary Wet Plant (PWP) for processing. The processed material will then be trucked to the existing Mineral Separation Plant (MSP) located at the Central Processing Complex (CPC) in Empangeni. A process flow diagram for the Phase 1 operations is presented in **Figure 2-3**, while the site layout is depicted in **Figure 2-4**.

The proposed mine infrastructure for Phase 1 will include the mining areas as well as a temporary site with the following infrastructure to support this operation:

- Conservancy Septic tank system – 2 x 6,000 litre tanks placed under ground.
- Mining equipment parking area.
- Workshop laydown area.
- Water storage tanks (2 x 10 kilolitre tanks).
- Internal water reticulation (to offices & ablutions).
- Offices and ablution units.
- Internal electrical reticulation.
- External lighting.
- Light duty vehicle (LDV) parking area.
- Guard house.
- Security fence.
- A gravel access road (200 m access road) to connect the laydown yard to the District Road which connects to the R102.
- A general and hazardous waste storage area.
- Fuel and Lubricant Storage: it is anticipated that a 23 m^3 storage tank will be provided and it is estimated that 153,422 litres will be utilised per annum.

It is proposed that the ore mined at Port Durnford will be transported using highway road trucks to the Fairbreeze PWP. The preferred route at present is transport along a short gravel road from the site onto the R102, then left onto Hely Hutchinson Road and onto the N2 highway via the onramp closest to Mtunzini. Direct access to Fairbreeze PWP is then possible from an offramp of the N2.

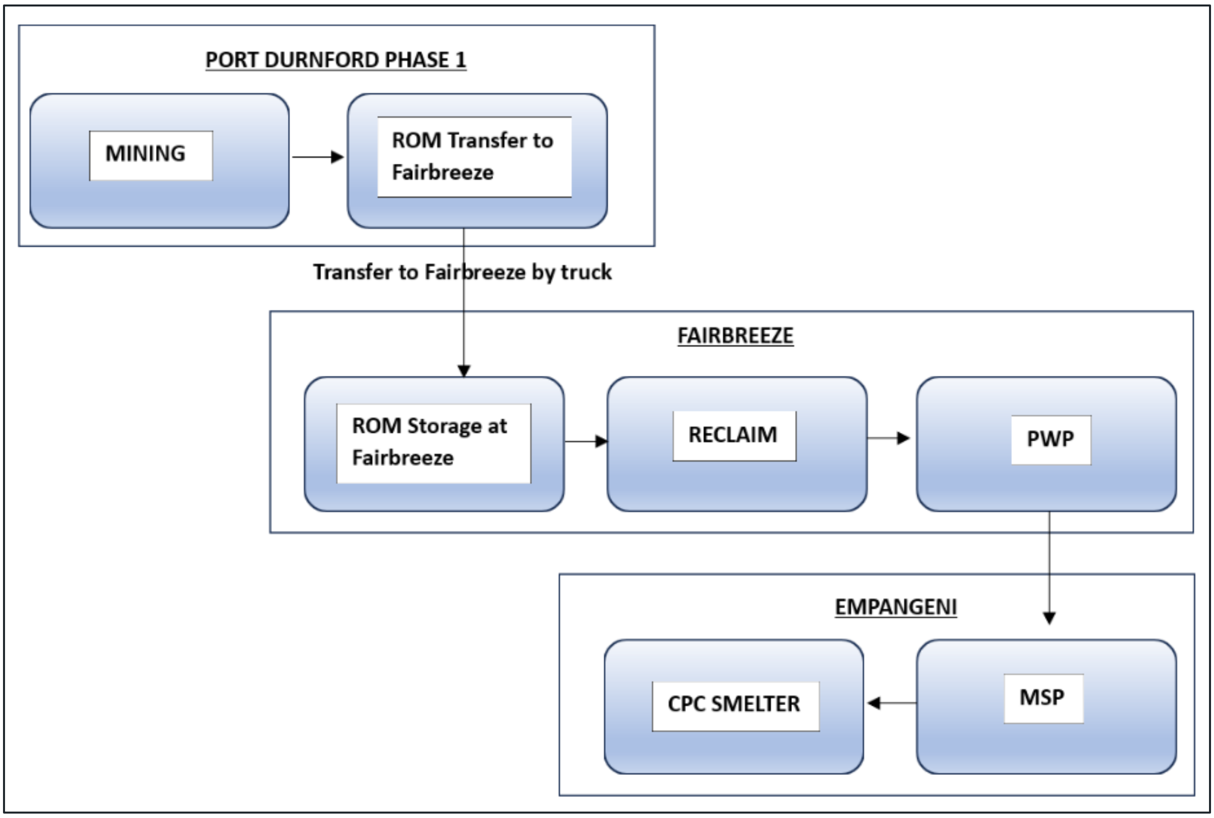


Figure 2-3: Phase 1 block flow diagram

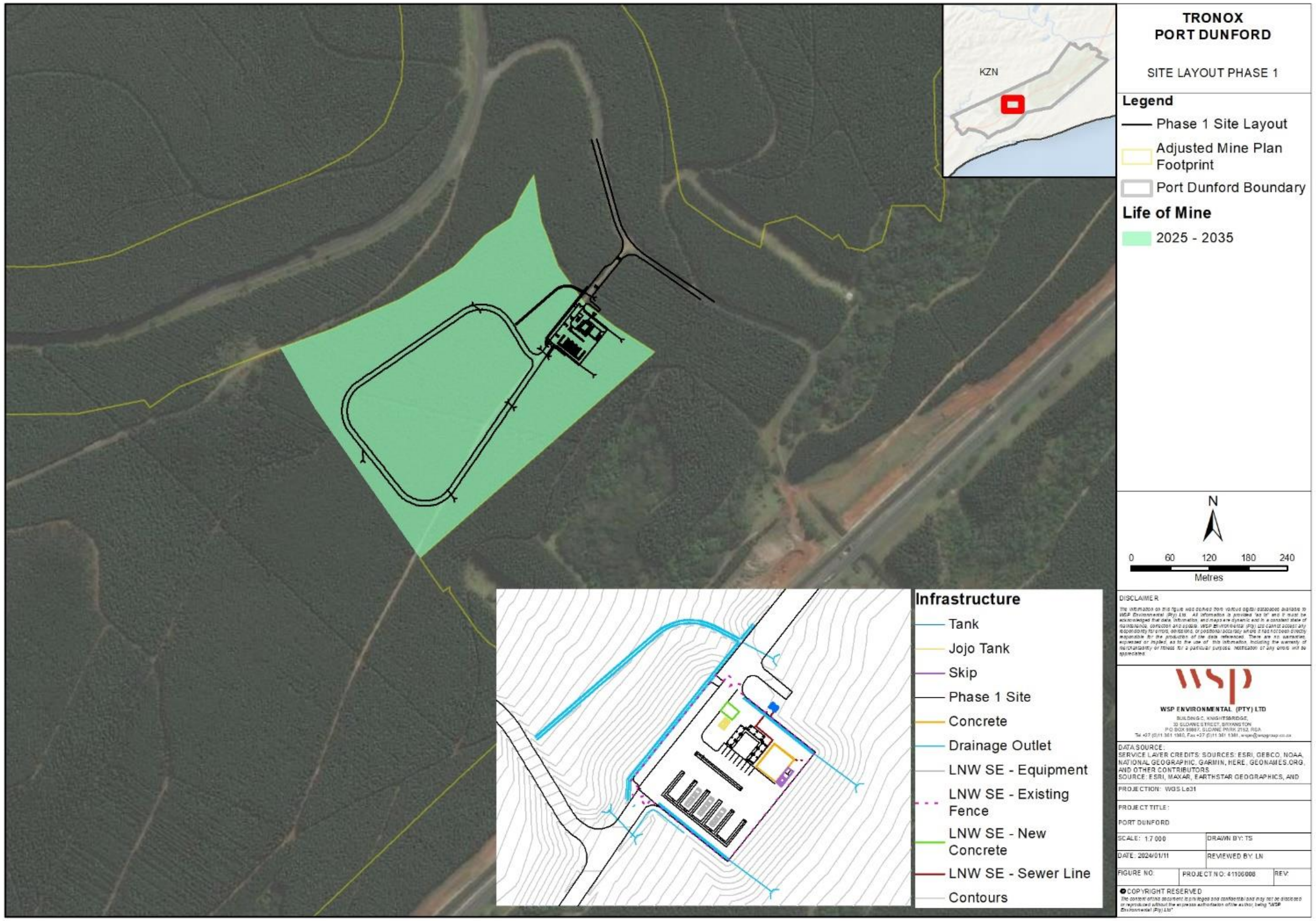


Figure 2-4: Phase 1 (100 tph) layout

PHASE 2 MINING

From 2036 to the end of the Life Of Mine (LOM), the low-rate truck and shovel mining method will be replaced by a high-rate 3,000 tph mining operation, utilizing two dozer trap mining units (DTMUs). The DTMUs will be mobile as mining will occur in phases across the planed mining area. The DTMUs will be fed via bulldozers and will operate in parallel to collect and prepare the ROM for further hydraulic transfer to Port Durnford's own PWP. The units will be skid-mounted and mobile and used to screen vegetation, rocks and oversized materials. The remaining ROM will then be slurried and pumped to the PWP where it will first pass through a trommel screen to remove further oversized material.

The 3,000 tph operation will involve a full production facility which will consist of a new PWP, constructed to process the Port Durnford ROM material and residue storage facilities (RSFs) will need to be constructed to contain the fines tailings produced from the PWP. All bulk services (such as power and raw water), and associated infrastructure to support this operation will also be required. All HMC produced at the PWP will then be transferred as feedstock via truck to the existing MSP in Empangeni.

At the PWP, the following processes will occur:

- Mined material (ROM) will be deslimed and placed through a spiral circuit to separate out the coarse tailings which will then be used for backfilling and for the establishment of the walls of the residue storage facilities.
- The spiral concentrate will be put through a magnetic separation circuit to remove the reject magnetite which is fed back into the coarse tailings circuit.
- The non-magnetic material forms the HMC which feeds into the PWP, MSP and ultimately the CPC.
- Fine tailings are collected from the desliming process, thickener is added, and process water retrieved before disposal on the RSFs.

A process flow diagram for the Phase 2 operations is presented in **Figure 2-5**, while the site infrastructure layout and LOM plan are depicted in **Figure 2-6** and **Figure 2-7** respectively.

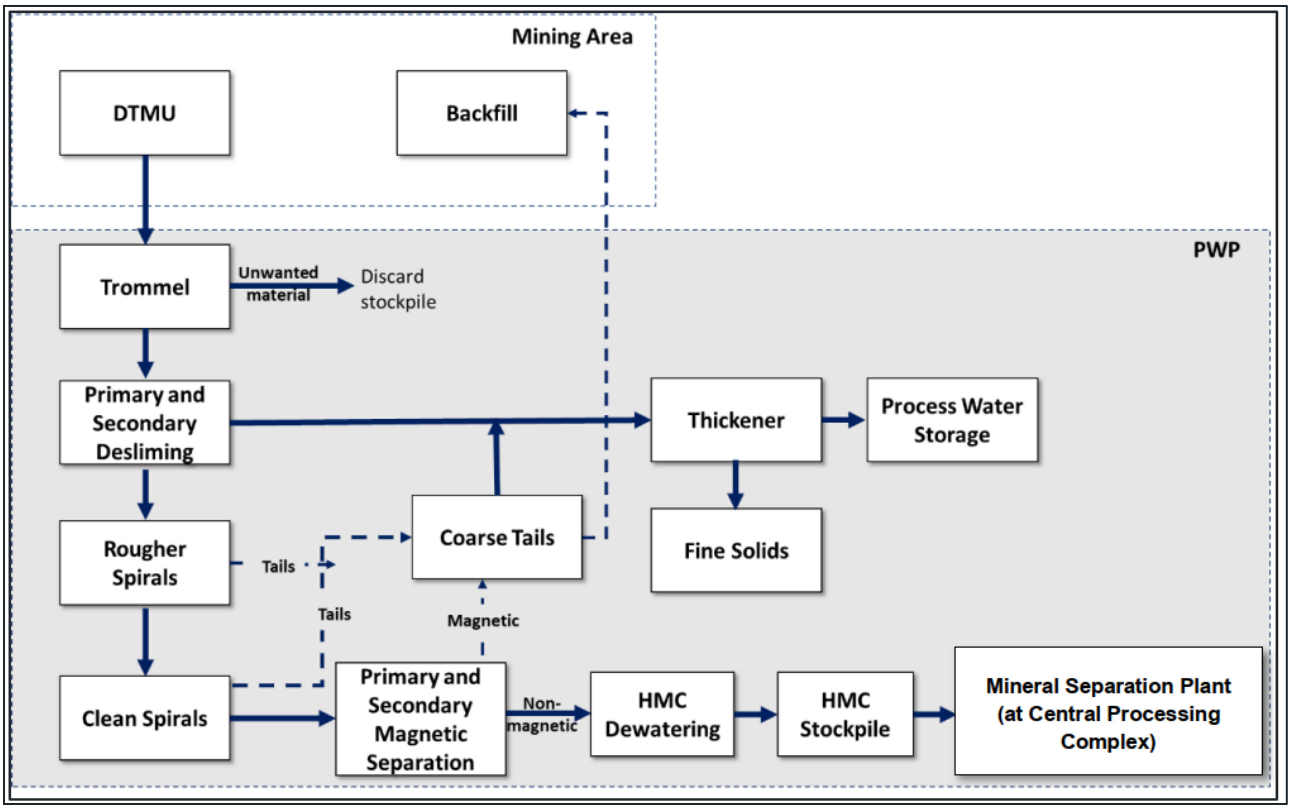


Figure 2-5: Phase 2 block flow diagram

For the Phase 2 operations, the following infrastructure is proposed:

- PWP: which will produce HMC to be the used as feedstock at the existing MSP. The infrastructure of the PWP will include:
  - Feed preparation and fines removal area.
  - Gravity separation area.
  - Magnetic separation area.
  - Fine tails dewatering and pumping area.
  - 33kV sub-station and power factor correction yards.
  - Eskom yard.
  - Raw and process water storage and distribution area.
  - Compressed air plant.
  - Potable water treatment plant.
  - Sewage treatment plant.
  - Workshop and stores.
  - Fine tails treatment area.
  - HMC dewatering, stockpiling and reclaim area.
  - MSP tails handling.
  - Gypsum plants.
  - Mine Complex including administration office with parking, control room, change house, mess, security office, laboratory and sample room.
  - A fit for purpose and legally compliant fire water pumping station and distribution system.
- Access and haul roads.

- Two RSFs (Site 9 and Site C).
- Sand tailings disposal.
- Temporary topsoil stockpiles.

The HMC processed at Port Durnford will be transported using highway road trucks to the MSP in Empangeni. The preferred route at present is from the Port Durnford PWP along the N2 and exiting the offramp at the R34 into Empangeni. It is understood that there is an existing underpass (about 3.5 km from the PWP) that will be changed into an intersection/ slipway onto the N2.

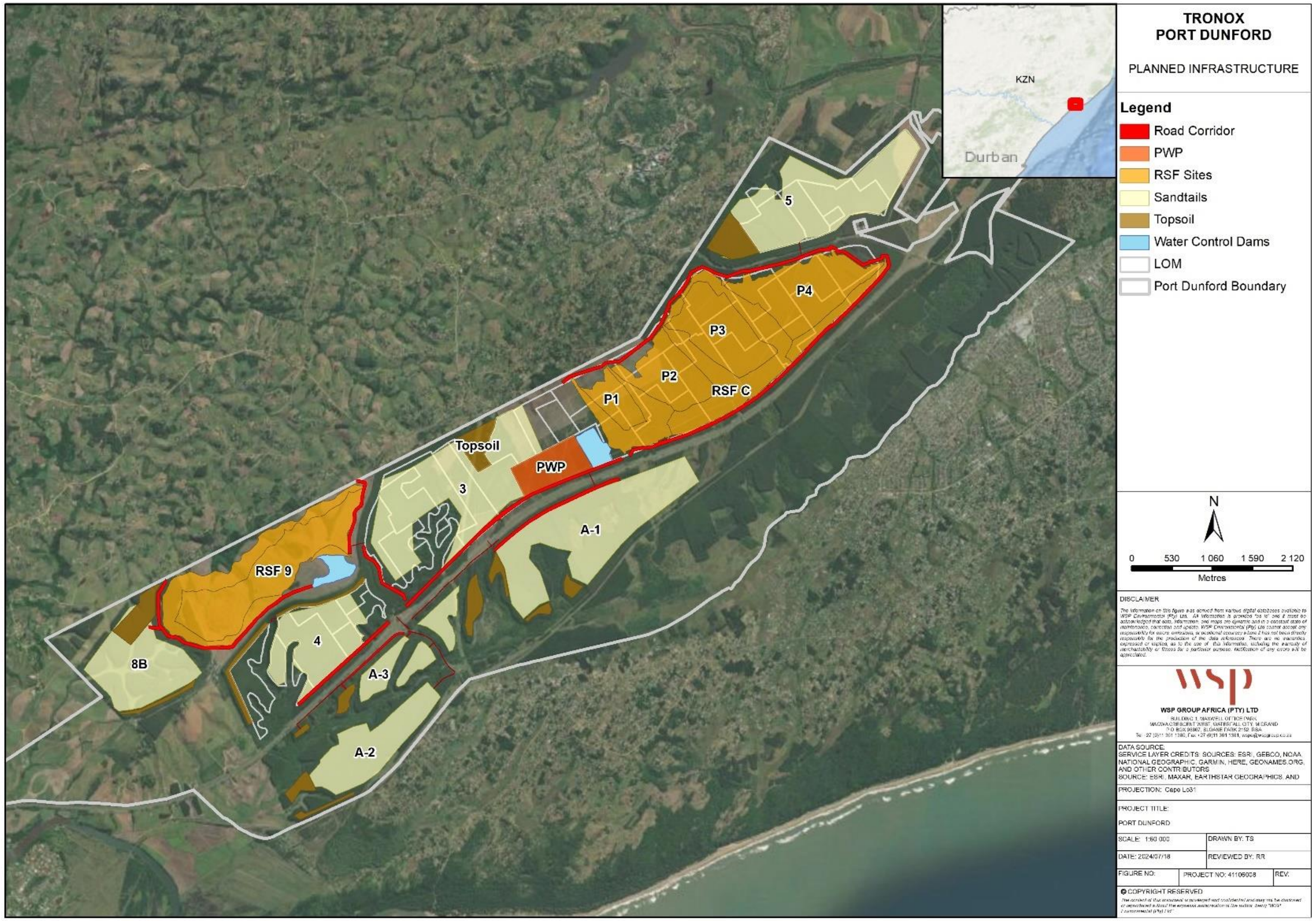


Figure 2-6: Phase 2 (3,000 tph) layout

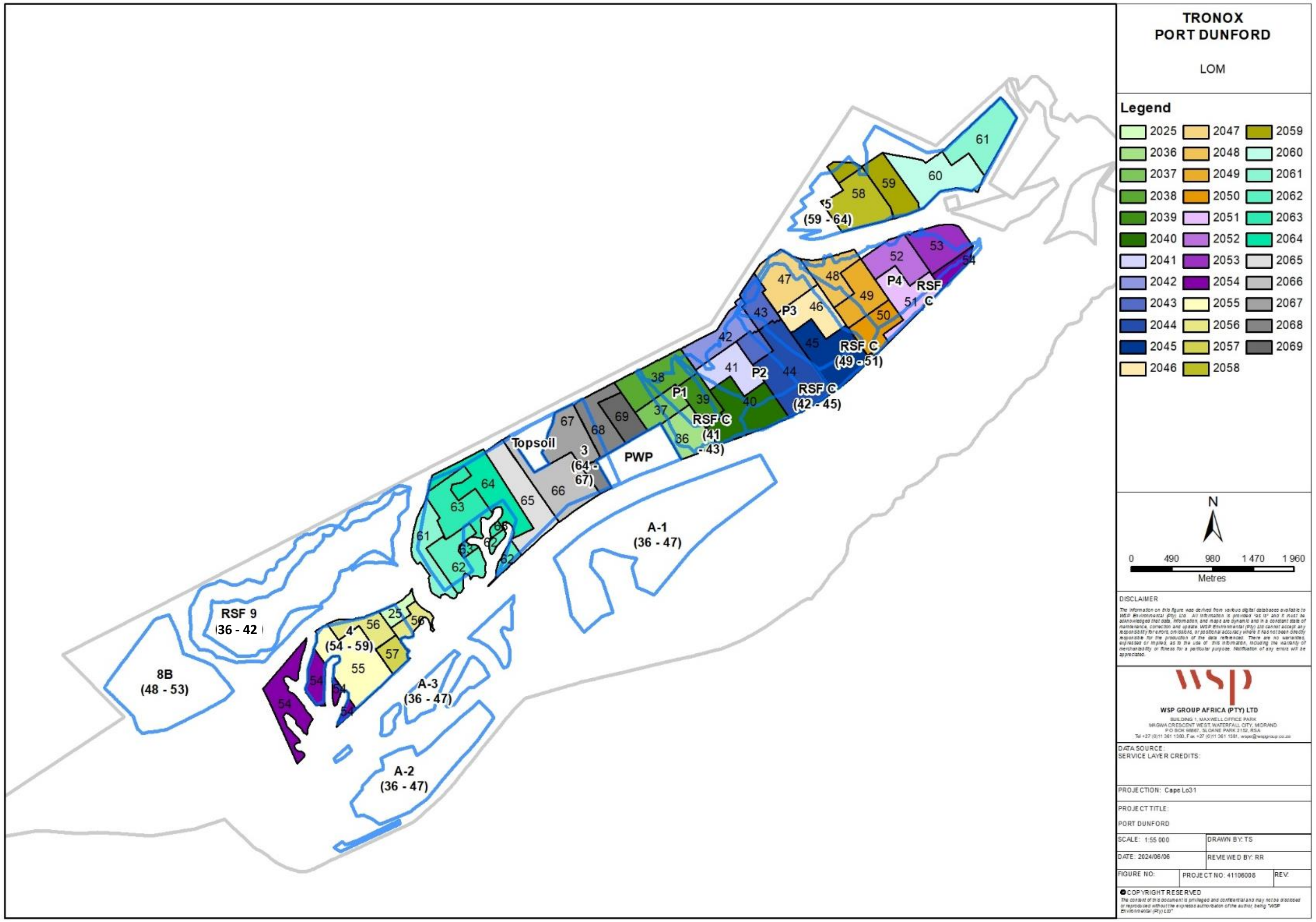


Figure 2-7: Phase 2 Life of Mine Plan

3 REGULATORY FRAMEWORK

3.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

Ambient air quality standards are defined as "*targets for air quality management which establish the permissible concentration of a particular substance in, or property of, discharges to air, based on what a particular receiving environment can tolerate without significant deterioration*". The aim of these standards is to provide a benchmark for air quality management and governance. South Africa's National Ambient Air Quality Standards (NAAQS) are based primarily on guidance offered by two standards set by the South African National Standards (SANS):

- SANS 69:2004 Framework for setting and implementing national ambient air quality standards; and
- SANS 1929:2005 Ambient Air Quality – Limits for common pollutants.

SANS 69:2004 makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values. SANS 1929:2005 uses the provisions in SANS 69:2004 to establish air quality objectives for the protection of human health and the environment and stipulates that limit values are initially set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve acceptable air quality nationally.

Ambient air quality standards are specified in the National Environmental Management: Air Quality Act (NEM:AQA), with the priority pollutants being sulphur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), ozone (O_3), benzene, lead (Pb) and carbon monoxide (CO). Standards for SO_2, NO_2, PM_{10}, O_3, C_6H_6, Pb and CO were promulgated in 2009, with the standards for $PM_{2.5}$ later promulgated in 2012.

Only the NAAQS applicable to this AQIA are presented in **Table 3-1** below.

Table 3-1: South African National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration µg/m³	Permissible Frequency of Exceedance	Compliance Date
Particulate Matter (PM_{10})	24 hours	75	4	1 January 2015
	1 year	40	0	1 January 2015
Particulate Matter ($PM_{2.5}$)	24 hours	40	4	1 January 2016 – 31 December 2029
		25	4	1 January 2030
	1 year	20	0	1 January 2016 – 31 December 2029
		15	0	1 January 2030

3.2 NATIONAL DUST CONTROL REGULATIONS

On 01 November 2013 the legislated standards for dust fallout were promulgated in the form of the NEM:AQA National Dust Control Regulations (GNR 827). These regulations provide the acceptable / allowable dust fallout rates for both residential and non-residential areas, as presented in **Table 3-2**.

Table 3-2: Acceptable Dust Fallout Rates as per the National Dust Control Regulations

Restriction Areas	Dust Fallout Rate (D) ($mg/m^2/day$) 30-day average	Permitted frequency of exceeding dust fallout rate	Reference Method
Residential Area	D < 600	Two within a year, not sequential months	ASTM D1739
Non-Residential Area	600 < D < 1,200	Two within a year, not sequential months	ASTM D1739
The method to be used for measuring dust fall rate and the guideline for locating sampling points shall be ASTM D1739:1970, or equivalent method approved by any internally recognised body.			

4 METHODOLOGY

To assess the environmental air quality impacts of the operation of the proposed Project, proposed (modelled) ambient emissions were assessed. Comparisons of the proposed air quality impacts at various specified sensitive receptors representative of the surrounding area, enabled an assessment of predicted air quality impacts at these locations as a result of the operation of the proposed Project. Such air pollution predictions were then assessed against the NAAQS and National Dust Control Regulations, respectively.

It is noted that detailed construction phase plans and equipment specifications are not yet available. It is also understood that this phase is very erratic in nature. As such, a quantitative assessment of construction phase air quality impacts was not undertaken, but rather a qualitative discussion thereof.

4.1 EMISSION CHARACTERISATION

An emission inventory is a list of air pollution sources, their physical and chemical parameters, as well as the quantification of emissions. Emissions are calculated using emission factors or mass balance approaches, requiring chemical and activity data inputs. For the purposes of this assessment, proposed operations are assessed, under normal operating conditions.

It is noted that detailed construction phase plans and equipment specifications are not yet available. It is also understood that this phase is very erratic in nature. As such, a quantitative assessment of construction phase air quality impacts was not undertaken, but rather a qualitative discussion thereof.

Emission factors are used to estimate emissions where actual emission data is not available. In most cases, these factors are averages of available data of acceptable quality and are generally assumed to be representative of long-term averages for all facilities in the source category. An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. Emission factors are always expressed as a function of the weight, volume, distance, or duration of the activity emitting the pollutant. The general equation used for the estimation of emissions is:

$$E = A \times EF \times \left(1 - \frac{ER}{100}\right)$$

Where:

E = emission rate

A = activity rate

EF = emission factor

ER = overall emission reduction efficiency (%)

The Regulations Regarding Air Dispersion Modelling (*Modelling Regulations*) recommend the use of published emission factors for national consistency, in this case, the United States Environmental Protection Agency (US EPA) AP-42 and the Australian Government National Pollutant Inventory (NPI) emission factors were applied where applicable, as detailed in the following sections, and aligned with the *Modelling Regulations*.

Given that the proposed operations involve mining operations, only particulate related pollutants are of concern, and therefore assessed in this AQIA, namely Particulate Matter (PM as PM_{10}, $PM_{2.5}$ and dust fallout (calculated as Total Suspended Particulates (TSP)).

For Phase 2, mining is expected to progress across the site (from 2036 – 2069) and as such, the modelling scenarios have been split into key periods (based on location of emission sources) for ease of assessment. For the dispersion modelling, the following scenarios were considered (operational years are indicated in brackets):

- Phase 2 Scenario 1 (3,000 tph) Operations (2036 – 2047)
- Phase 2 Scenario 2 (3,000 tph) Operations (2048 – 2053)
- Phase 2 Scenario 3 (3,000 tph) Operations (2054 – 2069)

PHASE 1 OPERATIONS

Activity Data

This scenario assesses the Phase 1 mining operations, which will be situated on the Remainder of Richards 16802. Approximately 14 ha will be mined on Portion 1 of Richard 16802, over a ten-year period, between 2025 – 2035 during Phase 1. The mining will operate at a rate of 100 tph. Active mining will take place five days a week per month, for twelve hours a day. The ROM material will be mined mechanically and hauled via trucks to the Fairbreeze mine for stockpile and processing. Dust mitigation will be achieved by wetting the unpaved roads. No on-site processing or storage is proposed for the Phase 1 mining operation. Given that the proposed active operational period will be intermittent and for the purpose of this report, emissions from this scenario have been quantified, however, the emission sources have not been modelled. **Table 4-1** presents the main processes for the proposed operations, and **Table 4-2** presents the operation period of the proposed operations.

Table 4-1: Unit processes

Unit process	Unit Process Function	Batch or Continuous Process
Material Handling	Mechanical excavation of material using front-end loaders.	Batch
Truck Loading	The use of front-end loaders to load ore and overburden from mine area onto haul trucks.	Batch

Material offloading and stockpiling is not represented as it was assumed that the emissions relating to Phase 1 activities at Fairbreeze mine are accounted for within the Fairbreeze PWP emission quantification.

Table 4-2: Hours of operation

Unit process	Operating Hours	Days of Operation / Unit
Material Handling	12 hours	5 days a week/ month
Truck Loading	12 hours	5 days a week/ month

Material Handling Sources

Proposed operations at Port Durnford comprise volume sources relating to material handling activities occurring within the active pit.

Emission rates were calculated using US EPA AP42 emission factors. To estimate emissions from materials handling related volume sources, use was made of the US EPA AP42 emission factor equation extracted from Section 13.2.4 Aggregate Handling and Storage Piles, as presented below:

$$E = k(0.016)\frac{\left(\frac{u}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Equation 4-1

Where: u is the mean wind speed (3 m/s from WRF data), M is the material moisture content (2.1%, as per US EPA Chapter 13.2.4) and k is the particle size multiplier (TSP = 0.74, PM_{10} = 0.35 and $PM_{2.5}$ = 0.053, as per US EPA AP42 13.2.4).

The equation has an “A” Confidence Rating, being rated by the US EPA AP42 as being excellent, with the factor developed from A or B rated source test data from a variety of industries. It is assumed that material handled will be wet when deposited on open surfaces. An assumed mitigation factor of 50% was applied as per the Australian Government National Pollutant Inventory. Assumed emissions from offloading of tailings will be negligible as the material is naturally moist when handled mitigating the generation of particulate matter emissions. **Table 4-3** presents the raw material quantities, and associated moisture contents, handled by the volume sources and **Table 4-4** presents the calculated, controlled emission rates.

Table 4-3: Raw materials handled at volume sources

Raw Material Type	Maximum Permitted Consumption Rate (t/a)	Moisture Content (%)
Removal of material by front-end loader	312,000	2.1
Loading of haul trucks	312,000	2.1

Table 4-4: Material handling source emission rates (controlled)

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Removal of material	4.60E-02	2.17E-02	3.29E-03	5.16E-01	2.44E-01	3.70E-02
Loading haul trucks	1.38E-02	6.52E-03	988E-04	1.55E-01	7.33E-02	1.11E-02

Wind Erosion Sources

Proposed operations at Port Durnford comprise area sources related to wind erosion, to account for wind erosion impacts on open areas, use was made of the Australian NPI Mining Section 1.1.17: Wind Erosion from Active Stockpiles, adopted from the US EPA AP-42:

$$E = \text{EF x A}$$

Equation 4-2

Where: EF is the emission factor (TSP = 0.4 kg/ha/hr, PM_{10} = 0.2 kg/ha/hr), A is the source area (ha). As recommended by the NPI, and in the absence of detailed data, an emission factor of 0.4 kg/ha/annum be applied to calculate wind erosion from active stockpiles, with the US EPA database estimating that 50% of TSP will comprise PM_{10}. Given that a $PM_{2.5}$ ratio is not available, it was conservatively assumed that 15% of PM_{10} will comprise $PM_{2.5}$ as per the US EPA database. **Table 4-5** presents each individual area source's dimensions.

Table 4-5: Wind erosion source dimensions

Source Description	Height (m)	Length (m)	Width (m)
Mined out area[1]	0	280	172

Note:

1- The mined-out areas will be backfilled, given this the maximum source height is assumed to be at ground level.

Table 4-6 presents the emission rates for the area sources at Port Durnford relating to wind erosion.

Table 4-6: Wind erosion source emission rates

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Mined out area	2.67E-01	1.33E-01	2.00E-02	8.41E+00	4.20E+00	6.31E-01

Road Sources

The Port Durnford facility will make use of a road network, predominantly for the dispatch of raw materials from site. ROM will be transported to Fairbreeze mine by truck on paved public roads (the R102 and N2) for further processing. Given that the paved road network consists of National public roads, it is conservatively assumed that the addition to traffic from the Port Durnford proposed operations will be negligible. Unpaved roads onsite consist of the quarry haul roads. It has been assumed that haul roads at the Fairbreeze PWP facility are accounted for within the Fairbreeze mine emission quantification.

PM emissions generated from vehicles travelling on paved roads were calculated using the US EPA's AP42 Section 13.2.1 Paved Roads equation. The equation quantifies PM emissions from the resuspension of loose material on the road surface due to vehicle travel on a dry paved road:

$$E = k(sL)^{0.91} \times (W)^{1.02} \qquad g/VKT$$

Equation 4-3

Where E = particulate emission factor

k = particle size multiplier for particle size range

sL = road surface silt loading (g/m²)

W = average weight (tons) of vehicles traveling on the road

This emission factor relates the concentration of particulate emissions (in grams) to the number of kilometres travelled by vehicles on site (VKT). Dust mitigation will be achieved by wetting the unpaved roads. The vehicle weight provided by Tronox was utilised in the equation. **Table 4-7** presents the paved road specifications, while **Table 4-8** presents calculated paved road emission rates.

Table 4-7: Paved road specifications

Paved Road Name	Length (m)	Vehicles / Year	Vehicles / Day	Trips / Day	Total VKT / Day	Total VKT / Year
Port Durnford to Fairbreeze mine	6,453	2,600	10	10	645.30	167,778

Table 4-8: Paved road emission rates

Source Description	TSP Emission Rate ($g/m^2/s$)	PM_{10} Emission Rate ($g/m^2/s$)	$PM_{2.5}$ Emission Rate ($g/m^2/s$)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Port Durnford to Fairbreeze mine	1.69E-05	3.39E-06	6.47E-07	3.45E+00	6.89E-01	1.69E-01

PM emissions generated from vehicles travelling on unpaved roads were calculated using the US EPA's AP42 Section 13.2.2 Unpaved Roads equation. The equation quantifies PM emissions from the resuspension of loose material on the road surface due to vehicle travel on unpaved roads.

$$E = k(\frac{S}{12})^a \, (\frac{W}{3})^b \;\; x\, 281.9 \quad g/VKT$$

Equation 4-4

Where E = particulate emission factor

k = particle size multiplier for particle size range

S = road surface silt loading (%)

W = average weight (tons) of vehicles traveling on the road

This emission factor relates the concentration of particulate emissions (in grams) to the number of kilometres travelled by vehicles on site (VKT). An average vehicle weight of 23.5 tons, as indicated by Tronox, was utilised in the equation. **Table 4-9** presents the unpaved road specifications, while **Table 4-10** presents calculated unpaved road emission rates.

Table 4-9: Unpaved road specifications

Unpaved Road Name	Length (m)	Vehicles / Year	Vehicles / Day	Trips / Day	Total VKT / Day	Total VKT / Year
Quarry road	919	2,600	10	10	76.58	19,911.67

Table 4-10: Unpaved road emission rates

Source Description	TSP Emission Rate ($g/m^2/s$)	PM_{10} Emission Rate ($g/m^2/s$)	PM_{10} Emission Rate ($g/m^2/s$)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	PM_{10} Emission Rate (t/a)
Quarry road	1.33E-04	3.39E-05	3.39E-06	3.08E+1	7.85E+00	7.85E-01

Emission Source Apportionment

Figure 4-1, **Figure 4-2** and **Figure 4-3** illustrates emission contributions for each group of sources to overall emissions for TSP, PM_{10}, and $PM_{2.5}$ source contributions, respectively. The largest source of emissions from the proposed operations are the road sources, contributing 79% of total TSP emissions, 67% of total PM_{10} emissions and 50% of total $PM_{2.5}$ emissions. The second largest contributor to emissions is the wind erosion source group, followed by the material handling sources, although these emissions constitute a small portion of total emissions when compared to contributions from wind erosion sources.

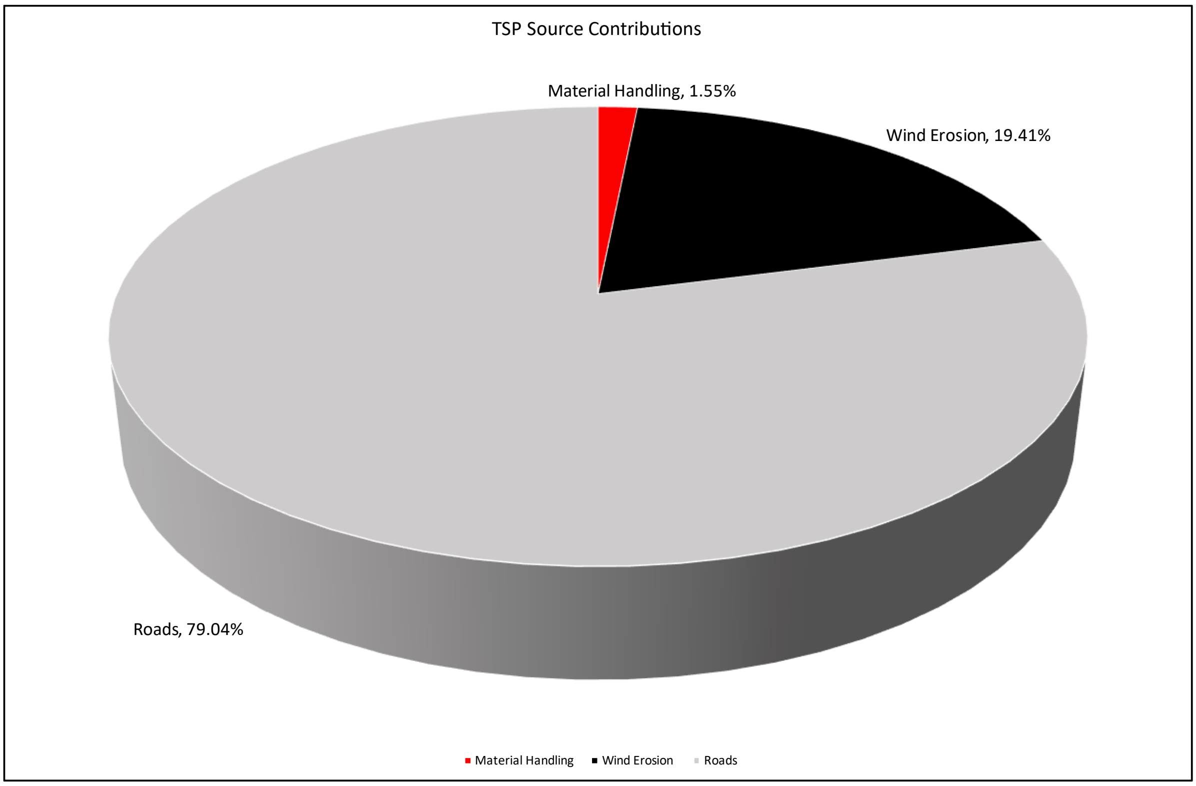


Figure 4-1: TSP source contributions

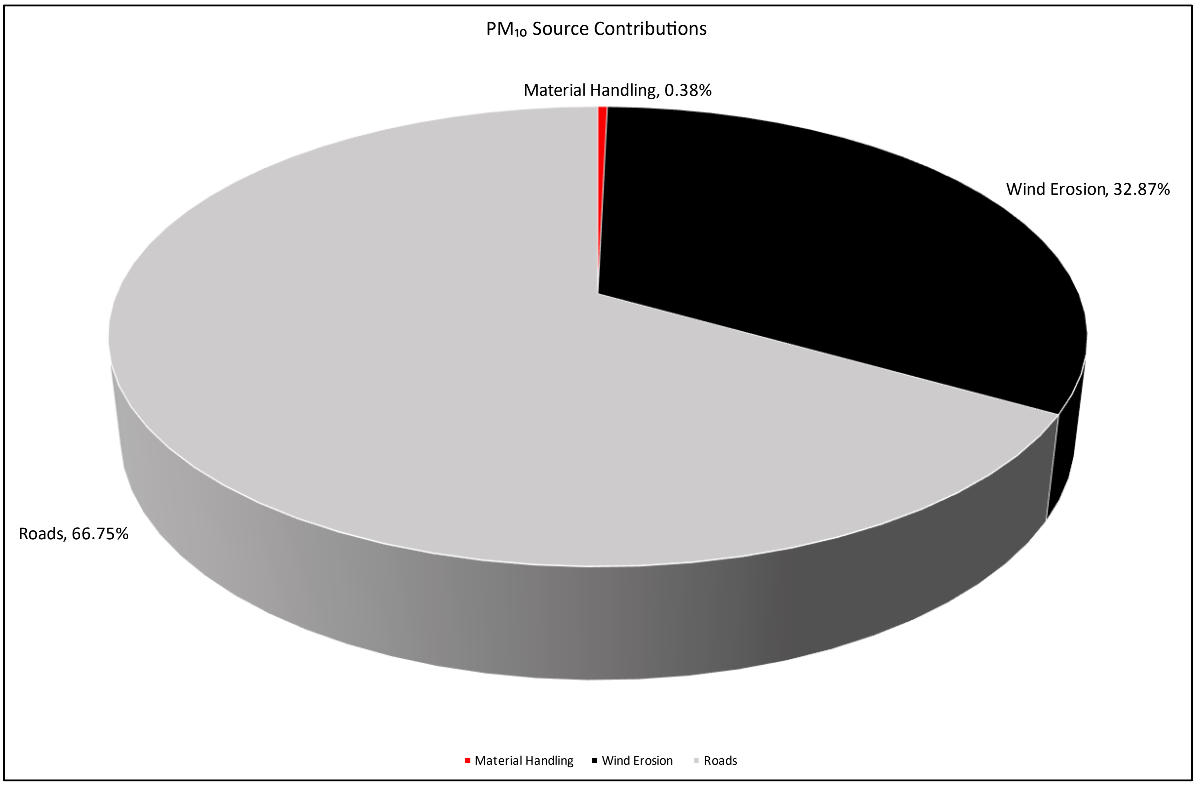


Figure 4-2: PM$_{10}$ source contributions

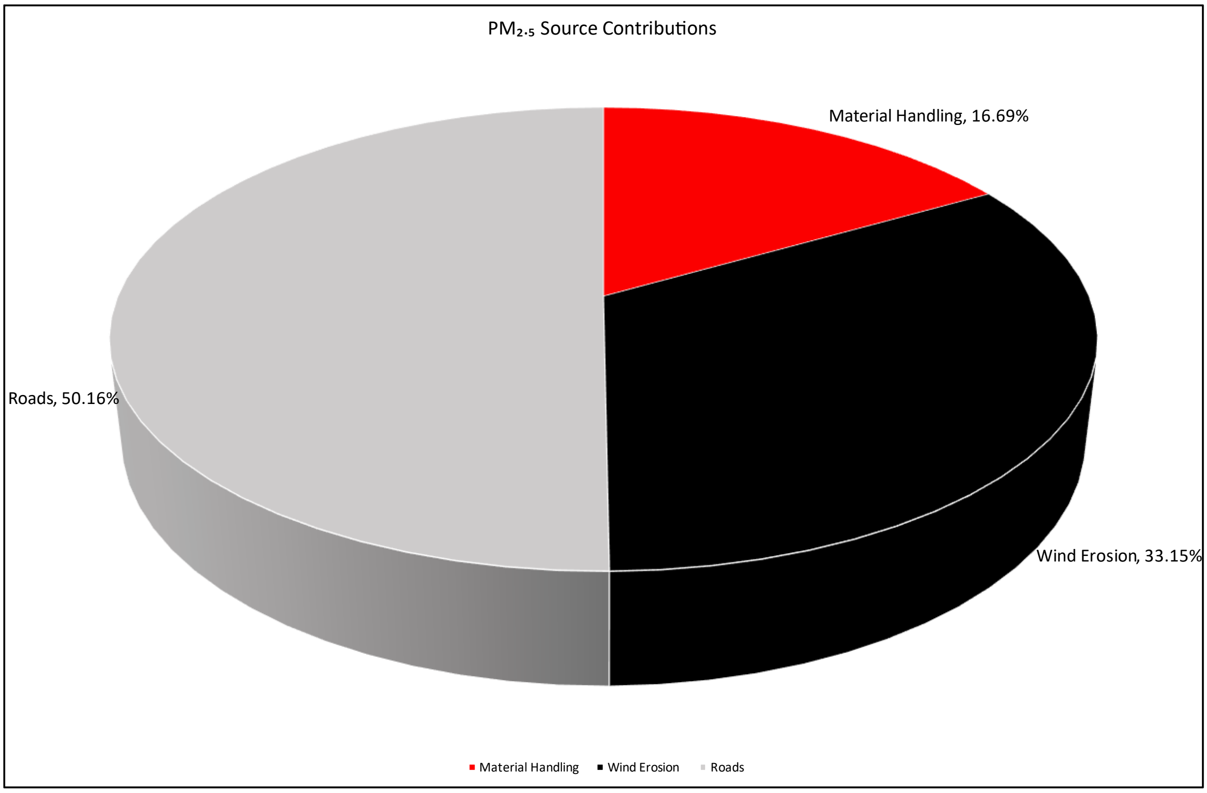


Figure 4-3: PM$_{2.5}$ source contributions

PHASE 2 SCENARIO 1 OPERATIONS

Activity Data

This scenario assesses the Phase 2 mining operations, which will succeed the Phase 1 operation and commence in 2036. Phase 2 Scenario 1 operations were assessed to occur over an eleven-year period, between 2036 – 2047. The mining will operate at a rate of 3,000 tph. Active mining will take place 24 hours a day throughout the year. Two DTMUs will be in operation containing vibrating screen and primary pump station. DTMUs will be serviced by two D11 dozers and a CAT390 Excavator. The ROM material will be mined mechanically and pumped to the PWP for processing. No on-site storage is proposed for the Phase 2 mining operation with processed material been transported via haul road to be used as feedstock at the existing MSP located in Empangeni. Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. **Table 4-11** presents the main processes for the proposed operations, and **Table 4-12** presents the operation period of the proposed operations.

Table 4-11: Unit processes

Unit process	Unit Process Function	Batch or Continuous Process
Material Handling	Mechanical excavation of material using front-end loaders.	Continuous
Truck Loading	The use of front-end loaders to load ore and overburden from mine area onto haul trucks.	Continuous
Offloading of Topsoil	Topsoil offloading at the topsoil stockpile	Batch
Processing Plant	Crushing and screening at the PWP	Continuous

Material offloading and stockpiling is not represented as it was assumed that the emissions relating to Phase 2 activities at the MSP are accounted for within the Empangeni emission quantification.

Table 4-12: Hours of operation

Unit process	Operating Hours	Days of Operation / Unit
Material Handling	24 hours	365 days/ year
Truck Loading	24 hours	365 days/ year
Offloading of Topsoil	24 hours	365 days/ year
Processing Plant	24 hours	365 days/ year

Material Handling Sources

Proposed operations at Port Durnford comprise volume sources relating to material handling activities occurring within the active pit.

Emission rates were calculated using US EPA AP42 emission factors. To estimate emissions from materials handling related volume sources, use was made of the US EPA AP42 emission factor equation extracted from Section 13.2.4 Aggregate Handling and Storage Piles, as per **Equation 4-1** above. It is assumed that material handled will be wet when deposited on open surfaces. An assumed mitigation factor of 50% was applied as per the Australian Government National Pollutant Inventory. Assumed emissions from offloading of tailings will be negligible as the material will be wet when handled and pumped to the discharge stockpiles mitigating the generation of particulate matter emissions. **Table 4-13** presents the raw material quantities, and associated moisture contents, handled by the volume sources and **Table 4-14** presents the calculated, controlled emission rates.

Table 4-13: Raw materials handled at volume sources

Raw Material Type	Maximum Permitted Consumption Rate (t/a)	Moisture Content (%)
Removal of material by front-end loader	26,280,000	2.1
Loading of haul trucks	26,280,000	2.1
Offloading of Topsoil	300,000	2.1
Processing Plant	26,280,000	2.1

Table 4-14: Material handling source emission rates (controlled)

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Removal of material	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Loading haul trucks	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Offloading of Topsoil	1.57E-02	1.13E-03	7.45E-03	4.96E-01	3.56E-02	2.35E-01
Processing Plant	5.21E+00	1.79E+00	5.38E-01	1.64E+03	5.65E+02	1.70E+02

Wind Erosion Sources

Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. Proposed operations at Port Durnford comprise of area sources related to wind erosion presented in **Figure 4-4**. To account for wind erosion impacts on open areas, use was made of the Australian NPI Mining Section 1.1.17: Wind Erosion from Active Stockpiles, adopted from the US EPA AP-42, as per **Equation 4-2** above. **Table 4-15** presents each individual area sources' dimensions.

Table 4-15: Wind erosion source dimensions

Source Description	Height (m)	Length (m)	Width (m)
Topsoil Stockpile	3	510	320
Site 9 RSF	46	2,860	752
A-1 Sand Tailings	10	2,860	965
A-2 Sand Tailings	10	1,931	635
A-3 Sand Tailings	10	1,545	429
Site RSF C Pit 1 – Pit 3[1]	0	2,340	1,390

Note:

1- The mined-out areas will be backfilled, given this the maximum source height is assumed to be at ground level.

Figure 4-4: Port Durnford Phase 2 Scenario 1 wind erosion source locations

Table 4-16 presents the emission rates for the area sources at Port Durnford relating to wind erosion.

Table 4-16: Wind erosion source emission rates

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Topsoil Stockpile	1.28E+00	6.39E-01	9.58E-02	4.03E+01	2.01E+01	3.02E+00
Site 9 RSF	1.20E+01	6.01E+00	9.02E-01	3.79E+02	1.90E+02	2.84E+01
A-1 Sand Tailings	1.08E+01	5.38E+00	8.07E-01	3.39E+02	1.70E+02	2.55E+01
A-2 Sand Tailings	5.45E+00	2.72E+00	4.08E-01	1.72E+02	8.59E+01	1.29E+01
A-3 Sand Tailings	3.39E+00	1.70E+00	2.54E-01	1.07E+02	5.35E+01	8.02E+00
Site RSF C Pit 1 – Pit 3	1.73E+01	8.66E+00	1.30E+00	5.46E+02	2.73E+02	4.10E+01

Road Sources

The Port Durnford facility will make use of paved road network, predominantly for the dispatch of processed materials from site. Material will be transported to the existing MSP at Empangeni by haul truck on paved public roads (the N2 and R34) for further processing. Given the additional number of trucks per hour and that the road network consists of paved National public roads, it is conservatively assumed that particulate emission contributions from these sources will not produce a significant impact. The emissions from this scenario have been quantified, however, the emission sources have not been modelled. Unpaved roads onsite consist of the service roads, which will not be traversed by haul trucks. Dust mitigation will be achieved by wetting the unpaved roads. It has been assumed that haul roads at the MSP facility are accounted for within the Empangeni facility emission quantification.

PM emissions generated from vehicles travelling on paved roads were calculated as per **Equation 4-3** above.

This emission factor relates the concentration of particulate emissions (in grams) to the number of kilometres travelled by vehicles on site (VKT). The vehicle weight provided by Tronox was utilised in the equation. **Table 4-17** presents the paved road specifications, while **Table 4-18** presents calculated paved road emission rates.

Table 4-17: Paved road specifications

Paved Road Name	Length (m)	Vehicles / Year	Vehicles / Day	Trips / Day	Total VKT / Day	Total VKT / Year
Port Durnford to MSP	6,911	25,550	70	70	483.77	176,576.05

Table 4-18: Paved road emission rates

Source Description	TSP Emission Rate ($g/m^2/s$)	PM_{10} Emission Rate ($g/m^2/s$)	$PM_{2.5}$ Emission Rate ($g/m^2/s$)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)

Port Durnford to MSP	1.18E-05	2.35E-06	5.77E-07	2.05E+01	4.10E+00	1.01E+00

PM emissions generated from vehicles travelling on unpaved roads were not calculated. It is assumed that unpaved roads will not be used for haulage of materials, rather as access routes for light duty vehicles which will travel intermittently. Given this, the emissions from the unpaved road network are assumed to be intermittent and negligible.

Emission Source Apportionment

Figure 4-5, **Figure 4-6** and **Figure 4-7** illustrates emission contributions for each group of sources to overall emissions for TSP, PM_{10}, and $PM_{2.5}$ source contributions, respectively. The largest source of emissions from the proposed operations are the material handling sources, contributing 51% of total TSP emissions, 42% of total PM_{10} emissions and 60% of total $PM_{2.5}$ emissions. The second largest contributor to emissions is the wind erosion source group, followed by the road sources, although these emissions constitute a small portion of total emissions when compared to contributions from material handling and wind erosion sources.

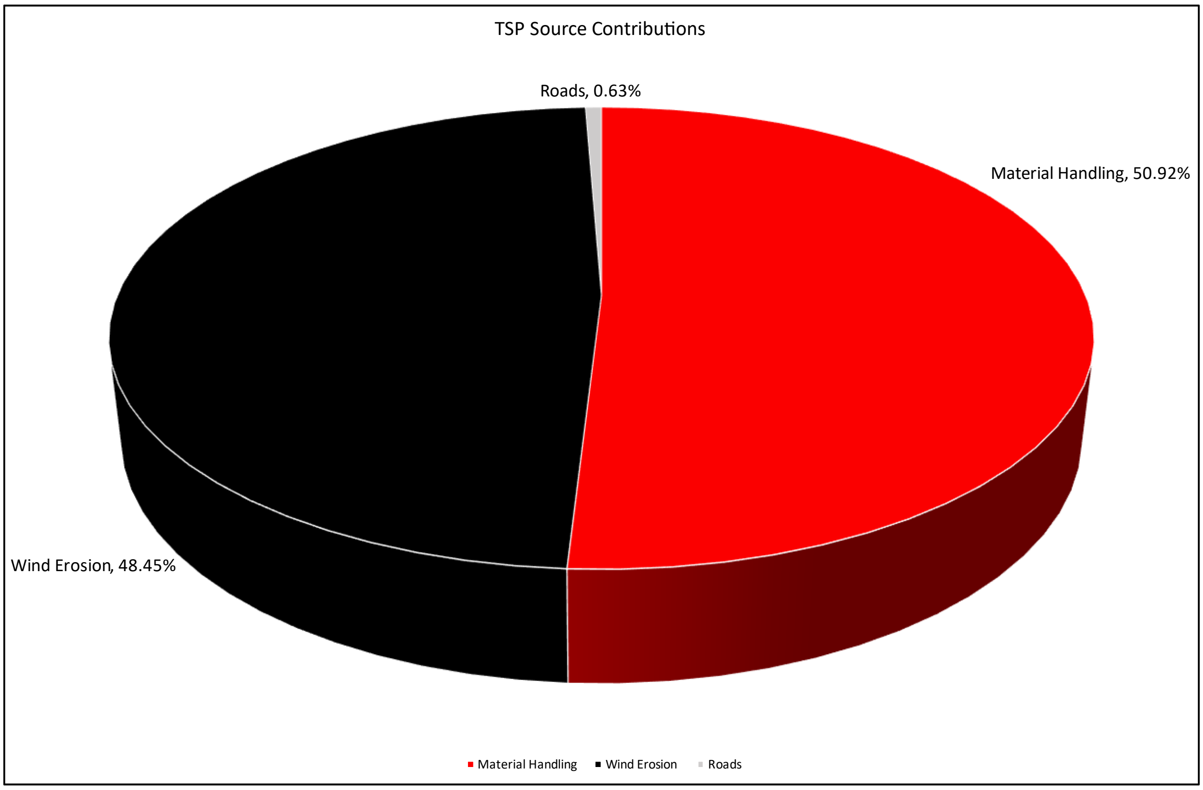


Figure 4-5: TSP source contributions

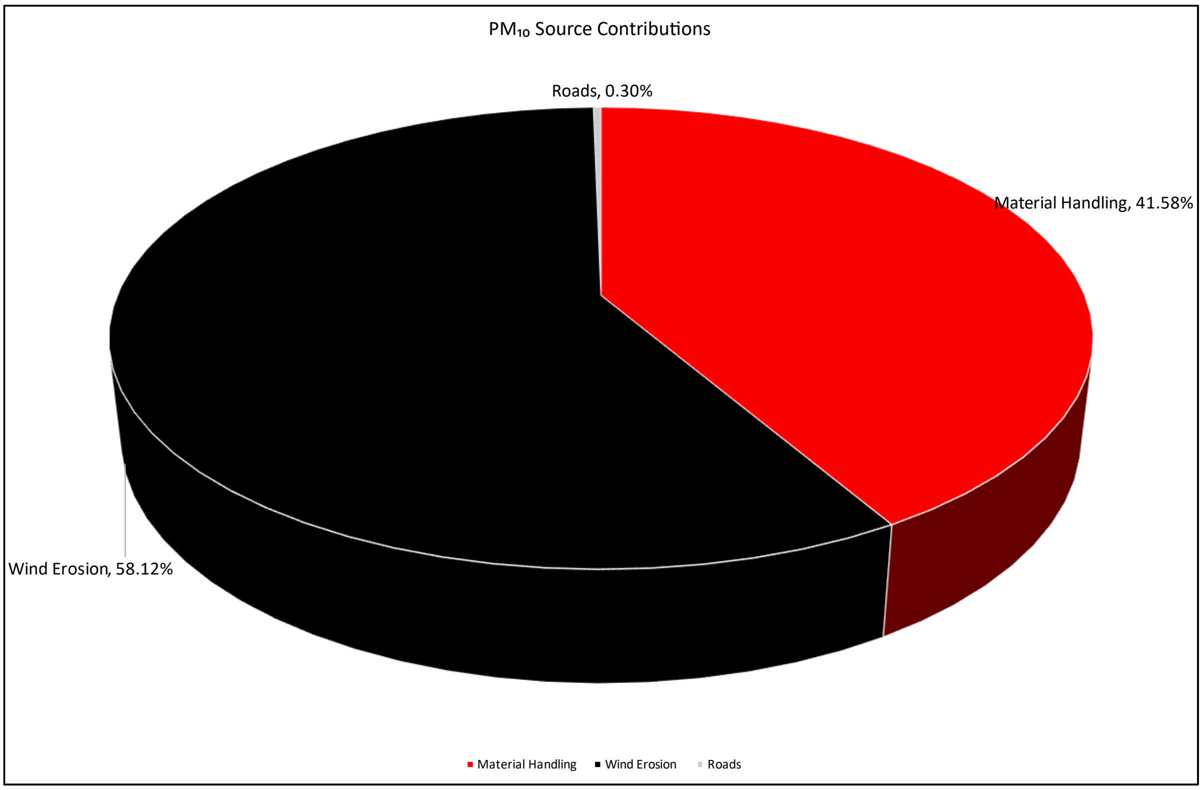


Figure 4-6: PM$_{10}$ source contributions

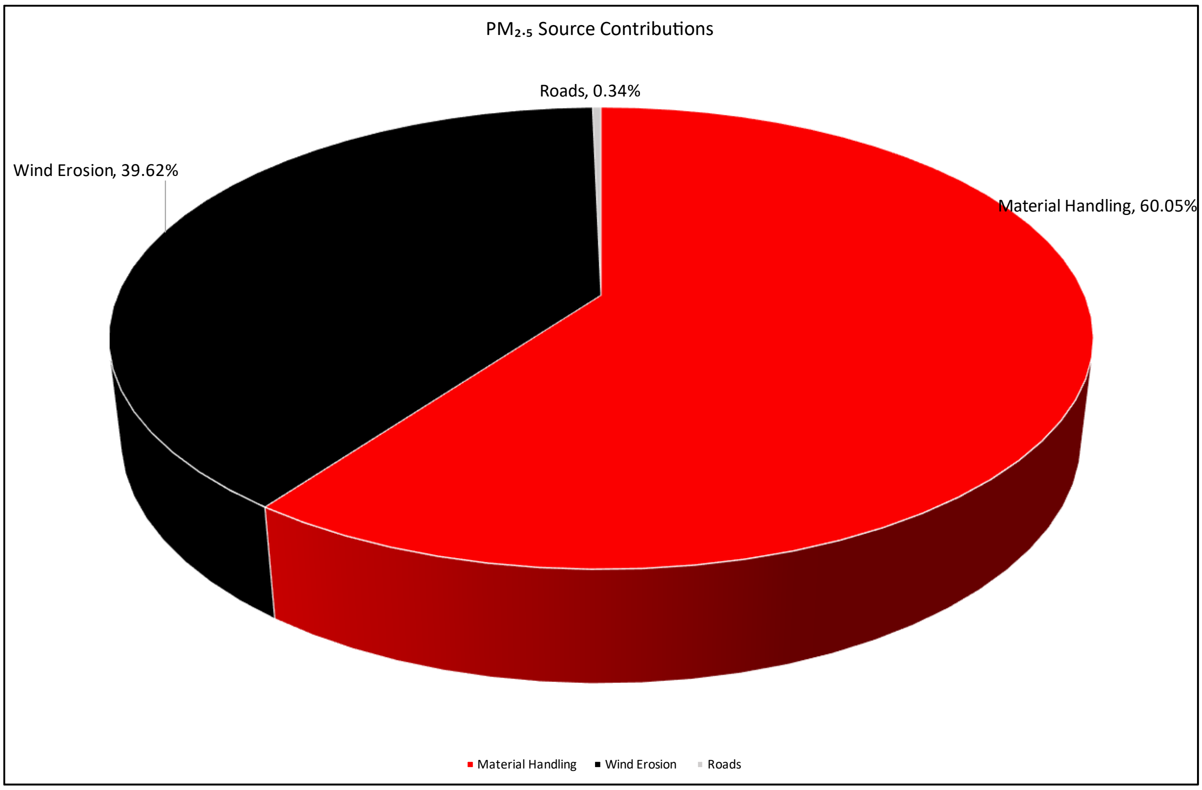


Figure 4-7: PM$_{2.5}$ source contributions

PHASE 2 SCENARIO 2 OPERATIONS

Activity Data

This scenario assesses the Phase 2 mining operations, which will succeed the Phase 1 operation and commence in 2036. Phase 2 Scenario 2 operations were assessed to occur over an eleven-year period, between 2048 – 2053. The mining will operate at a rate of 3,000 tph. Active mining will take place 24 hours a day throughout the year. Two DTMUs will be in operation containing vibrating screen and primary pump station. DTMUs will be serviced by two D11 dozers and a CAT390 Excavator. The ROM material will be mined mechanically and pumped to the PWP for processing. No on-site storage is proposed for the Phase 2 mining operation with processed material been transported via haul road to be used as feedstock at the existing MSP located in Empangeni. Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. **Table 4-19** presents the main processes for the proposed operations, and **Table 4-20** presents the operation period of the proposed operations.

Table 4-19: Unit processes

Unit process	Unit Process Function	Batch or Continuous Process
Material Handling	Mechanical excavation of material using front-end loaders.	Continuous
Truck Loading	The use of front-end loaders to load ore and overburden from mine area onto haul trucks.	Continuous
Offloading of Topsoil	Topsoil offloading at the topsoil stockpile	Batch
Processing Plant	Crushing and screening at the PWP	Continuous

Material offloading and stockpiling is not represented as it was assumed that the emissions relating to Phase 2 activities at the MSP are accounted for within the Empangeni emission quantification.

Table 4-20: Hours of operation

Unit process	Operating Hours	Days of Operation / Unit
Material Handling	24 hours	365 days/ year
Truck Loading	24 hours	365 days/ year
Offloading of Topsoil	24 hours	365 days/ year
Processing Plant	24 hours	365 days/ year

Material Handling Sources

Proposed operations at Port Durnford comprise volume sources relating to material handling activities occurring within the active pit.

Emission rates were calculated using US EPA AP42 emission factors. To estimate emissions from materials handling related volume sources, use was made of the US EPA AP42 emission factor equation extracted from Section 13.2.4 Aggregate Handling and Storage Piles, as **Equation 4-1** above. It is assumed that material handled will be wet when deposited on open surfaces. An assumed mitigation factor of 50% was applied as per the Australian Government National Pollutant Inventory. Assumed emissions from offloading of tailings will be negligible as the material will be wet when handled and pumped to the discharge stockpiles mitigating the generation of particulate matter emissions. **Table 4-21** presents the raw material quantities, and associated moisture contents, handled by the volume sources and **Table 4-22** presents the calculated, controlled emission rates.

Table 4-21: Raw materials handled at volume sources

Raw Material Type	Maximum Permitted Consumption Rate (t/a)	Moisture Content (%)
Removal of material by front-end loader	26,280,000	2.1
Loading of haul trucks	26,280,000	2.1
Offloading of Topsoil	300,000	2.1
Processing Plant	26,280,000	2.1

Table 4-22: Material handling source emission rates (controlled)

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Removal of material	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Loading haul trucks	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Offloading of Topsoil	1.57E-02	1.13E-03	7.45E-03	4.96E-01	3.56E-02	2.35E-01
Processing Plant	5.21E+00	1.79E+00	5.38E-01	1.64E+03	5.65E+02	1.70E+02

Wind Erosion Sources

Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. Proposed operations at Port Durnford comprise of area sources related to wind erosion presented in **Figure 4-8**. To account for wind erosion impacts on open areas, use was made of the Australian NPI Mining Section 1.1.17: Wind Erosion from Active Stockpiles, as per **Equation 4-2** above. **Table 4-23** presents each individual area sources' dimensions.

Table 4-23: Wind erosion source dimensions

Source Description	Height (m)	Length (m)	Width (m)
Topsoil Stockpile	3	510	320
Site 9 RSF	46	2,860	752
A-1 Sand Tailings	10	2,860	965
A-2 Sand Tailings	10	1,931	635
A-3 Sand Tailings	10	1,545	429
Site RSF C Pit 1 – Pit 3[1]	0	2,340	1,390
Site RSF C Pit 4[1]	0	1,295	870
8B Stockpile	29	1,080	1,050

Note:

1- The mined-out areas will be backfilled, given this the maximum source height is assumed to be at ground level.

Figure 4-8: Port Durnford Phase 2 Scenario 2 wind erosion source locations

Table 4-24 presents the emission rates for the area sources at Port Durnford relating to wind erosion. It is proposed that stockpile and mined out areas will be rehabilitated as the operations progress. It was assumed that legacy operations will have a dust mitigation factor of 99% for vegetated areas.

Table 4-24: Wind erosion source emission rates

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Topsoil Stockpile	1.28E+00	6.39E-01	9.58E-02	4.03E+01	2.01E+01	3.02E+00
Site 9 RSF	2.41E-01	1.20E-01	1.80E-02	7.58E+00	3.79E+00	5.69E-01
A-1 Sand Tailings	1.08E+01	5.38E+00	8.07E-01	3.39E+02	1.70E+02	2.55E+01
A-2 Sand Tailings	5.45E+00	2.72E+00	4.08E-01	1.72E+02	8.59E+01	1.29E+01
A-3 Sand Tailings	3.39E+00	1.70E+00	2.54E-01	1.07E+02	5.35E+01	8.02E+00
Site RSF C Pit 1 – Pit 3	1.73E+01	8.66E+00	1.30E+00	5.46E+02	2.73E+02	4.10E+01
Site RSF C Pit 4	6.97E+00	3.49E+00	5.23E-01	2.20E+02	1.10E+02	1.65E+01
8B Stockpile	6.37E+00	3.18E+00	4.78E-01	2.01E+02	1.00E+02	1.51E+01

Road Sources

The Port Durnford facility will make use of paved road network, predominantly for the dispatch of processed materials from site. Material will be transported to the existing MSP at Empangeni by haul truck on paved public roads (the N2 and R34) for further processing, as presented under **Phase 2 Scenario 1 Operations** above.

Emission Source Apportionment

Figure 4-9, **Figure 4-10** and **Figure 4-11** illustrates emission contributions for each group of sources to overall emissions for TSP, PM_{10}, and $PM_{2.5}$ source contributions, respectively. The largest source of emissions from the proposed operations are the material handling sources, contributing 50% of total TSP emissions, 41% of total PM_{10} emissions and 60% of total $PM_{2.5}$ emissions. The second largest contributor to emissions is the wind erosion source group, followed by the road sources, although these emissions constitute a small portion of total emissions when compared to contributions from material handling and wind erosion sources.

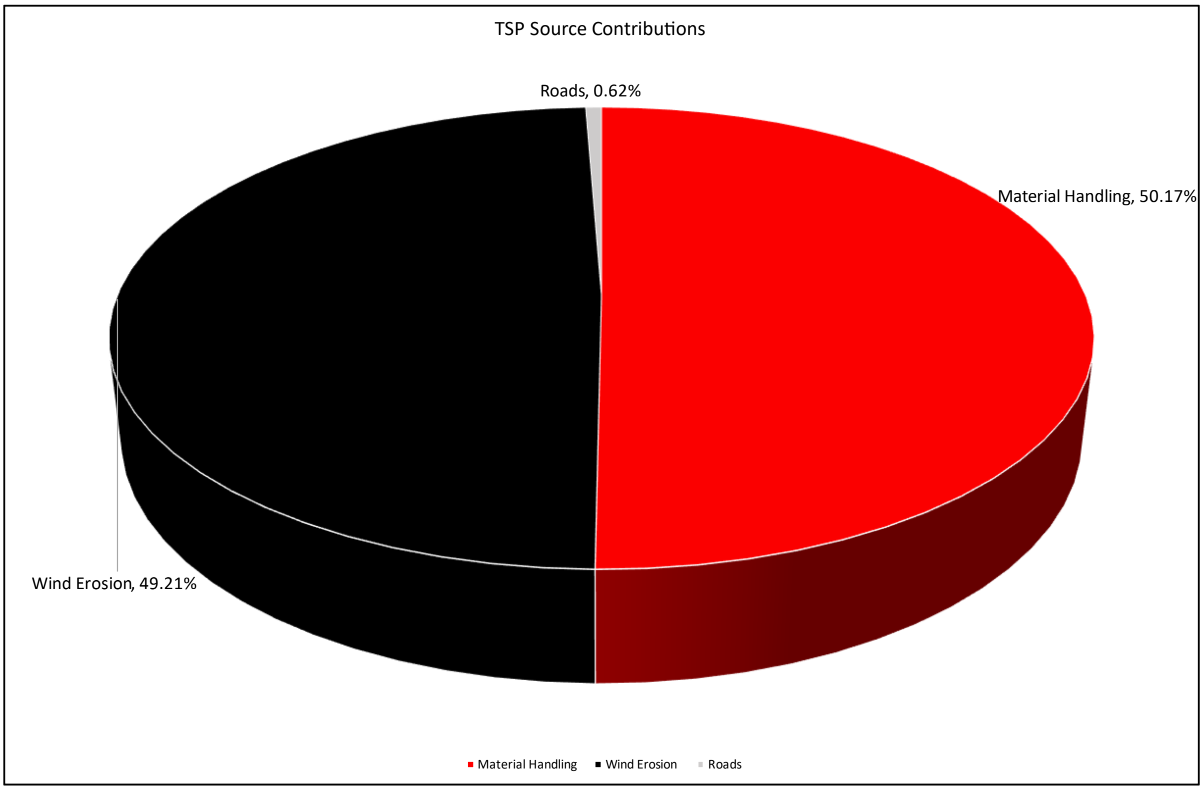


Figure 4-9: TSP source contributions

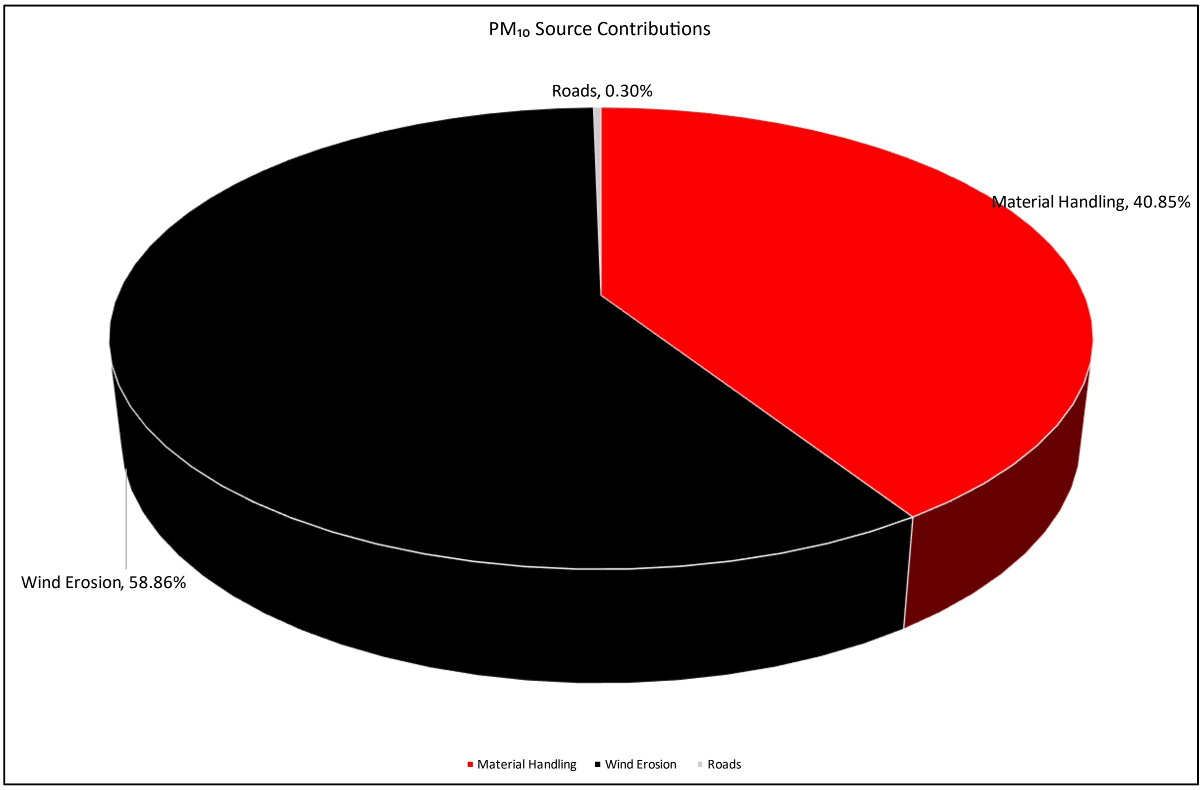


Figure 4-10: PM_{10} source contributions

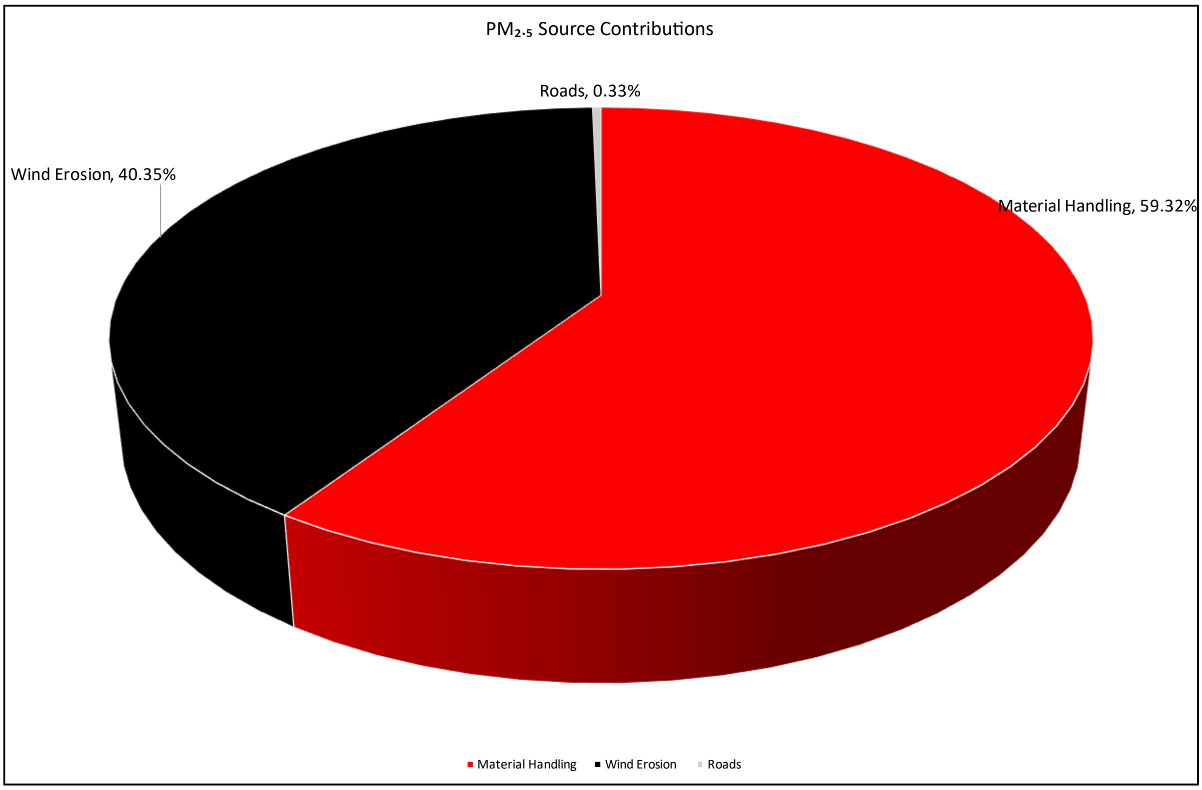


Figure 4-11: PM$_{2.5}$ source contributions

PHASE 2 SCENARIO 3 OPERATIONS

Activity Data

This scenario assesses the Phase 2 mining operations, which will succeed the Phase 1 operation and commence in 2036. Phase 2 Scenario 3 operations were assessed to occur over an eleven-year period, between 2054 – 2069. The mining will operate at a rate of 3,000 tph. Active mining will take place 24 hours a day throughout the year. Two DTMUs will be in operation containing vibrating screen and primary pump station. DTMUs will be serviced by two D11 dozers and a CAT390 Excavator. The ROM material will be mined mechanically and pumped to the PWP for processing. No on-site storage is proposed for the Phase 2 mining operation with processed material been transported via haul road to be used as feedstock at the existing MSP located in Empangeni. Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. **Table 4-25** presents the main processes for the proposed operations, and **Table 4-26** presents the operation period of the proposed operations.

Table 4-25: Unit processes

Unit process	Unit Process Function	Batch or Continuous Process
Material Handling	Mechanical excavation of material using front-end loaders.	Continuous
Truck Loading	The use of front-end loaders to load ore and overburden from mine area onto haul trucks.	Continuous

Unit process	Unit Process Function	Batch or Continuous Process
Offloading of Topsoil	Topsoil offloading at the topsoil stockpile	Batch
Processing Plant	Crushing and screening at the PWP	Continuous

Material offloading and stockpiling is not represented as it was assumed that the emissions relating to Phase 2 activities at the MSP are accounted for within the Empangeni emission quantification.

Table 4-26: Hours of operation

Unit process	Operating Hours	Days of Operation / Unit
Material Handling	24 hours	365 days/ year
Truck Loading	24 hours	365 days/ year
Offloading of Topsoil	24 hours	365 days/ year
Processing Plant	24 hours	365 days/ year

Material Handling Sources

Proposed operations at Port Durnford comprise volume sources relating to material handling activities occurring within the active pit.

Emission rates were calculated using US EPA AP42 emission factors. To estimate emissions from materials handling related volume sources, use was made of the US EPA AP42 emission factor equation extracted from Section 13.2.4 Aggregate Handling and Storage Piles, as per **Equation 4-1** above. It is assumed that material handled will be wet when deposited on open surfaces. An assumed mitigation factor of 50% was applied as per the Australian Government National Pollutant Inventory. Assumed emissions from offloading of tailings will be negligible as the material will be wet when handled and pumped to the discharge stockpiles mitigating the generation of particulate matter emissions. **Table 4-27** presents the raw material quantities, and associated moisture contents, handled by the volume sources and **Table 4-28** presents the calculated, controlled emission rates.

Table 4-27: Raw materials handled at volume sources

Raw Material Type	Maximum Permitted Consumption Rate (t/a)	Moisture Content (%)
Removal of material by front-end loader	26,280,000	2.1
Loading of haul trucks	26,280,000	2.1
Offloading of Topsoil	300,000	2.1
Processing Plant	26,280,000	2.1

Table 4-28: Material handling source emission rates (controlled)

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Removal of material	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Loading haul trucks	3.45E-01	2.47E-02	1.63E-01	1.09E+01	7.79E-01	5.14E+00
Offloading of Topsoil	1.57E-02	1.13E-03	7.45E-03	4.96E-01	3.56E-02	2.35E-01
Processing Plant	5.21E+00	1.79E+00	5.38E-01	1.64E+03	5.65E+02	1.70E+02

Wind Erosion Sources

Phase 2 mining will progress over sections of the planned mining area over the operational period, with mined out areas being backfilled and rehabilitated. To this extent minimising the areas exposed to wind erosion. Proposed operations at Port Durnford comprise of area sources related to wind erosion presented in **Figure 4-12**. To account for wind erosion impacts on open areas, use was made of the Australian NPI Mining Section 1.1.17: Wind Erosion from Active Stockpiles, as per **Equation 4-2** above. **Table 4-29** presents each individual area sources' dimensions.

Table 4-29: Wind erosion source dimensions

Source Description	Height (m)	Length (m)	Width (m)
Topsoil Stockpile	3	510	320
Site 9 RSF	46	2,860	752
A-1 Sand Tailings	10	2,860	965
A-2 Sand Tailings	10	1,931	635
A-3 Sand Tailings	10	1,545	429
Site RSF C Pit 1 – Pit 3[1]	0	2,340	1,390
Site RSF C Pit 4[1]	0	1,295	870
8B Stockpile	29	1,080	1,050
Pit 3[1]	0	2,570	1,120
Pit 4[1]	0	1,400	940
Pit 5[1]	0	2,870	1, 080

Note:

1- The mined-out areas will be backfilled, given this the maximum source height is assumed to be at ground level.

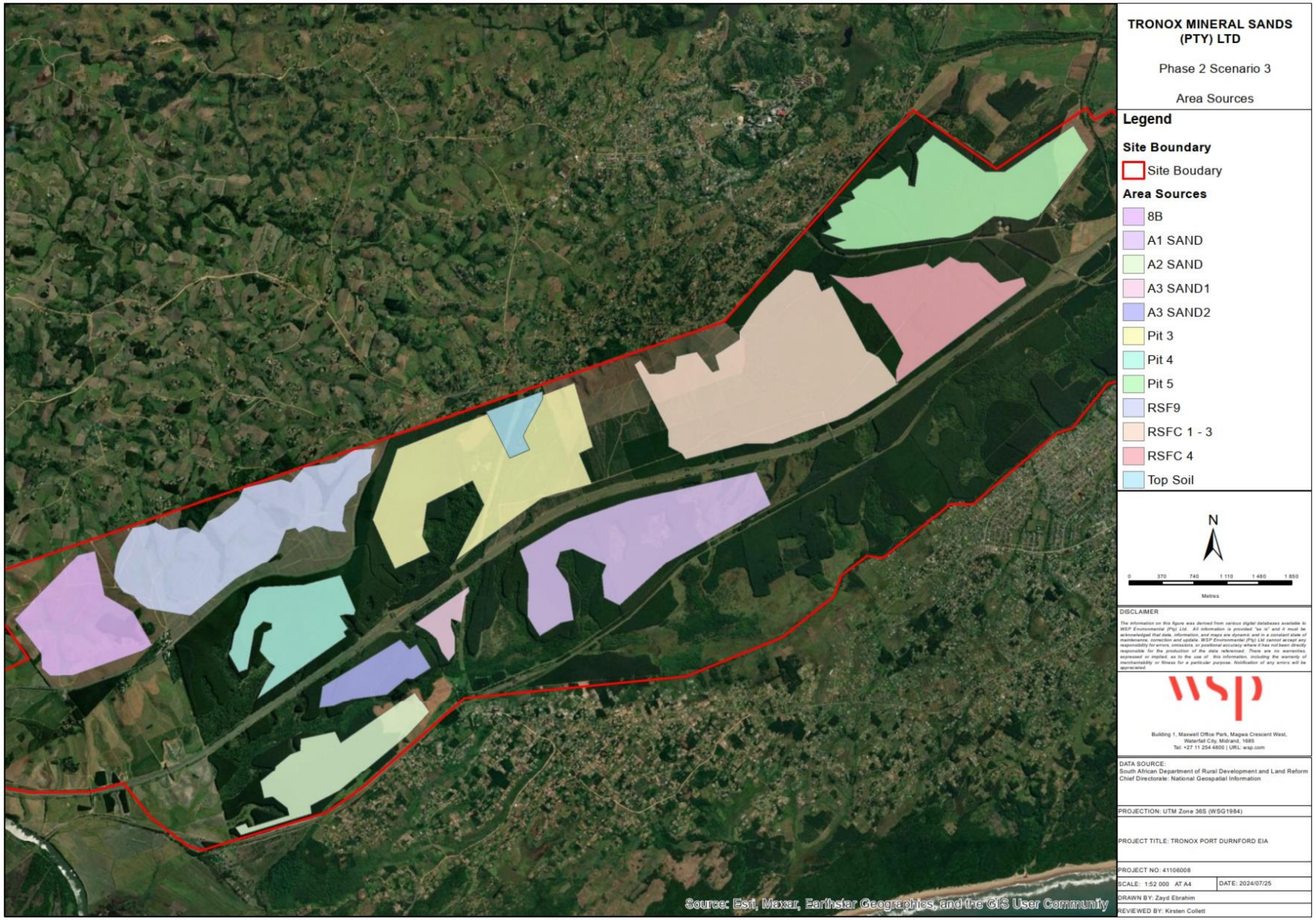


Figure 4-12: Wind erosion Phase 2 Scenario 3 area source locations

Table 4-30 presents the emission rates for the area sources at Port Durnford relating to wind erosion. It is proposed that stockpile and mined out areas will be rehabilitated as the operations progress. It was assumed that legacy operations will have a dust mitigation factor of 99% for vegetated areas.

Table 4-30: Wind erosion source emission rates

Source Description	TSP Emission Rate (g/s)	PM_{10} Emission Rate (g/s)	$PM_{2.5}$ Emission Rate (g/s)	TSP Emission Rate (t/a)	PM_{10} Emission Rate (t/a)	$PM_{2.5}$ Emission Rate (t/a)
Topsoil Stockpile	1.28E+00	6.39E-01	9.58E-02	4.03E+01	2.01E+01	3.02E+00
Site 9 RSF	2.41E-01	1.20E-01	1.80E-02	7.58E+00	3.79E+00	5.69E-01
A-1 Sand Tailings	2.15E-01	1.08E-01	1.61E-02	6.79E+00	3.39E+00	5.09E-01
A-2 Sand Tailings	1.09E-01	5.45E-02	8.17E-03	3.43E+00	1.72E+00	2.58E-01
A-3 Sand Tailings	6.78E-02	3.39E-02	5.09E-03	2.14E+00	1.07E+00	1.60E-01
Site RSF C Pit 1 – Pit 3	3.46E-01	1.73E-01	2.60E-02	1.09E+01	5.46E+00	8.19E-01
Site RSF C Pit 4	6.97E+00	3.49E+00	5.23E-01	2.20E+02	1.10E+02	1.65E+01
8B Stockpile	6.37E+00	3.18E+00	4.78E-01	2.01E+02	1.00E+02	1.51E+01
Pit 3	1.27E+01	6.33E+00	9.49E-01	3.99E+02	2.00E+02	2.99E+01
Pit 4	5.56E+00	2.78E+00	4.17E-01	1.75E+02	8.76E+01	1.31E+01
Pit 5	1.10E+01	5.50E+00	8.25E-01	3.47E+02	1.73E+02	2.60E+01

Road Sources

The Port Durnford facility will make use of paved road network, predominantly for the dispatch of processed materials from site. Material will be transported to the existing MSP at Empangeni by haul truck on paved public roads (the N2 and R34) for further processing, as presented under **Phase 2 Scenario 1 Operations** above.

Emission Source Apportionment

Figure 4-13, **Figure 4-14** and **Figure 4-15** illustrates emission contributions for each group of sources to overall emissions for TSP, PM_{10}, and $PM_{2.5}$ source contributions, respectively. The largest source of emissions from the proposed operations are the material handling sources, contributing 54% of total TSP emissions, 44% of total PM_{10} emissions and 63% of total $PM_{2.5}$ emissions. The second largest contributor to emissions is the wind erosion source group, followed by the road sources, although these emissions constitute a small portion of total emissions when compared to contributions from material handling and wind erosion sources.

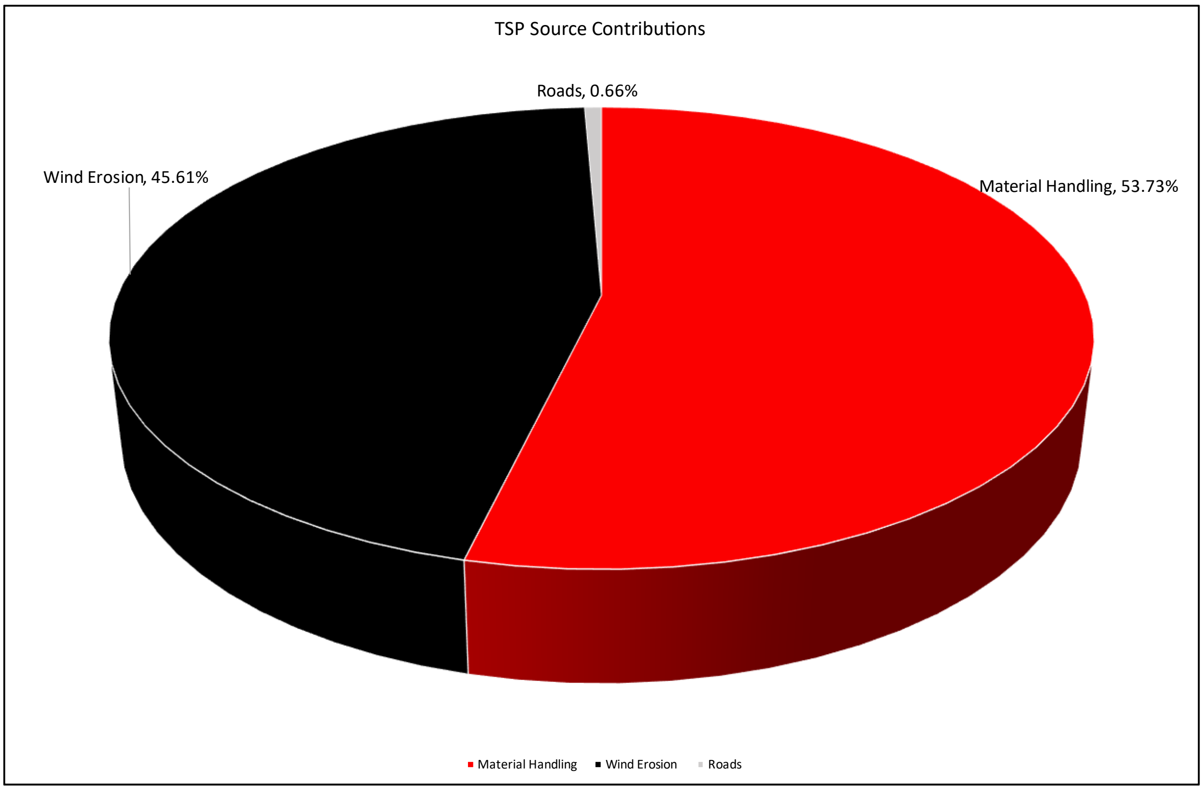


Figure 4-13: TSP source contributions

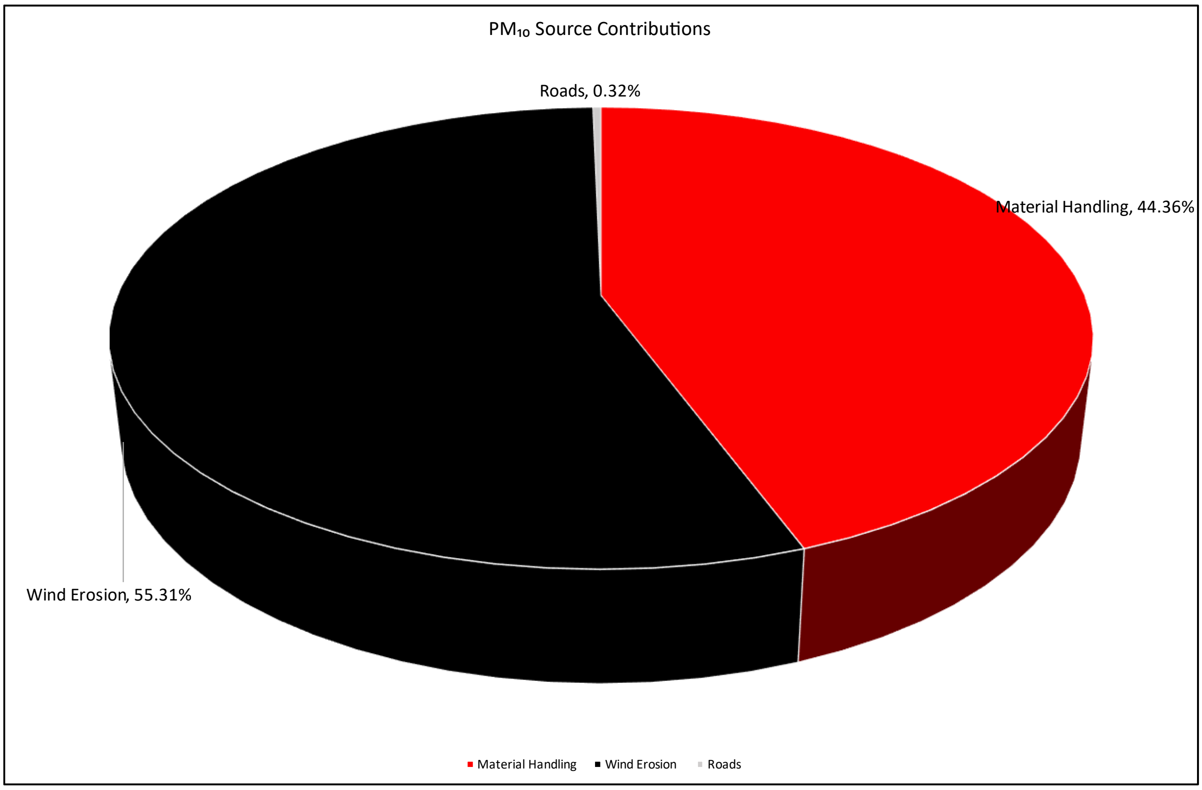


Figure 4-14: PM_{10} source contributions

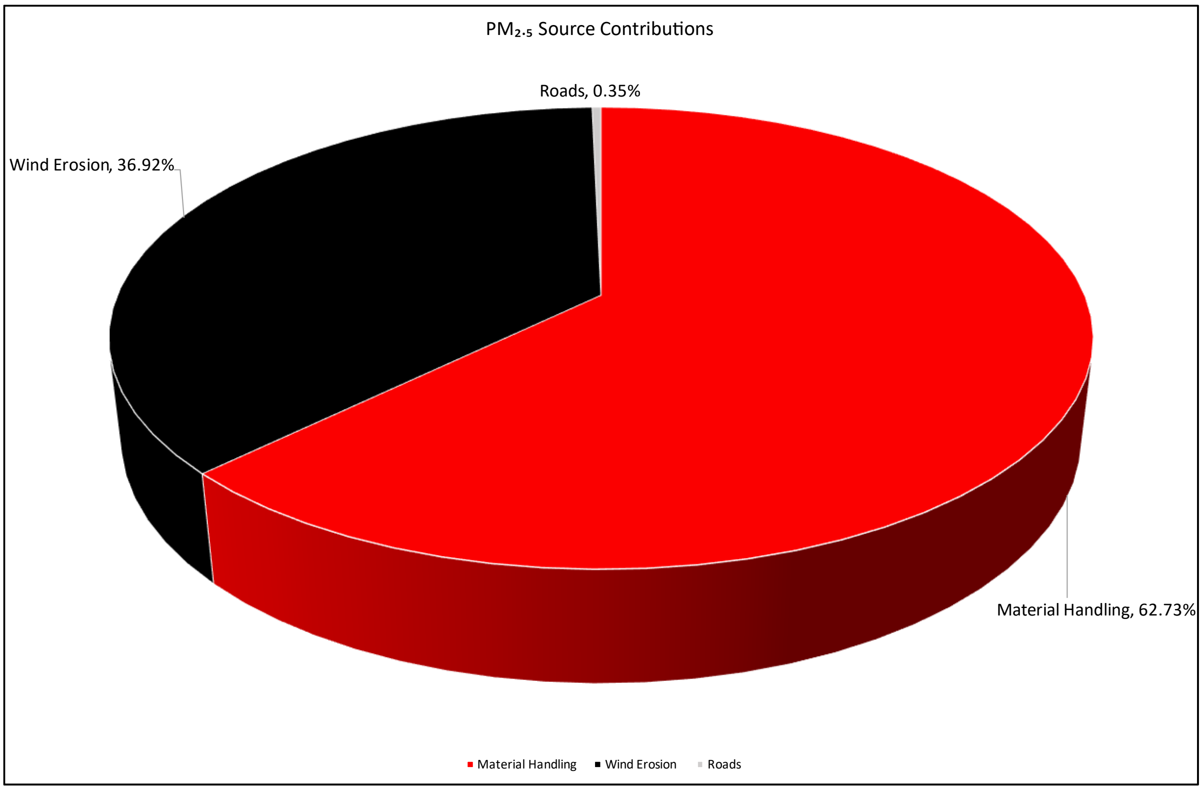


Figure 4-15: $PM_{2.5}$ source contributions

5 METEOROLOGICAL DATA

The climate experienced within the interior of South Africa is controlled predominantly by subtropical high pressure, with temporary disruptions by low pressure cells or fronts. This high-pressure zone is located along 33°S latitude and is associated with strong divergence at the surface and convergence in the upper atmosphere (Tyson and Preston-Whyte, 2000). **Figure 5-1** below shows the predominant macroscale atmospheric circulations over the subcontinent. Easterly waves and lows tend to be summer phenomena, while the westerly wave and lows tend to be autumn to spring phenomena.

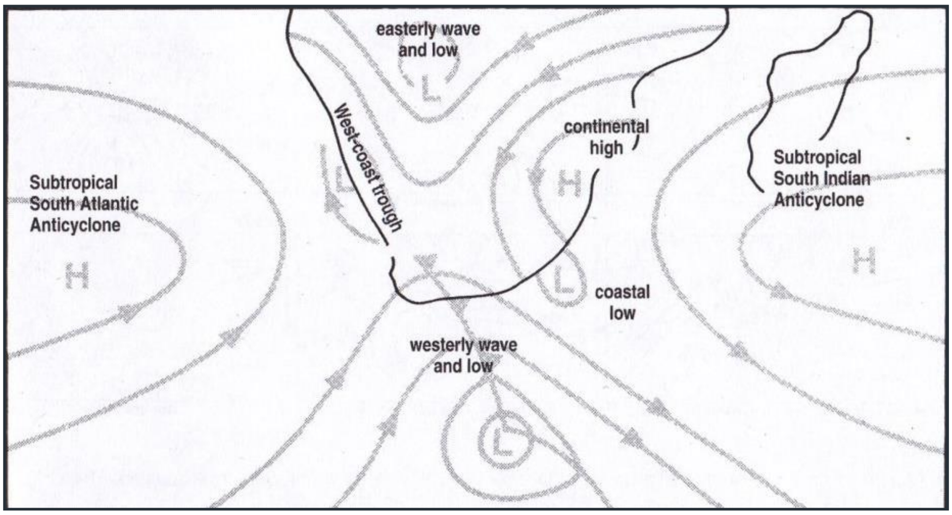


Figure 5-1: South African meteorological phenomena (Tyson & Preston-Whyte, 2000)

Rain falls predominantly in winter and spring over the south-western sector of the country due to the influence of westerly waves. Upper-level divergence and surface-level convergence occurs to the rear of a trough, which causes uplift and cloud formation resulting in precipitation. A surface trough over the west coast and an upper-tropospheric westerly atmospheric wave to the west of the continent can result in widespread rainfall over the western region. During summer, cold fronts associated with these westerly waves migrate further south and thus away from the coast of South Africa, limiting frontal rainfall in the region. While a warm ocean current and onshore winds promote summer rainfall along the east coast of south Africa, the cold Benguela ocean current along the west coast of South Africa limits evaporation off the ocean surface (Tyson and Preston-Whyte, 2000). Port Durnford consequently has a humid subtropical climate of warm wet summers and cool, dry winters.

Along the coastline, sea and land breeze circulations influence the diurnal wind profile. During the day, the land heats up more rapidly than the ocean surface, which has a higher heat capacity. The warmer air over the land rises causing a low pressure to develop. The cool air over the sea subsides and flows along the pressure gradient, causing a sea-land breeze to develop. The converse is true for night-time conditions, where the air above the land cools due to a lack of insulation, while the air above the sea remains warm. A land-sea breeze will therefore prevail at night.

Since meteorological conditions affect how pollutants emitted into the air are directed, diluted, and dispersed within the atmosphere, incorporation of reliable data to an air quality assessment is of the utmost importance. Dispersion comprises vertical and horizontal components of motion.

The stability of the atmosphere and the depth of the atmospheric mixing layer control the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as the plume 'stretches'. Mechanical turbulence is influenced by wind speed, in combination with surface roughness.

5.1 SURFACE DATA

Parameters that need to be taken into account in the characterisation of dispersion potential include wind speed, wind direction, atmospheric stability, ambient air temperature and mixing depth. To accurately represent meteorological conditions for the Project, site-specific data from the South African Weather Service (SAWS) Mtunzini weather station for the period January 2020 to December 2022, at a height of 41 m, was obtained. The station is located ~7 km west-southwest of the Project site. Meteorological data was also sourced from the South African Air Quality Information Systems (SAAQIS) for the nearest station to the site, with the best data recovery, namely the eSikhawini-Richards Bay Clean Air Association (RBCAA) station for the period January 2019 to December 2021. The station is located ~2 km east-southeast of the Project site. Additionally, modelled AERMET-Ready Weather Research and Forecasting (WRF)-Mesoscale Model Interface Program (MMIF) data was purchased from Lakes Environmental for comparison of the data and for use in the dispersion model. An AERMET-ready WRF dataset for the period January 2019 to December 2021 centred in the middle of the Project site and covering a domain of 50 km x 50 km was utilised.

The South African National Accreditation System (SANAS, 2012) TR 07-03 standards stipulate a minimum data recovery of 90% for the dataset to be deemed representative of conditions during a specific reporting period. The percentage recovery for the SAWS and WRF modelled data was above 90% and is thus considered reliable for use in this assessment. The eSikhawini-RBCAA station data recovery was below 90% and as such, the data should be viewed with caution. Station data statistics are provided in **Table 5-1** below. **Figure 5-2** illustrates the location of the meteorological stations relative to the Port Durnford site.

Table 5-1: Details of the surface meteorological stations near Tronox Port Durnford

Station Name	Latitude (°S)	Longitude (°E)	Altitude (masl)	Data Recovery		
				Temperature	Rainfall	Wind
SAWS Mtunzini	28.9470	31.7070	~37	97%	97%	97%
eSikhawini-RBCAA	28.8652	31.9117	~13	78%	78%	78%

Figure 5-2: Surface meteorological stations

WIND FIELD

Wind roses summarize wind speed and directional frequency at a location. Each directional branch on a wind rose represents wind originating from that direction, with each branch divided into segments of colour, representative of different wind speeds. Calm conditions are defined as wind speeds less than 0.5 m/s, although it is noted the SAWS wind sensor only records winds from 1 m/s.

Wind roses were developed using Lakes Environmental WRPlot Freeware (Version 8.0.2) for the full period of available data; diurnally for early morning (00h00 – 06h00), morning (06h00 – 12h00), afternoon (12h00 – 18h00) and night (18h00 – 00h00); and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November). Wind roses for the SAWS Mtunzini and eSikhawini-RBCAA meteorological stations, and WRF data are presented below in **Figure 5-3**, **Figure 5-4**, and **Figure 5-5** respectively. The following key items are highlighted:

Mtunzini Station Data

- North-easterly and west-south-westerly winds prevail in the region for the entire period, with calm conditions occurring ~22% of the time and an average wind speed of 3 m/s recorded.
- West-south-westerly winds prevail during the early morning hours (00h00-06h00).
- From the morning and into the night (06h00-00h00) north easterly winds prevail.
- North-easterly winds prevail during summer and spring, whilst west-south-westerly winds prevail during autumn and winter. The strongest wind speeds are observed during spring.

eSikhawini Station Data

- North-easterly and west-south-westerly winds prevail in the region for the entire period, with calm conditions occurring ~11% of the time and an average wind speed of 3 m/s recorded.
- North-easterly and west-south-westerly winds prevail during the early morning hours (00h00-06h00) into the late morning (06h00-12h00) and again at night (18h00-00h00), with an east-south-easterly wind also introduced at night.
- In the afternoon/ early evening (12h00-18h00) south-westerly winds prevail.
- Seasonal winds from the northeast and west-southwest prevail throughout the year with the strongest wind speeds observed during spring.

WRF Modelled Meteorological Data .

- North-north-easterly winds prevail in the region for the entire period, with calm conditions occurring ~1% of the time and an average wind speed of 5 m/s recorded.
- North-north-easterly winds prevail during the early morning hours (00h00-06h00) into the late morning (06h00-12h00) and again at night (18h00-00h00).
- In the afternoon (12h00-18h00) north-easterly winds prevail, with a strong southerly component also evident.
- Seasonal winds from the north-northeast prevail throughout the year with the strongest wind speeds observed during spring.

When comparing all meteorological data, it was observed that winds from the north-northeast prevailed using the modelled WRF data, whilst the Mtunzini station and eSikhawini station indicated a slight shift in winds with prevailing winds from the northeast. As such, similar trends in wind directions were observed. The slight changes in data can be associated with the height of the stations, the data recovery of the stations and the location of the stations.

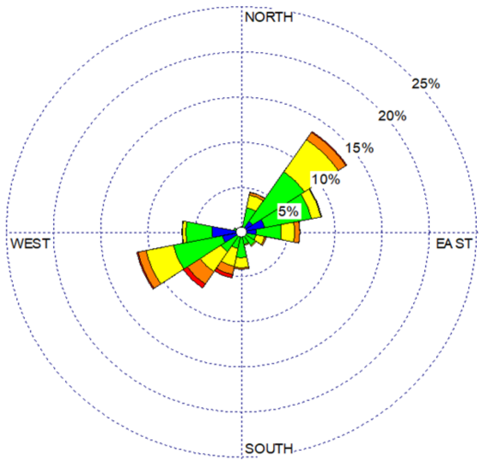
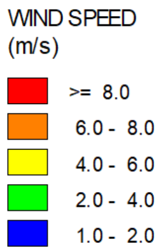
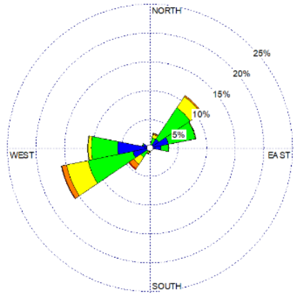
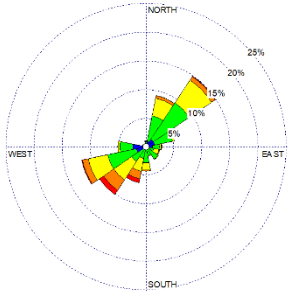
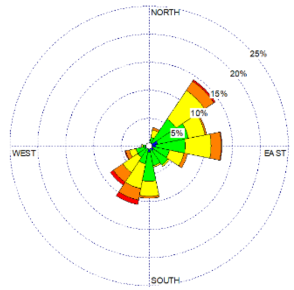
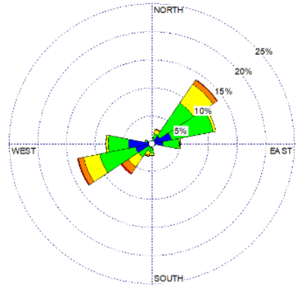
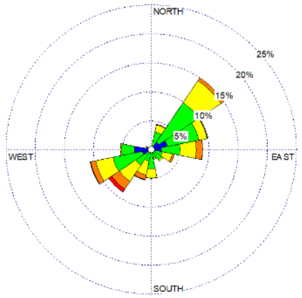
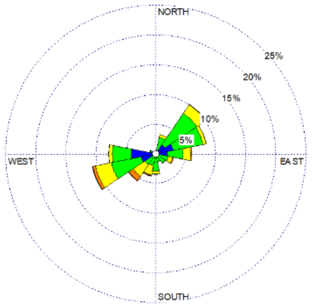
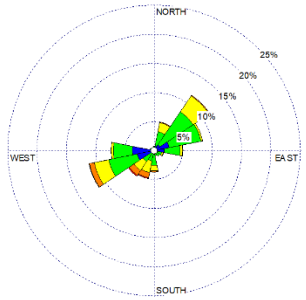
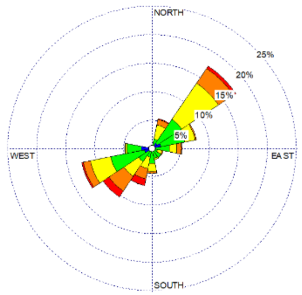
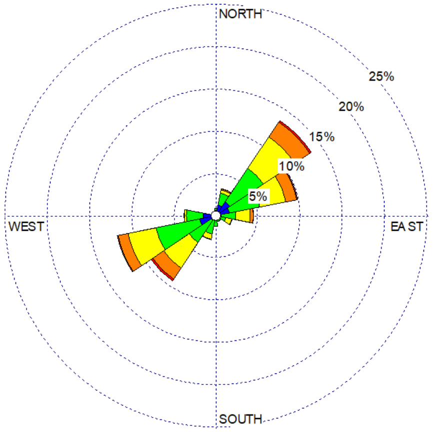
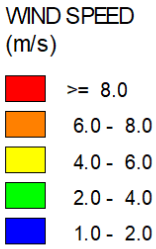
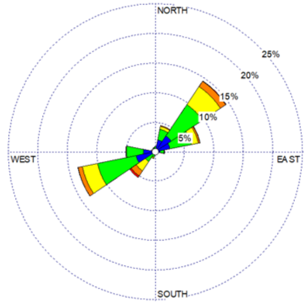
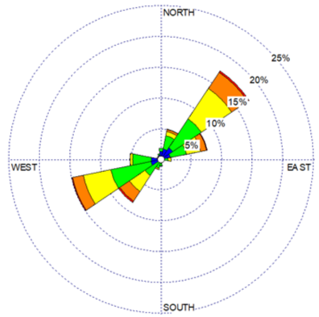
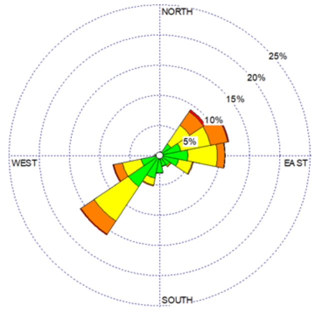
SAWS Mtunzini Station	Early Morning	Morning	Afternoon	Night
January 2020 – December 2022	00h00 – 06h00	06h00 – 12h00	12h00 – 18h00	18h00 – 00h00
 Calms = 22.42% 	 Calms = 35.06%	 Calms = 19.34%	 Calms = 6.96%	 Calms = 28.27%
	Summer	**Autumn**	**Winter**	**Spring**
	December, January & February	March, April & May	June, July & August	September, October & November
	 Calms = 1.11%	 Calms = 5.27%	 Calms = 8.68%	 Calms = 3.22%

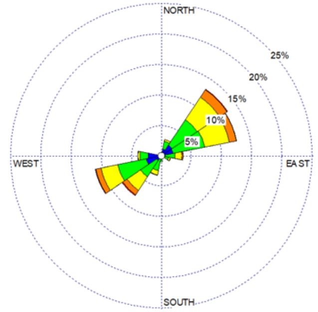
Figure 5-3: Local wind conditions at the SAWS Mtunzini meteorological station for the period 2020 – 2022

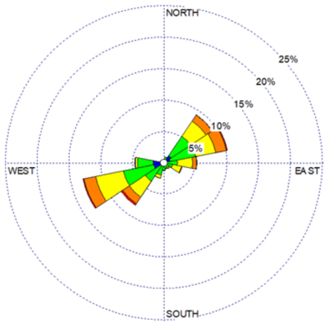
<table>
<tr><td>eSikhawini Station</td><td>Early Morning</td><td>Morning</td><td>Afternoon</td><td>Night</td></tr>
<tr><td>January 2019 – December 2021</td><td>00h00 – 06h00</td><td>06h00 – 12h00</td><td>12h00 – 18h00</td><td>18h00 – 00h00</td></tr>
<tr><td rowspan="3">

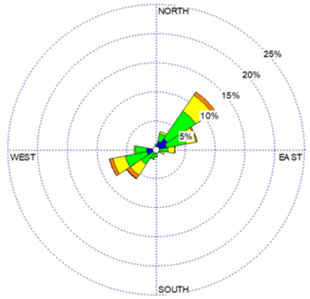
Calms = 11.20%

</td><td>

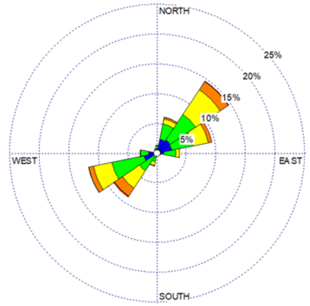
Calms = 21.13%</td><td>

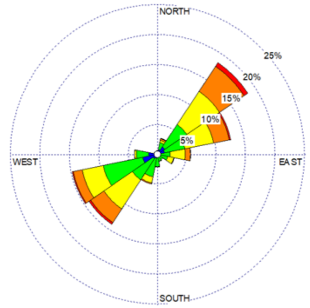
Calms = 8.45%</td><td>

Calms = 1.45%</td><td>

Calms = 14.19%</td></tr>
<tr><td>Summer
December, January & February</td><td>Autumn
March, April & May</td><td>Winter
June, July & August</td><td>Spring
September, October & November</td></tr>
<tr><td>

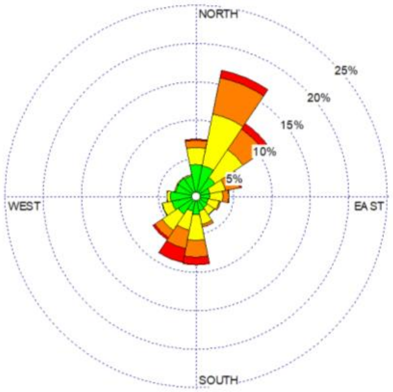
Calms = 8.66%</td><td>

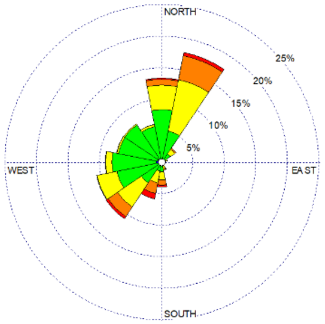
Calms = 12.23%</td><td>

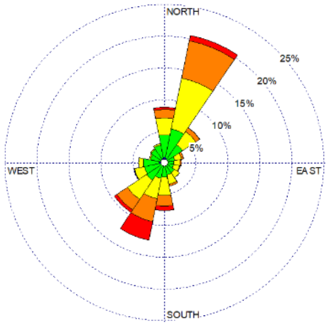
Calms = 13.74%</td><td>

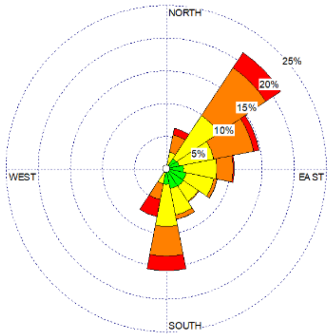
Calms = 10.12%</td></tr>
</table>

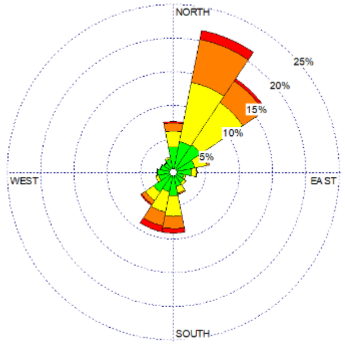
Figure 5-4: Local wind conditions at the eSikhawini-RBCAA meteorological station for the period 2019 – 2021

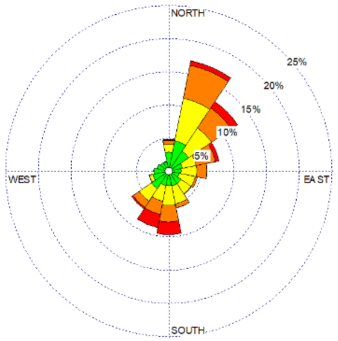
<table>
<tr><th>WRF AERMET Data</th><th>Early Morning</th><th>Morning</th><th>Afternoon</th><th>Night</th></tr>
<tr><td>January 2019 – December 2021</td><td>00h00 – 06h00</td><td>06h00 – 12h00</td><td>12h00 – 18h00</td><td>18h00 – 00h00</td></tr>
<tr><td rowspan="4">

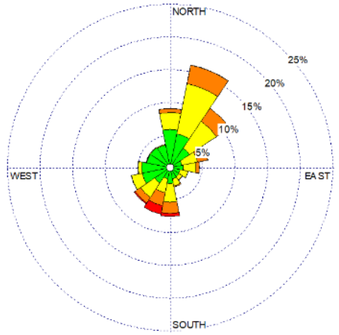
Calms = 1.06%
WIND SPEED (m/s)
>= 8.0
6.0 - 8.0
4.0 - 6.0
2.0 - 4.0
1.0 - 2.0</td>
<td>

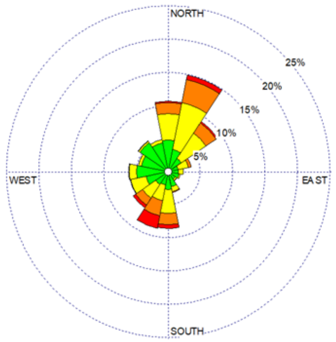
Calms = 0.98%</td>
<td>

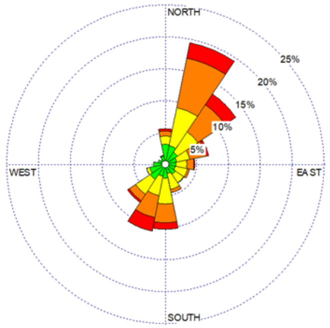
Calms = 1.76%</td>
<td>

Calms = 0.18%</td>
<td>

Calms = 1.29%</td></tr>
<tr><td>Summer</td><td>Autumn</td><td>Winter</td><td>Spring</td></tr>
<tr><td>December, January & February</td><td>March, April & May</td><td>June, July & August</td><td>September, October & November</td></tr>
<tr><td>

Calms = 1.40%</td>
<td>

Calms = 1.12%</td>
<td>

Calms = 0.85%</td>
<td>

Calms = 0.96%</td></tr>
</table>

Figure 5-5: Local wind conditions at the WRF AERMET data for the period 2019 – 2021

TEMPERATURE AND RAINFALL

Ambient air temperature influences plume buoyancy as the higher the plume temperature is above the ambient air temperature, the higher the plume will rise. Further, the rate of change of atmospheric temperature with height influences vertical stability (i.e. formation of mixing or inversion layers), while rainfall is an effective removal mechanism of atmospheric pollutants and thus also relevant in the assessment of pollution potential.

Figure 5-6 presents the average, maximum and minimum temperatures, whilst **Figure 5-7** presents the humidity and total monthly rainfall recorded using the Mtunzini station data for the 2020 to 2022 period. The region typically receives the highest levels of rainfall during the warmer, summer (December to February) months, with drier conditions during the cooler, winter months (June, July and August). The total rainfall received for 2020, 2021 and 2022 was 1037 mm, 1591 mm and 1208 mm, respectively. Temperatures ranged from a low of 2°C, 1°C and 2°C in 2020, 2021 and 2022, respectively in winter to a high of 41°C, 43°C and 39°C in 2020, 2021 and 2022, respectively in summer. The average temperature for 2019, 2020 and 2021 recorded was 25°C, 24°C and 24°C, respectively. The average relative humidity for 2020, 2021 and 2022 recorded was 75%, 76% and 76%, respectively.

Figure 5-8 presents the average, maximum and minimum temperatures, whilst **Figure 5-9** presents the humidity and total monthly rainfall recorded using WRF modelled data for the 2019 to 2021 period. Clear seasonal variations are evident in the temperature and rainfall values for the area. The region typically receives the highest levels of rainfall during the warmer, summer (December to February) months, with drier conditions during the cooler, winter months (June, July and August). The total rainfall received for 2019, 2020 and 2021 was 1596 mm, 946 mm and 1636 mm, respectively. Temperatures ranged from a low of 7°C, 6°C and 5°C in 2019, 2020 and 2021, respectively in winter to a high of 39°C, 41°C and 40°C in 2019, 2020 and 2021, respectively in summer. The average temperature for 2019, 2020 and 2021 recorded was 25°C, 26°C and 25°C, respectively. The average relative humidity for 2019, 2020 and 2021 recorded was 73%, 71% and 73%, respectively.

Due to the missing data from the eSikhawini station no graphs have been displayed but a discussion has been provided. Clear seasonal variations were also evident in the temperature values for the area. Temperatures ranged from a low of 12°C, 8°C and 9°C in 2019, 2020 and 2021, respectively in winter to a high of 38°C, 40°C and 43°C in 2019, 2020 and 2021, respectively in summer. The maximum average temperature for 2019, 2020 and 2021 recorded was 24°C, 26°C and 26°C, respectively. The average relative humidity for 2019, 2020 and 2021 recorded was 67%, 72% and 77%, respectively.

Both data sets produced similar ranged results and are thus deemed representative of the site.

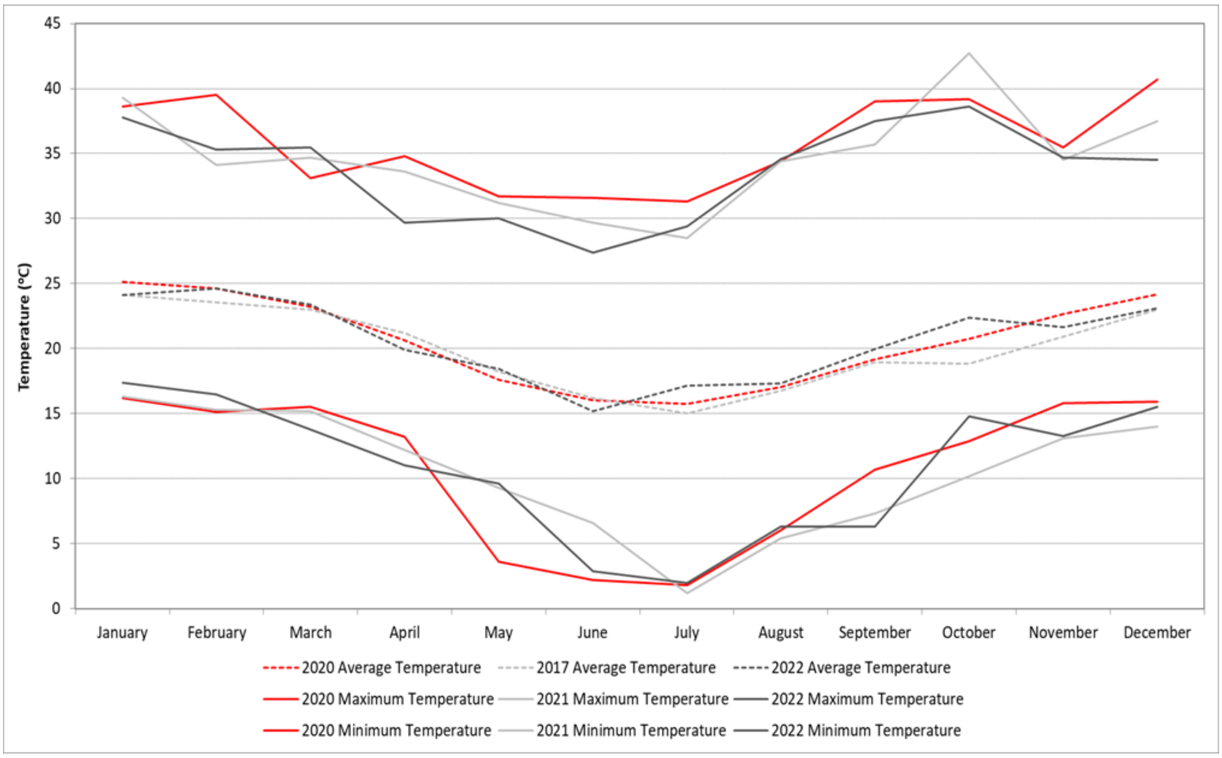


Figure 5-6: Average, maximum and minimum monthly temperatures for the Port Dunford region for the period January 2020 to December 2022 using the Mtunzini meteorological station data

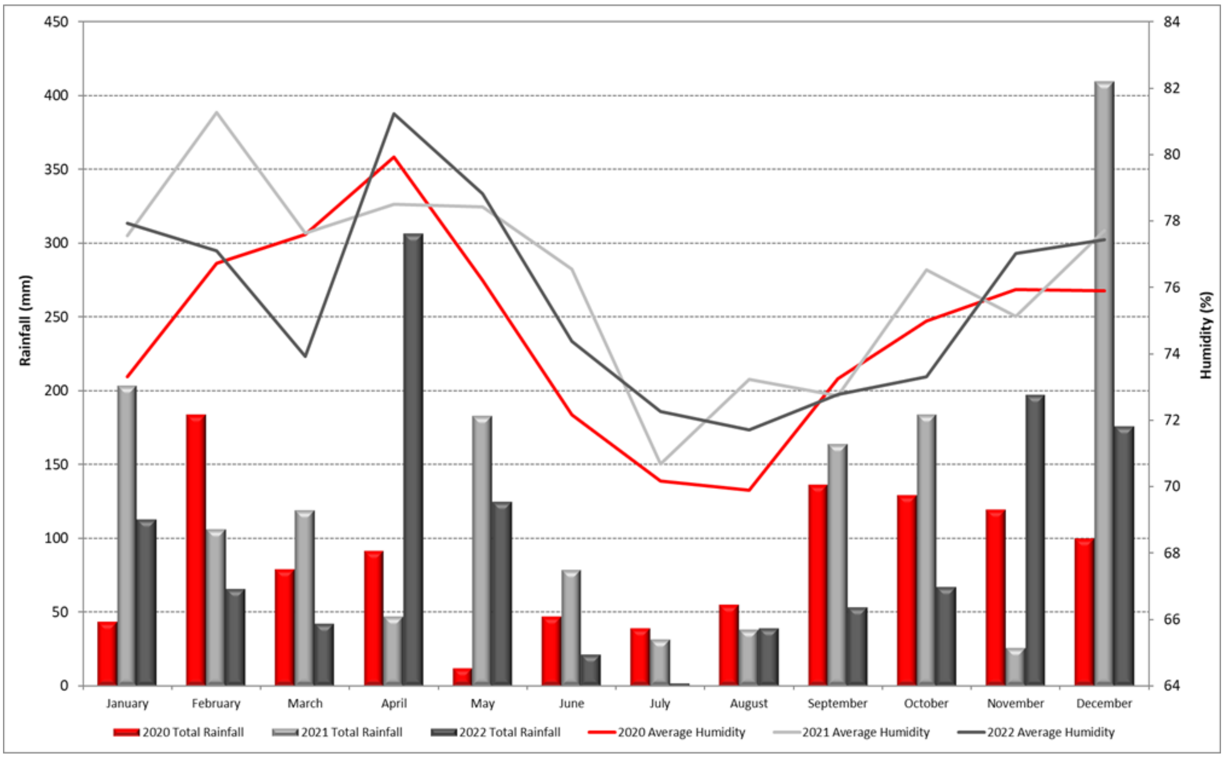


Figure 5-7: Total monthly rainfall and average humidity for the Port Dunford region for the period January 2020 to December 2022 using the Mtunzini meteorological station data

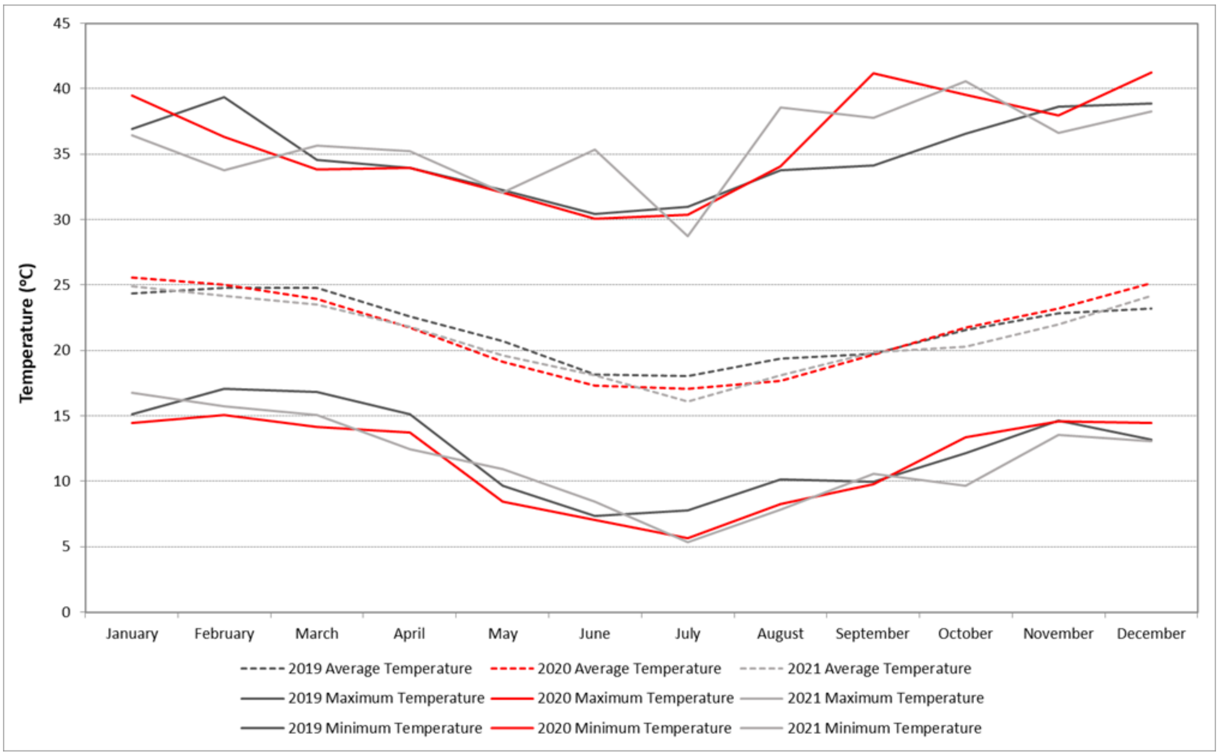


Figure 5-8: Average, maximum and minimum monthly temperatures for the Port Dunford region for the period January 2019 to December 2021 using modelled WRF data

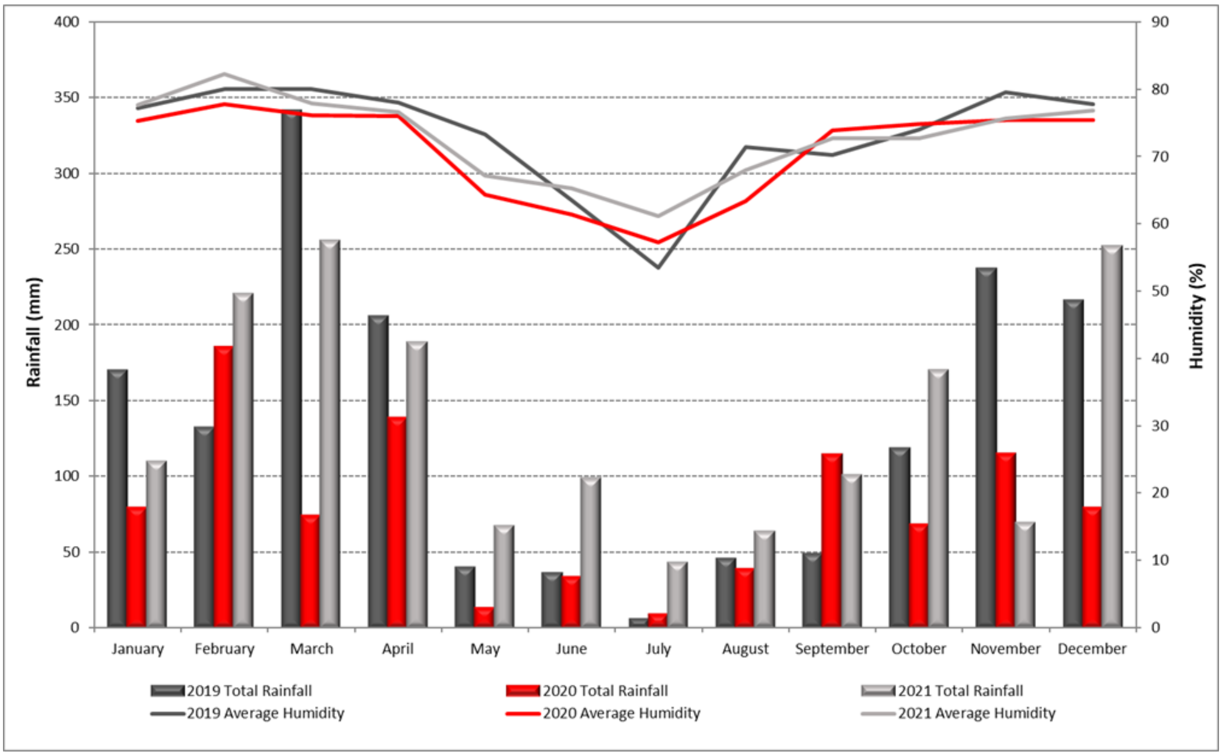


Figure 5-9: Total monthly rainfall and average humidity for the Port Dunford region for the period January 2019 to December 2021 using modelled WRF data

6 AMBIENT CONCENTRATIONS

The predominant land use in the Project development area is agriculture, resulting in particulate matter emissions. Other emission sources in the area include mining, industry, vehicle tailpipe emissions and domestic fuel burning at neighbouring residential areas and settlements.

6.1 AMBIENT PM CONCENTRATIONS

Particulate matter monitoring is measured at the nearby Mtunzini monitoring station, located ~9 km from the Port Durnford site. However, the station data was poor with low data recovery and could not be used for assessment purposes. As such, ambient measured PM_{10} concentrations were sourced from the eSikhaleni RBCAA station and from the South African Air Quality Information System (SAAQIS) eSikhawini monitoring station, which are the closest stations to the site with suitable data recovery (both located ~6 km from the Port Durnford site). Data was obtained for the January 2020 to December 2023 period for both monitoring stations. Data for the 2023 period, however, was not assessed due to the poor data recovery for both stations. **Table 6-1** shows the coordinates and data recovery for the two monitoring stations. As per the South African National Accreditation System (SANAS, 2012) TR 07-03 standards, a minimum data recovery of 90% is required for assessing compliance with the NAAQS. Given this, most of the available data must be viewed with caution in terms of representing ambient quality experienced at the Port Durnford site.

Table 6-1: Ambient monitoring station locations and data recovery

Station Name	Latitude (°S)	Longitude (°E)	Altitude (masl)	Data Recovery			
				2020	2021	2022	2023
eSikhaleni	28.8689	31.9097	~17	79.00%	92.80%	75.50%	2.40%
eSikhawini	28.8652	31.9117	~13	85.60%	96.40%	71.10%	52.40%

Figure 6-1: Surface ambient stations

Figure 6-2 presents the 24-hour average PM_{10} concentrations measured at the eSikhaleni monitoring station for the period January 2020 – December 2022. For this period, two exceedances of the 24-hour National Ambient Air Quality Standard (NAAQS) (75 µg/m^3) were recorded, occurring in June 2021 and July 2021, remaining compliant as four exceedances of the standard are permitted per calendar year. An annual average concentration of 25.30 µg/m^3, 23.29 µg/m^3 and 12.90 µg/m^3 was measured in 2020, 2021 and 2022, respectively. These concentrations remain below the annual average NAAQS (40 µg/m^3).

Figure 6-3 presents the 24-hour average PM_{10} concentrations measured at the eSikhawini monitoring station for the period January 2020 – December 2022. For this period, two exceedances of the 24-hour NAAQS (75 µg/m^3) were recorded in June 2021 and July 2021, remaining compliant as four exceedances of the standard are permitted per calendar year. An annual average concentration of 23.35 µg/m^3, 22.84 µg/m^3 and 12.50 µg/m^3 was measured in 2020, 2021 and 2022, respectively. These concentrations remain below the annual average NAAQS (40 µg/m^3).

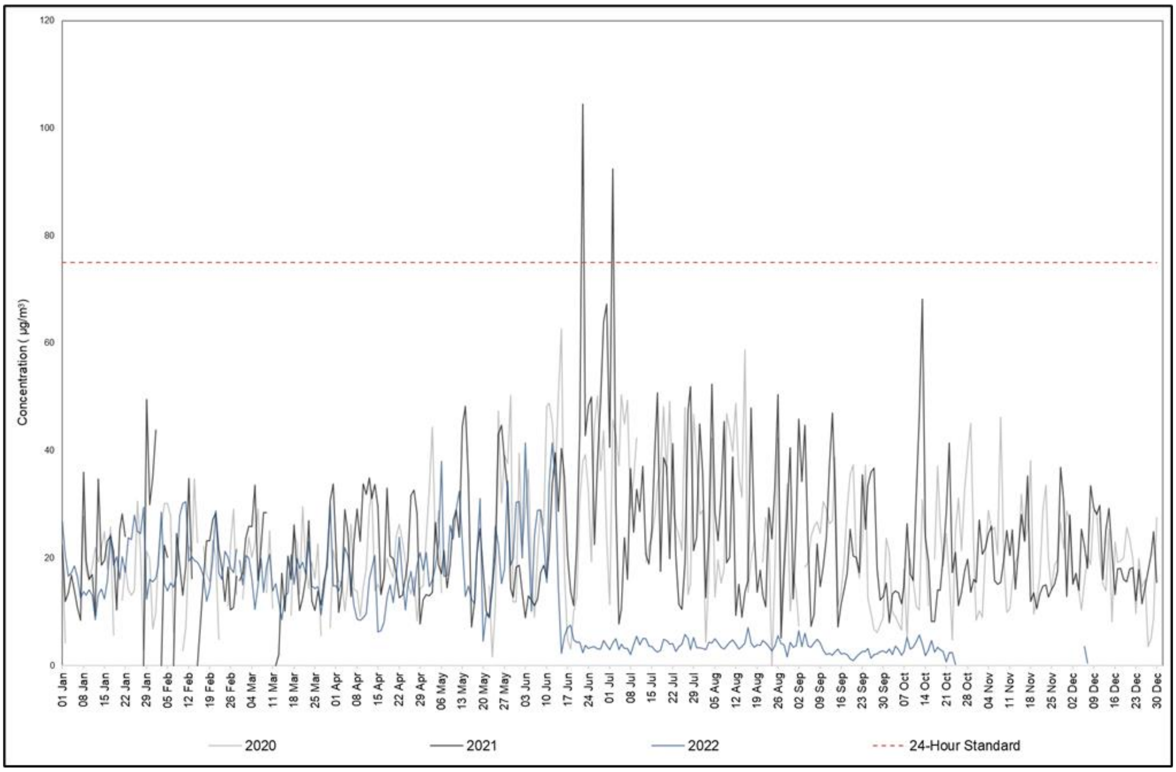


Figure 6-2: Daily average PM_{10} concentration at the eSikhaleni monitoring station from January 2020 to December 2022

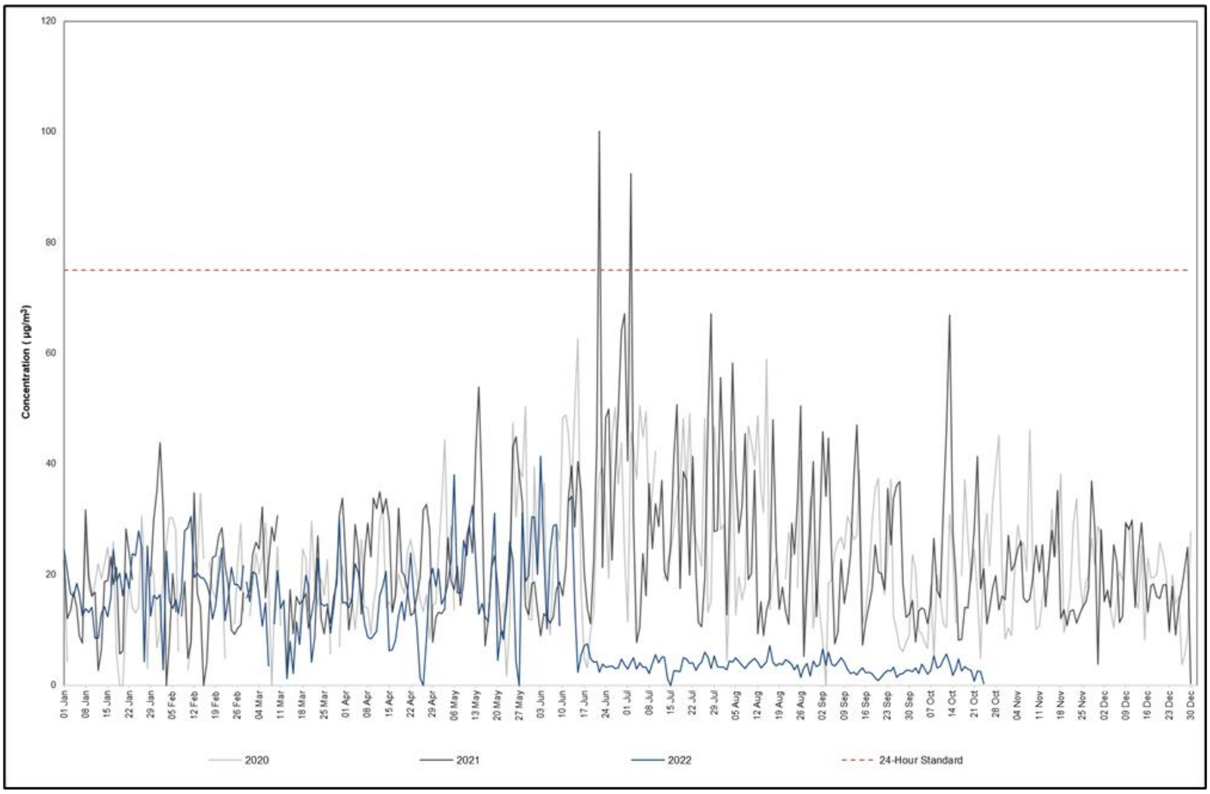


Figure 6-3: Daily average PM_{10} concentrations at the eSikhawini monitoring station from January 2020 to December 2022

7 MODELLING PROCEDURES

7.1 ASSESSMENT LEVEL AND DISPERSION MODEL

As per the *Modelling Regulations*, the level of assessment is dependent on technical factors such as geophysical and meteorological context and the complexity of the emissions inventory. The temporal and spatial resolution and accuracy required from a model must also be considered. For this assessment, the AERMOD dispersion modelling software suite was utilised. AERMOD is a Level 2 dispersion model recommended within the *Modelling Regulations* and is internationally recognised by organisations such as the United States Environmental Protection Agency. With the following capabilities, AERMOD is well equipped to simulate the dispersion of emissions from the project:

- It is a new generation air dispersion model designed for short-range dispersion (<50 km) of airborne pollutants in steady state plumes.
- It incorporates air dispersion based on boundary layer turbulence structure and scaling, including treatment of both surface and elevated sources and both simple and complex terrain.
- It uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour that cumulatively offer long-term ambient concentrations whilst also capturing short-term peaks.

7.2 MODEL INPUTS

METEOROLOGICAL DATA

The meteorological data that was used in the dispersion model was obtained from Lakes Environmental Consultants Inc., in the form of WRF Pre-processed meteorological data, for the period January 2019 – December 2021. This is the most complete and representative dataset for the site.

Data input into the model includes measured surface and upper air meteorological data with wind speed, wind direction, temperature, pressure, precipitation, cloud cover and ceiling height.

RECEPTORS

Sensitive Receptors

Sensitive receptors are identified as areas that may be impacted negatively due to air quality associated with the proposed development. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The sensitive receptors identified in the area surrounding the proposed development are indicative of the general area that the receptor is located, as every single induvial receptor cannot be accounted for in the study. These representative receptors are listed in **Table 7-1**. Representative receptors were selected based on proximity to the study area and are places where sensitive individuals may be impacted, such as residences, retirement homes, schools, or medical facilities. Their proximity from the site boundary is shown in **Figure 7-1**.

Table 7-1: Representative receptor locations

ID	Representative Receptor Name	Receptor Type	Distance from Site Boundary (km)	Direction	Latitude (°S)	Longitude (°E)
0	Africa Christian Ministries	Residential	3.4	South-southeast	28.903	31.909
1	Amadaka	Residential	2.7	East	28.864	31.934
2	Bhiliya	Residential	5.4	East	28.831	31.945
3	Church of Jesus Christ of Latter Day Saints	Residential	1.1	South	28.908	31.869
4	Dube	Residential	2.0	East	28.861	31.928
5	Empembeni	Residential	6.5	East	28.875	31.971
6	Empembeni Primary School	Residential/ School	7.4	East	28.862	31.982
7	Engunjini	Residential	5.1	North	28.841	31.812
8	Eniwe	Residential/ School	0.9	North-northeast	28.840	31.865
9	eSikhawini H	Residential	1.0	East	28.867	31.915
10	Gobandlovu	Residential	0.6	East	28.858	31.905
11	Gubhethuka	Residential	7.9	East	28.855	31.985
12	Injabuloyesizwe Primary School	Residential/ School	2.4	South	28.913	31.883
13	Isikhalasenkosi High School	Residential/ School	1.8	South	28.908	31.878
14	Izingeni	Residential	5.0	West	28.928	31.705
15	Khandisa	Residential	0.6	North-northeast	28.860	31.852
16	Kuleka	Residential	7.7	North-northeast	28.783	31.902
17	Kwashodlisa	Residential	4.0	North	28.860	31.792
18	Lubisana	Residential	5.9	North	28.840	31.794
19	Mabuyeni	Residential	4.9	East	28.862	31.954
20	Mahunu	Residential	1.2	South	28.916	31.861
21	Mangeza	Residential	3.6	North-northeast	28.839	31.839
22	Mankunzana	Residential	5.8	North	28.857	31.757
23	Manzamnyama Primary School	Residential/ School	5.7	North	28.864	31.747
24	Mhlanga Primary School	Residential/ School	0.9	South	28.920	31.840
25	Mntokhona Primary School	Residential/ School	1.7	South	28.930	31.832
26	Msasandla	Residential	2.5	North-northwest	28.891	31.758
27	Mtunzini	Residential	0.7	Southwest	28.938	31.771
28	Muntonokudla Secondary School	Residential/ School	1.0	North	28.888	31.795
29	Mvuzemvuze Primary School	Residential/ School	0.3	North	28.879	31.833
30	Ncombo	Residential	5.7	East	28.877	31.962
31	Ndabayakhe Full Gospel Church	Residential	5.1	North-northeast	28.806	31.851

ID	Representative Receptor Name	Receptor Type	Distance from Site Boundary (km)	Direction	Latitude (°S)	Longitude (°E)
32	Ndabenkulu Temple	Residential	2.0	South	28.909	31.880
33	Ndindima	Residential	4.4	Southeast	28.888	31.936
34	Ndleleni	Residential	3.0	East	28.847	31.929
35	Nelisiwe Temple	Residential	1.4	South	28.937	31.822
36	Ngwelezana Hospital	Residential	8.2	North-northeast	28.774	31.866
37	Ngwelezane	Residential	6.6	North-northeast	28.789	31.870
38	Njomane Home	Residential	0.1	North	28.893	31.804
39	Nqutshini	Residential	6.6	North-northeast	28.794	31.847
40	Nqutshini Primary School	Residential/ School	6.8	North-northeast	28.802	31.830
41	Nyembe	Residential	0.9	South	28.935	31.819
42	Obanjeni Primary School	Residential/ School	4.7	West	28.926	31.709
43	Ongoye	Residential	1.3	North	28.870	31.830
44	PD Seventh Day Adventist Church	Residential	0.3	North	28.891	31.807
45	Port Dunford	Residential	0.07	South	28.915	31.828
46	Qantayi High School	Residential/ School	1.1	South	28.923	31.837
47	Residential Area 1	Residential	0.05	North	28.863	31.856
48	Residential Area 2	Residential	0.01	North	28.875	31.845
49	Residential Area 3	Residential	0.03	North	28.881	31.832
50	Residential Area 4	Residential	0.1	North	28.901	31.788
51	Residential Area 5	Residential	0.4	West	28.911	31.765
52	Residential Area 6	Residential	0.1	South	28.924	31.819
53	Sbhamu	Residential	3.2	West	28.921	31.729
54	Sikhalasenkosi	Residential	1.9	South	28.896	31.895
55	The Church of Jesus Christ (uMhlathuze City)	Residential	0.4	South	28.915	31.845
56	Uzimgwenya	Residential	0.07	East	28.866	31.904
57	Vulindlelaa	Residential	2.0	North	28.859	31.837
58	Zenzeleni Mashamase Secondary School	Residential/ School	3.9	Northwest	28.901	31.730
59	Zimeme High School	Residential/ School	5.8	North	28.867	31.740

Figure 7-1: Representative receptors surrounding the Port Durnford Project site

FACILITY FENCELINE

As defined in the *Modelling Regulations*, ambient air quality objectives are applied to areas outside the facility fence line. Within the facility boundary, environmental conditions are prescribed by occupational health and safety criteria. The facility boundary is defined based on these criteria:

- The facility fence line or the perimeter where public access is restricted.
- If the facility is located within a larger facility, the facility boundary is that of the encompassing facility.
- If a public access road passes through the facility, the facility boundary is the perimeter of the road.

MODELLING SCENARIOS

For Phase 2, mining is expected to progress across the site (from 2036 – 2069) and as such, the modelling scenarios have been split into key periods (based on location of emission sources) for ease of assessment. For the dispersion modelling, the following scenarios were considered (operational years are indicated in brackets):

- Phase 2 Scenario 1 (3,000 tph) Operations (2036 – 2047)
- Phase 2 Scenario 2 (3,000 tph) Operations (2048 – 2053)
- Phase 2 Scenario 3 (3,000 tph) Operations (2054 – 2069)

The model scenarios assessed the Phase 2 proposed operations for $PM_{2.5}$, PM_{10} and TSP (presented as dust fallout) for short-term (24-hour, and 30-day average) and long-term (annual) averaging periods for comparison with the applicable NAAQS, as applicable to each pollutant.

TERRAIN INPUT

Terrain influences dispersion of pollutants, especially during periods of stable conditions. The NASA Shuttle Radar Topographic Mission (SRTM) digital elevation model (DEM) (resolution 30 m x 30 m) was extracted and inputted to the model to account for terrain influences on dispersion (refer to **Figure 2-2**). For the land use categorization, a surface output was created from the Global Land Cover Characterization Global Coverage – Version 2 (1 km x 1 km resolution).

MODELLING DOMAIN

A 15 km x 15 km modelling domain was defined to include Port Durnford to the south and identified representative receptors to the north of the proposed Project boundary. The *Modelling Regulations* specify the use of a multi-tier grid and recommend specific tier resolutions; 50 m for general area of maximum impact, 100 m for 5 km from the facility of interest, 250 m for 10 km from the facility of interest and 1,000 m exceeding 10 km from the facility of interest. Given this, the tiered grid resolution applied in the model comprise:

- 50 m grid spacing up to 500 m from the site.
- 100 m grid spacing up to 5 km form the site.
- 250 m grid spacing up to 10 km from the site.
- 500 m grid spacing exceeding 10 km from the site.

MODEL INPUT PARAMETERS

Table 7-2 presents the model input parameters to be utilised in this assessment.

Table 7-2: Dispersion model input parameters

Parameter	Model Input
Model	
Assessment Level	Level 2
Dispersion Model	AERMOD
Supporting Models	AERMAP
Emissions	
Pollutants modelled	PM_{10}, $PM_{2.5}$ and dust fallout
Scenarios	Phase 2 Scenario 1 Phase 2 Scenario 2 Phase 2 Scenario 3
Chemical transformation	N/A
Exponential decay	N/A
Settings	
Terrain setting	Elevated
Terrain data	SRTM3
Terrain data resolution (m)	90
Land characteristics (bowen ratio, surface albedo, surface roughness)	Urban
Grid Receptors	
Modelling domain (km)	24 x 24
Property line resolution (m)	50
Fine grid resolution (m)	250
Medium grid resolution (m)	500
Course grid resolution (m)	1,000

8 RESULTS

8.1 CONSTRUCTION PHASE

Unlike general industry, construction activities are not always stationary and in one location. Construction activities at the proposed site will include various air pollution sources including earth-moving equipment (trucks, cranes, scrapers and loaders), concrete mixers and materials handling activities, among others. Due to the erratic and transient nature of such construction activities as well as the fact that detailed construction phase plans have not yet been developed for the proposed Project, air quality impacts from the construction phase of the Project could not be quantified.

All the emission sources will generate ambient air pollution and may impact on neighbouring sensitive receptors. As such, mitigation interventions are advised during the construction phase. These mitigation recommendations are detailed in the section that follows.

MITIGATION RECOMMENDATIONS

To minimise the ambient air impacts from the construction phase of the proposed Project, various mitigation techniques can be employed. These options include both management and technical options:

- Planning construction activities in consultation with local communities so that activities with the greatest potential to generate emissions are planned during periods of the day that will result in least disturbance. Information regarding construction activities should be provided to all local communities. Such information includes:
  - Proposed working times.
  - Anticipated duration of activities.
  - Explanations on activities to take place and reasons for activities.
  - Contact details of a responsible person on site should complaints arise.
- Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment.
- Ensure access control to exposed areas reducing activity and wind entrainment.
- Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment.
- Dust mitigation achieved by wetting the unpaved roads.
- Where possible do not undertake material handling activities during windy conditions, considered to occur when constant wind speed is greater than 6 m/s (Kurosaki & Mikami, 2006).
- Development of a dust fallout monitoring network to identify areas of concern.
- Developing a mechanism to record and respond to complaints.

It is recommended that Tronox establish a dust fallout monitoring network around the proposed development fenceline to determine dust emissions from the proposed construction activities at the surrounding receptors. **Figure 8-16** below, represents the proposed dust fallout monitoring network. Due to the sensitive nature of the surrounding areas, monitoring locations at/near representative receptors (residential monitoring) were prioritized over fenceline receptors (non-residential monitoring). The monitoring locations were determined by the predicted dust fallout dispersion for each proposed phase assessed in ensuing sections, potential location security such as schools, gated communities, government buildings and facilities with pre-existing security measures, such as electrical terminals. Non-residential monitoring may be conducted, in the event that exceedances of the National Dust Control residential standards are identified at the proposed monitoring locations

8.2 OPERATIONAL PHASE

The following sections presents the dispersion modelling predictions associated with modelled scenarios. Ground level concentration predictions are presented in receptor tables and isopleths.

Given that the proposed active operational period for Phase 1 will be intermittent, for the purpose of this report this scenario has been quantified, however, the emission sources have not been modelled.

PHASE 2 SCENARIO 1

$PM_{2.5}$ Concentration Predictions

Table 8-1 presents predicted $PM_{2.5}$ concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-1** illustrates the maximum 24-hour $PM_{2.5}$ concentrations (P99) and **Figure 8-2** illustrates long-term average $PM_{2.5}$ concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_49 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 1 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

Table 8-1: Scenario 1 predicted $PM_{2.5}$ concentrations at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS ($\mu g/m^3$)	24-Hour Maximum ($\mu g/m^3$)	Annual NAAQS ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
5	Church of Jesus Christ of Latter Day Saints	40	1.8008	20	0.3076
6	Dube		0.5959		0.0665
10	Eniwe		0.9755		0.1009
11	eSikhawini H		0.7759		0.0883
12	Gobandlovu		0.7091		0.0941
15	Isikhalasenkosi High School		1.4691		0.2393
17	Khandisa		2.0141		0.2425
22	Mahunu		1.5761		0.3039
26	Mhlanga Primary School		1.6127		0.3981
27	Mntokhona Primary School		1.3964		0.3364
29	Mtunzini		0.7746		0.0919

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
30	Muntonokudla Secondary School		0.9810		0.1433
31	Mvuzemvuze Primary School		2.1853		0.3493
34	Ndabenkulu Temple		1.3913		0.2236
37	Nelisiwe Temple		1.4096		0.2854
40	Njomane Home		1.2610		0.2821
43	Nyembe		1.5061		0.3138
45	Ongoye		1.6242		0.2052
46	PD Seventh Day Adventist Church		1.3533		0.2677
47	Port Dunford		2.1931		0.6126
48	Qantayi High School		1.7493		0.3892
49	Residential Area 1		2.4000		0.3467
50	Residential Area 2		3.5066		0.6748
51	Residential Area 3		2.3348		0.3881
52	Residential Area 4		1.1364		0.2222
53	Residential Area 5		0.6773		0.0676
54	Residential Area 6		2.8251		0.7824
56	Sikhalasenkosi		1.2606		0.1818
57	The Church of Jesus Christ (uMhlathuze City)		2.1818		0.4821
58	Uzimgwenya		0.8456		0.1068
59	Vulindlelaa		1.3904		0.1521
	Maximum Fence line Concentration [X: 387652m; Y: 6805423m] – 24-Hour		4.8204		-
	Maximum Fence line Concentration [X: 384887m; Y: 6800035m] – Long Term		-		0.9152

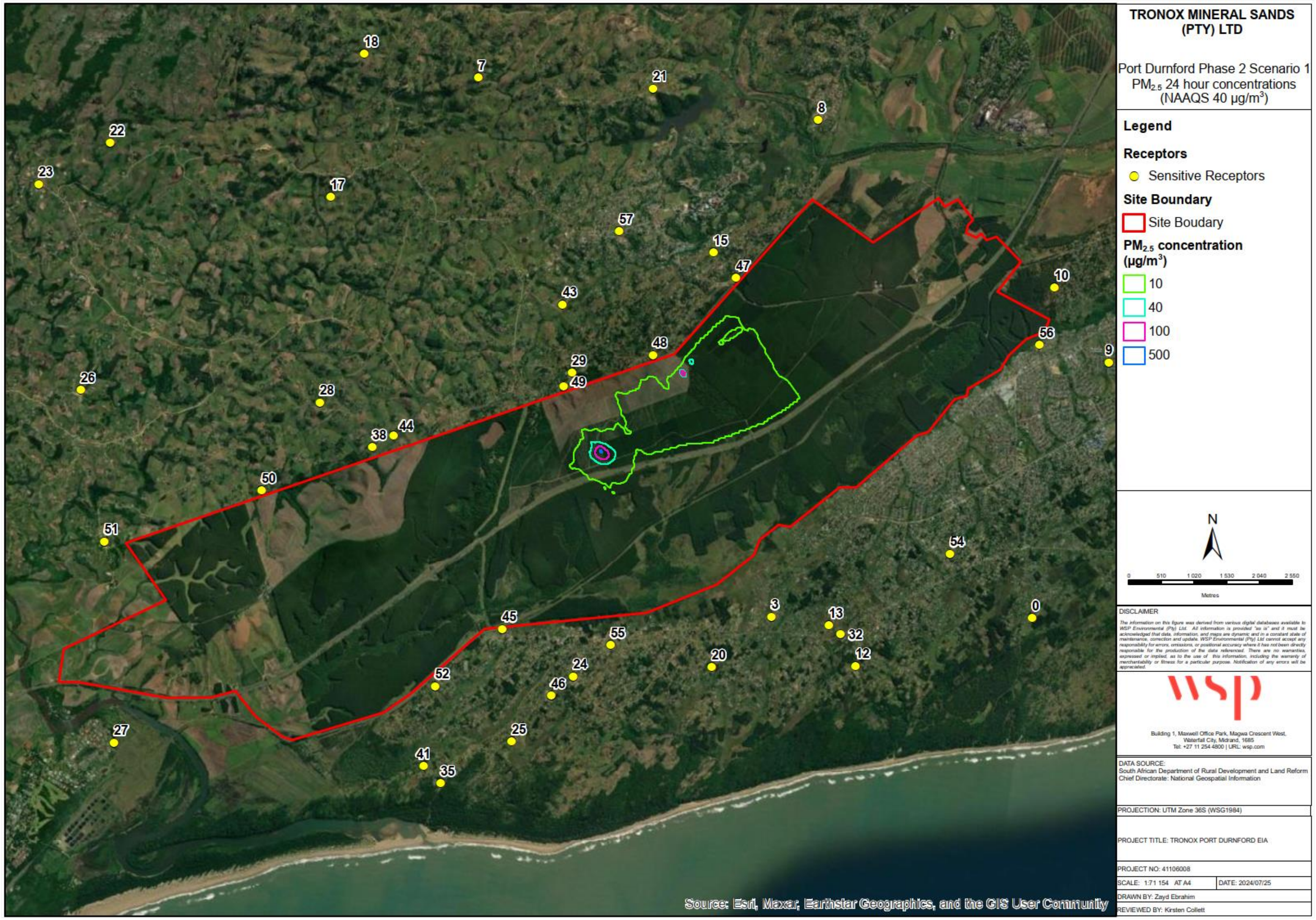


Figure 8-1: Scenario 1 predicted maximum 24-hour $PM_{2.5}$ concentrations (P99)

Figure 8-2: Scenario 1 predicted long-term average $PM_{2.5}$ concentrations

PM_{10} Concentration Predictions

Table 8-2 presents predicted PM_{10} concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-3** illustrates the maximum 24-hour PM_{10} concentrations (P99) and **Figure 8-4** illustrates long-term average PM_{10} concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_49 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 1 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

Table 8-2: Scenario 1 predicted PM_{10} concentrations at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
5	Church of Jesus Christ of Latter Day Saints	75	10.7748	40	1.8949
6	Dube		3.7396		0.4175
10	Eniwe		6.3407		0.6312
11	eSikhawini H		4.9638		0.5544
12	Gobandlovu		4.5723		0.5912
15	Isikhalasenkosi High School		9.1841		1.4768
17	Khandisa		12.6324		1.5119
22	Mahunu		10.1855		1.8755
26	Mhlanga Primary School		10.2990		2.4587
27	Mntokhona Primary School		9.1443		2.1312
29	Mtunzini		4.7621		0.5874
30	Muntonokudla Secondary School		6.2007		0.9038
31	Mvuzemvuze Primary School		11.6382		2.0798
34	Ndabenkulu Temple		8.7129		1.3807
37	Nelisiwe Temple		9.0524		1.8210
40	Njomane Home		7.9183		1.7975
43	Nyembe		9.5840		2.0146
45	Ongoye		9.2495		1.2153
46	PD Seventh Day Adventist Church		7.3061		1.6883
47	Port Dunford		14.0434		3.8872
48	Qantayi High School		10.9952		2.4308
49	Residential Area 1		15.7211		2.1873
50	Residential Area 2		22.4927		4.2100

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
51	Residential Area 3		12.5240		2.3146
52	Residential Area 4		7.0716		1.4399
53	Residential Area 5		4.2867		0.4283
54	Residential Area 6		18.3131		5.1154
56	Sikhalasenkosi		8.1929		1.1336
57	The Church of Jesus Christ (uMhlathuze City)		14.2253		2.9940
58	Uzimgwenya		5.1451		0.6716
59	Vulindlelaa		8.9496		0.9211
	Maximum Fence line Concentration [X: 387652m; Y: 6805423m] – 24-Hour		30.8889		-
	Maximum Fence line Concentration [X: 384823m; Y: 6799958m] – Long Term		-		5.9988

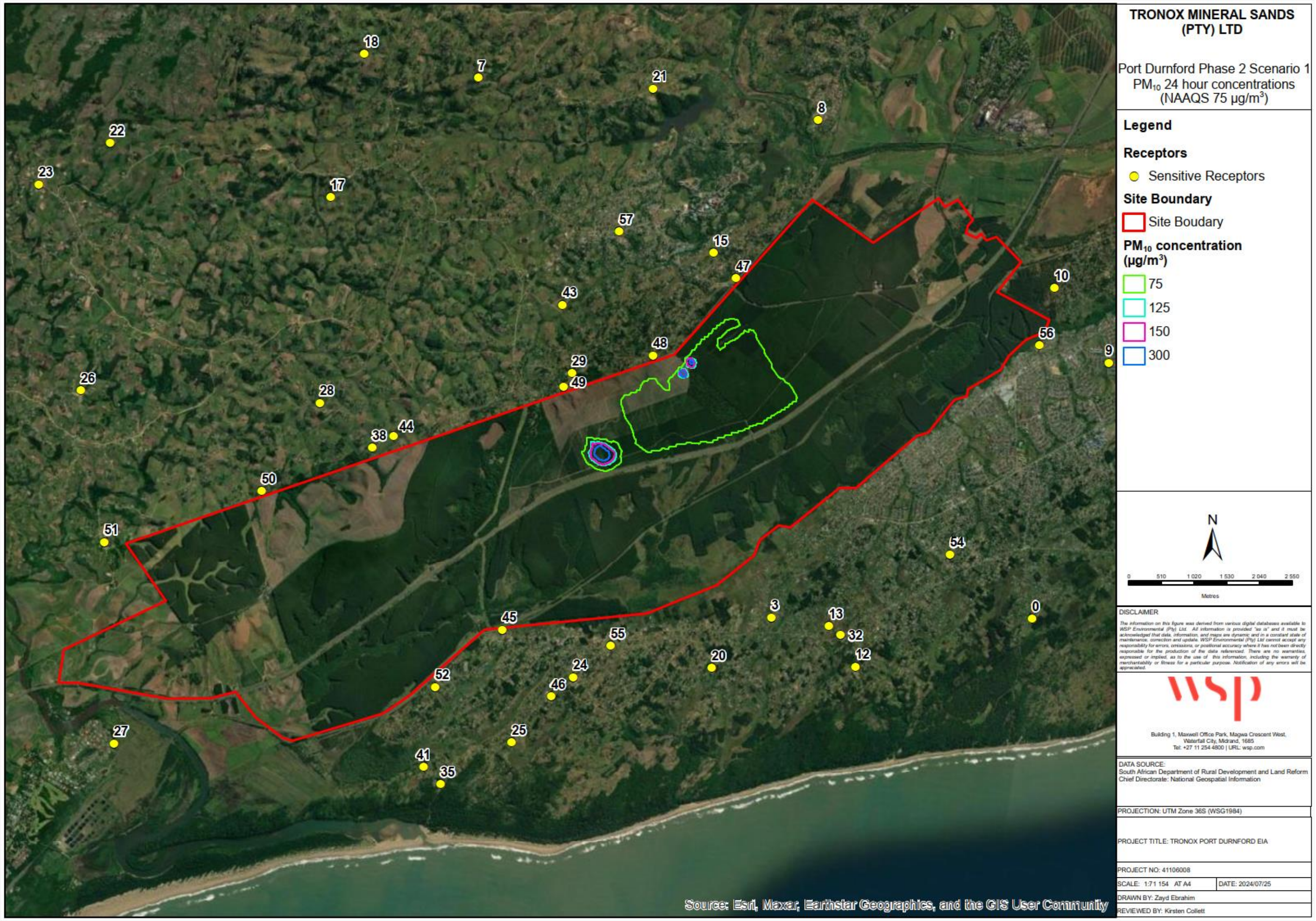


Figure 8-3: Scenario 1 predicted maximum 24-hour PM_{10} concentrations (P99)

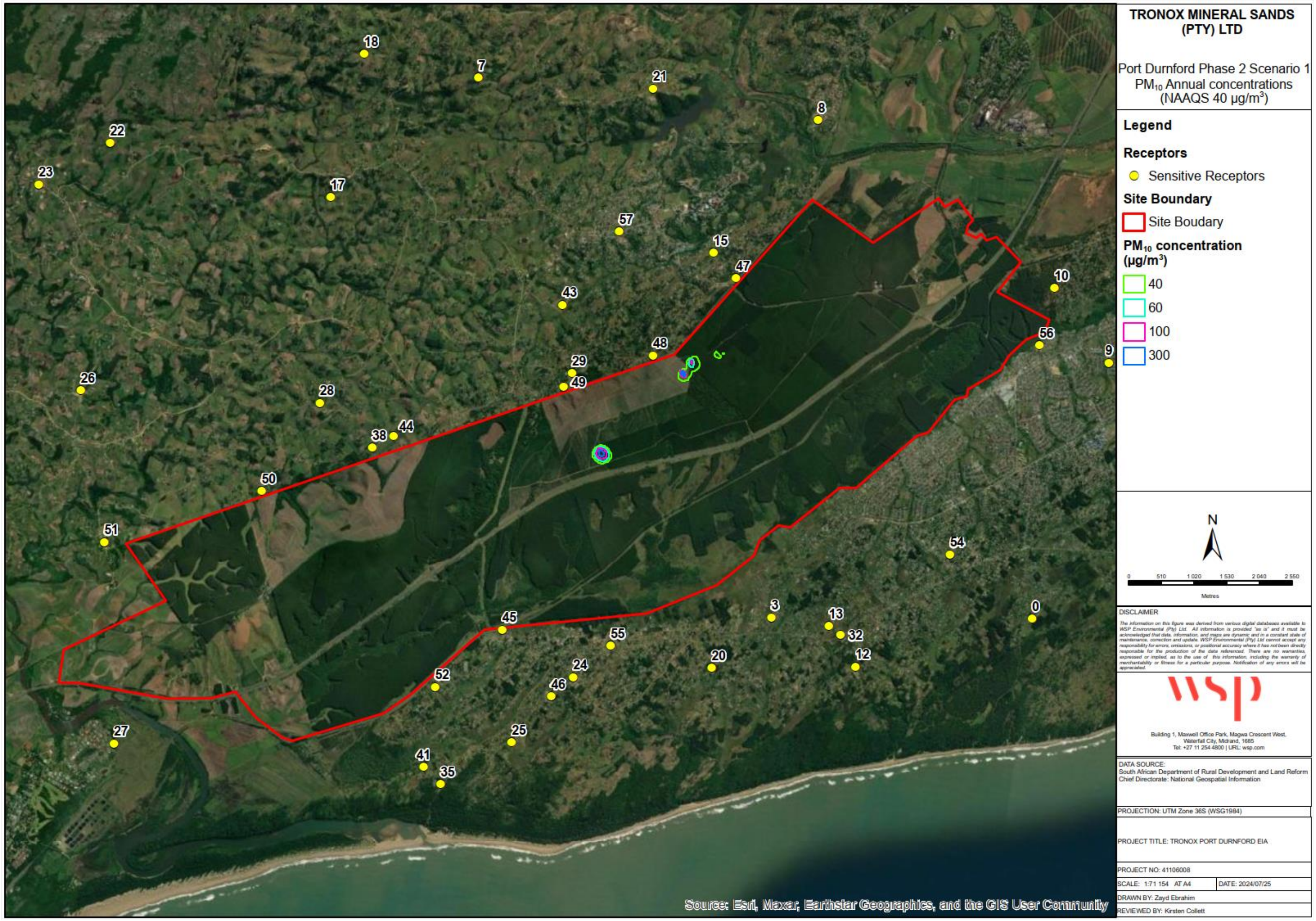


Figure 8-4: Scenario 1 predicted long-term average PM_{10} concentrations

Dust Fallout Predictions

Table 8-3 presents predicted 30-day average dust fallout rates at representative receptors for the proposed operations at Port Durnford, while **Figure 8-5** illustrates the dust fallout predicted rates. Key findings include:

- Exceedances of the residential standard are predicted to occur outside of the proposed fenceline boundary at twelve identified representative receptors:
  - Mhlanga Primary School (702.35 mg/m^2/day).
  - Muntonokudla Secondary School (640.08 mg/m^2/day).
  - Njomane Home (1,754.25 mg/m^2/day).
  - Nyembe (715.75 mg/m^2/day).
  - PD Seventh Day Adventist Church (1,485.62 mg/m^2/day).
  - Port Dunford (1,159.65 mg/m^2/day).
  - Qantayi High School (684.22 mg/m^2/day).
  - Residential Area 1 (663.54 mg/m^2/day).
  - Residential Area 2 (1,030.96 mg/m^2/day).
  - Residential Area 4 (2,033.14 mg/m^2/day).
  - Residential Area 6 (2,183.13 mg/m^2/day).
  - The Church of Jesus Christ (uMhlathuze City) (666.73 mg/m^2/day).
- The maximum predicted fenceline dust fallout rate was 3,278.53 mg/m^2/day, which occurs on the northern fenceline, exceeding the non-residential standard. Notably, the area of predicted exceedances is in close proximity to the fenceline.
- Highest predicted concentrations are predicted to occur in proximity to the PWP and DTMU's within the proposed development fenceline.

Table 8-3: Scenario 1 predicted dust fallout rates at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	Non-Residential Standard (mg/m^2/day)	Residential Standard (mg/m^2/day)	Dust Fallout Rate (mg/m^2/day)
5	Church of Jesus Christ of Latter Day Saints			321.42
6	Dube			75.25
10	Eniwe			154.84
11	eSikhawini H			126.32
12	Gobandlovu			140.32
15	Isikhalasenkosi High School			222.52
17	Khandisa			375.72
22	Mahunu		600	289.23
26	Mhlanga Primary School			**702.35**
27	Mntokhona Primary School			517.54
29	Mtunzini			428.67
30	Muntonokudla Secondary School			**640.08**
31	Mvuzemvuze Primary School			518.02
34	Ndabenkulu Temple			198.46

ID	Representative Receptor Name	Non-Residential Standard (mg/m²/day)	Residential Standard (mg/m²/day)	Dust Fallout Rate (mg/m²/day)
37	Nelisiwe Temple			470.18
40	Njomane Home			**1,754.25**
43	Nyembe			**715.75**
45	Ongoye			297.12
46	PD Seventh Day Adventist Church			**1,485.62**
47	Port Dunford			**1,159.65**
48	Qantayi High School			**684.22**
49	Residential Area 1			**663.54**
50	Residential Area 2			**1,030.96**
51	Residential Area 3			545.95
52	Residential Area 4			**2,033.14**
53	Residential Area 5			438.39
54	Residential Area 6			**2,183.13**
56	Sikhalasenkosi			170.58
57	The Church of Jesus Christ (uMhlathuze City)			**666.73**
58	Uzimgwenya			191.83
59	Vulindlelaa			200.46
	Highest Fence line Concentration [X: 390410m; Y: 6807555m]	1,200		**3,278.53**

Note: **Bold, red highlight** indicates exceedance of the National Dust Control Regulations Standard.

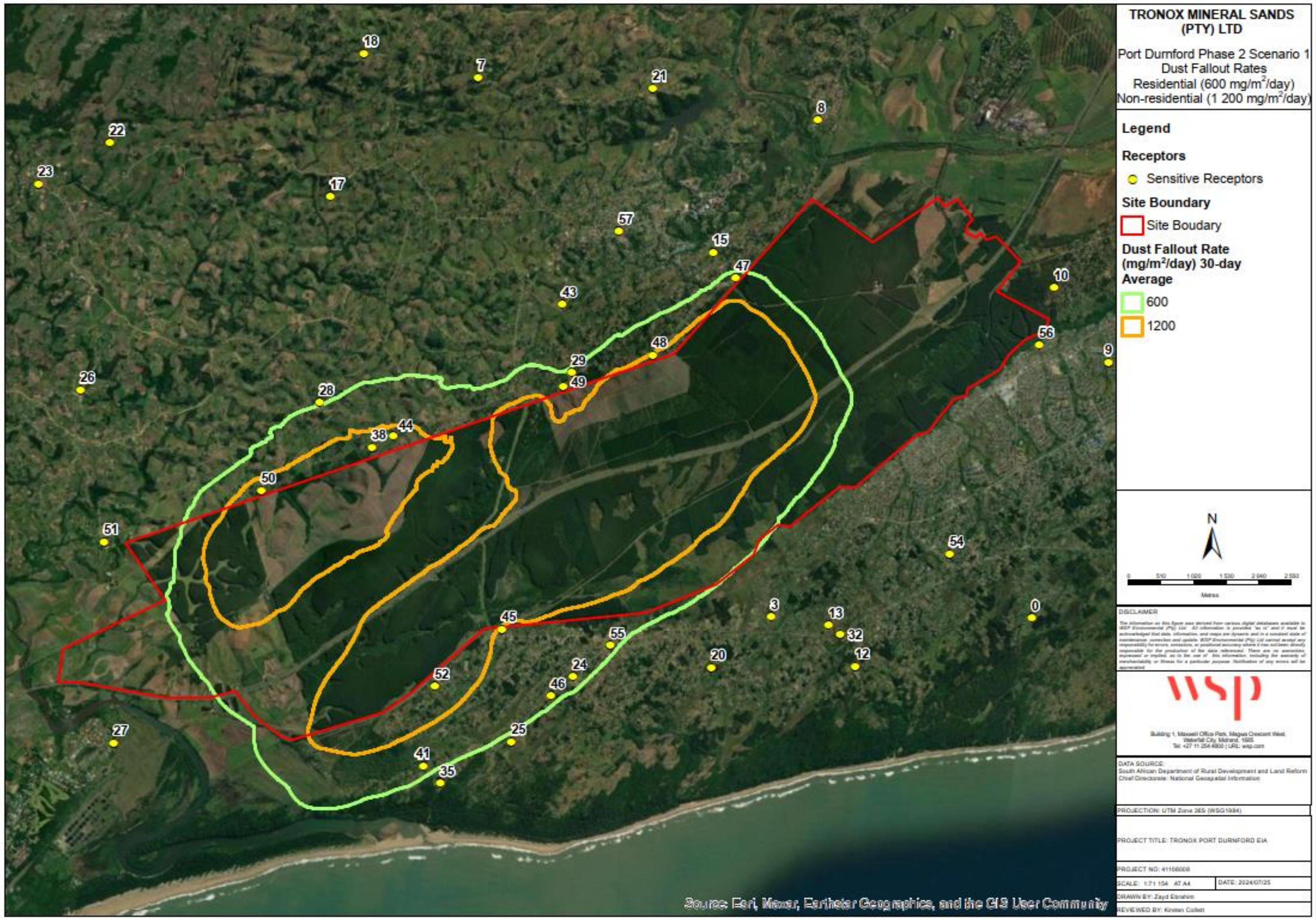


Figure 8-5: Scenario 1 predicted dust fallout rates

$PM_{2.5}$ Concentration Predictions

Table 8-4 presents predicted $PM_{2.5}$ concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-6** illustrates the maximum 24-hour $PM_{2.5}$ concentrations (P99) and **Figure 8-7** illustrates long-term average $PM_{2.5}$ concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_50 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 2 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

Table 8-4: Scenario 2 predicted $PM_{2.5}$ concentrations at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
5	Church of Jesus Christ of Latter Day Saints	40	2.6423	20	0.4545
6	Dube		0.9485		0.0994
10	Eniwe		1.2720		0.1500
11	eSikhawini H		1.2330		0.1398
12	Gobandlovu		1.1977		0.1515
15	Isikhalasenkosi High School		2.0663		0.3537
17	Khandisa		2.5030		0.3393
22	Mahunu		2.5011		0.4418
26	Mhlanga Primary School		2.7347		0.5653
27	Mntokhona Primary School		1.9328		0.4328
29	Mtunzini		0.9538		0.1362
30	Muntonokudla Secondary School		1.5199		0.1539
31	Mvuzemvuze Primary School		5.3750		0.5120
34	Ndabenkulu Temple		1.9423		0.3289
37	Nelisiwe Temple		1.9124		0.3592
40	Njomane Home		1.9611		0.2140
43	Nyembe		1.8244		0.3820
45	Ongoye		3.1954		0.3180
46	PD Seventh Day Adventist Church		2.1359		0.2335
47	Port Dunford		3.4066		0.7740
48	Qantayi High School		2.4094		0.5272
49	Residential Area 1		3.2281		0.4792

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
50	Residential Area 2		5.2471		0.8512
51	Residential Area 3		5.6124		0.5643
52	Residential Area 4		1.3195		0.1966
53	Residential Area 5		0.9628		0.1006
54	Residential Area 6		3.0472		0.8708
56	Sikhalasenkosi		1.8347		0.2720
57	The Church of Jesus Christ (uMhlathuze City)		3.2499		0.6643
58	Uzimgwenya		1.4720		0.1783
59	Vulindlelaa		1.7640		0.2237
	Maximum Fence line Concentration [X: 386420m; Y: 6804771m] – 24-Hour		14.6453		-
	Maximum Fence line Concentration [X: 384887m; Y: 6800035m] – Long Term		-		1.0069

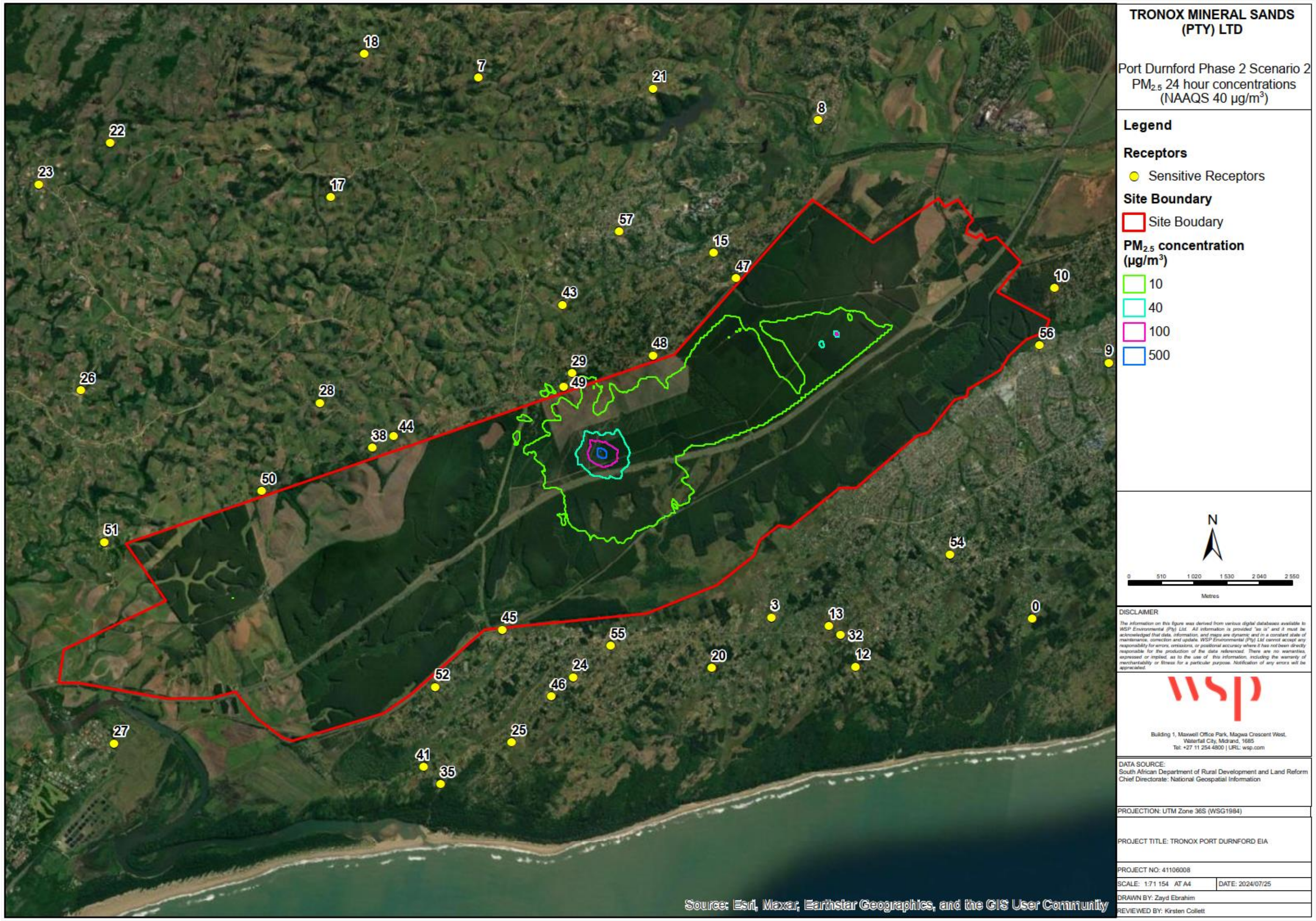


Figure 8-6: Scenario 2 predicted maximum 24-hour $PM_{2.5}$ concentrations (P99)

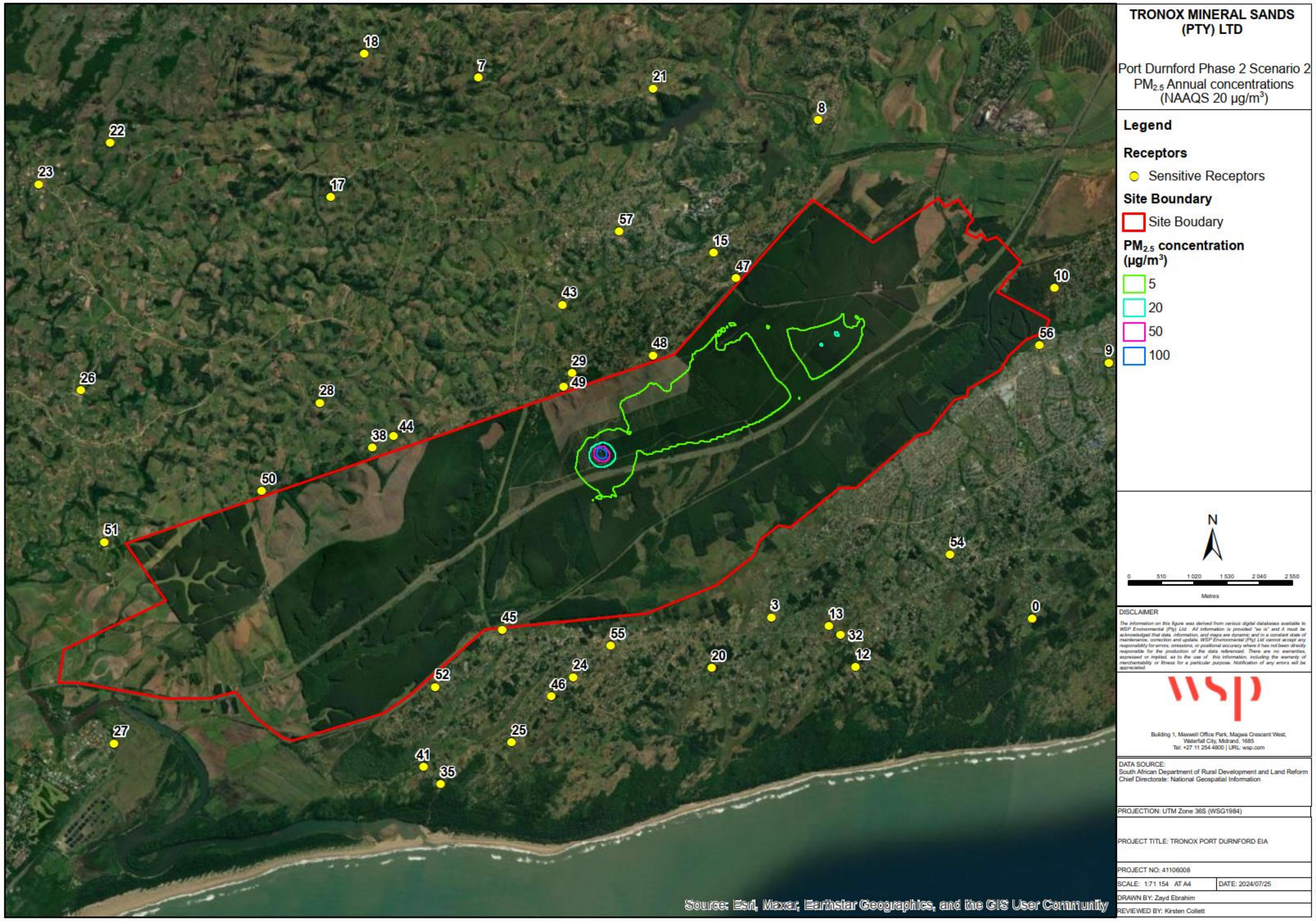


Figure 8-7: Scenario 2 predicted long-term average $PM_{2.5}$ concentrations

PM_{10} Concentration Predictions

Table 8-5 presents predicted PM_{10} concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-8** illustrates the maximum 24-hour PM_{10} concentrations (P99) and and **Figure 8-9** illustrates long-term average PM_{10} concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_49 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 2 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

Table 8-5: Scenario 2 predicted PM_{10} concentrations at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
5	Church of Jesus Christ of Latter Day Saints	75	11.2499	40	2.2855
6	Dube		5.7929		0.6448
10	Eniwe		6.8904		0.8758
11	eSikhawini H		7.2583		0.8798
12	Gobandlovu		6.6324		0.9447
15	Isikhalasenkosi High School		9.5568		1.8105
17	Khandisa		14.1744		1.8581
22	Mahunu		10.9202		2.2017
26	Mhlanga Primary School		11.7786		2.7871
27	Mntokhona Primary School		9.6556		2.3761
29	Mtunzini		5.9095		1.2073
30	Muntonokudla Secondary School		6.9451		1.5042
31	Mvuzemvuze Primary School		12.6011		2.4497
34	Ndabenkulu Temple		9.1308		1.6893
37	Nelisiwe Temple		9.4336		2.0882
40	Njomane Home		10.8068		3.1638
43	Nyembe		9.7909		2.2794
45	Ongoye		9.6111		1.5384
46	PD Seventh Day Adventist Church		10.3101		2.8672
47	Port Dunford		15.0364		4.2031
48	Qantayi High School		12.2307		2.7076
49	Residential Area 1		17.4243		2.7040
50	Residential Area 2		23.2781		4.4055

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
51	Residential Area 3		13.9271		2.7098
52	Residential Area 4		10.2188		2.9320
53	Residential Area 5		7.2338		0.8353
54	Residential Area 6		19.5225		5.4092
56	Sikhalasenkosi		9.4649		1.5198
57	The Church of Jesus Christ (uMhlathuze City)		14.5333		3.3128
58	Uzimgwenya		8.7962		1.1125
59	Vulindlelaa		9.3584		1.1607
	Maximum Fence line Concentration [X: 387652m; Y: 6805423m] – 24-Hour		28.4630		-
	Maximum Fence line Concentration [X: 384760m; Y: 6799882m] – Long Term		-		6.2955

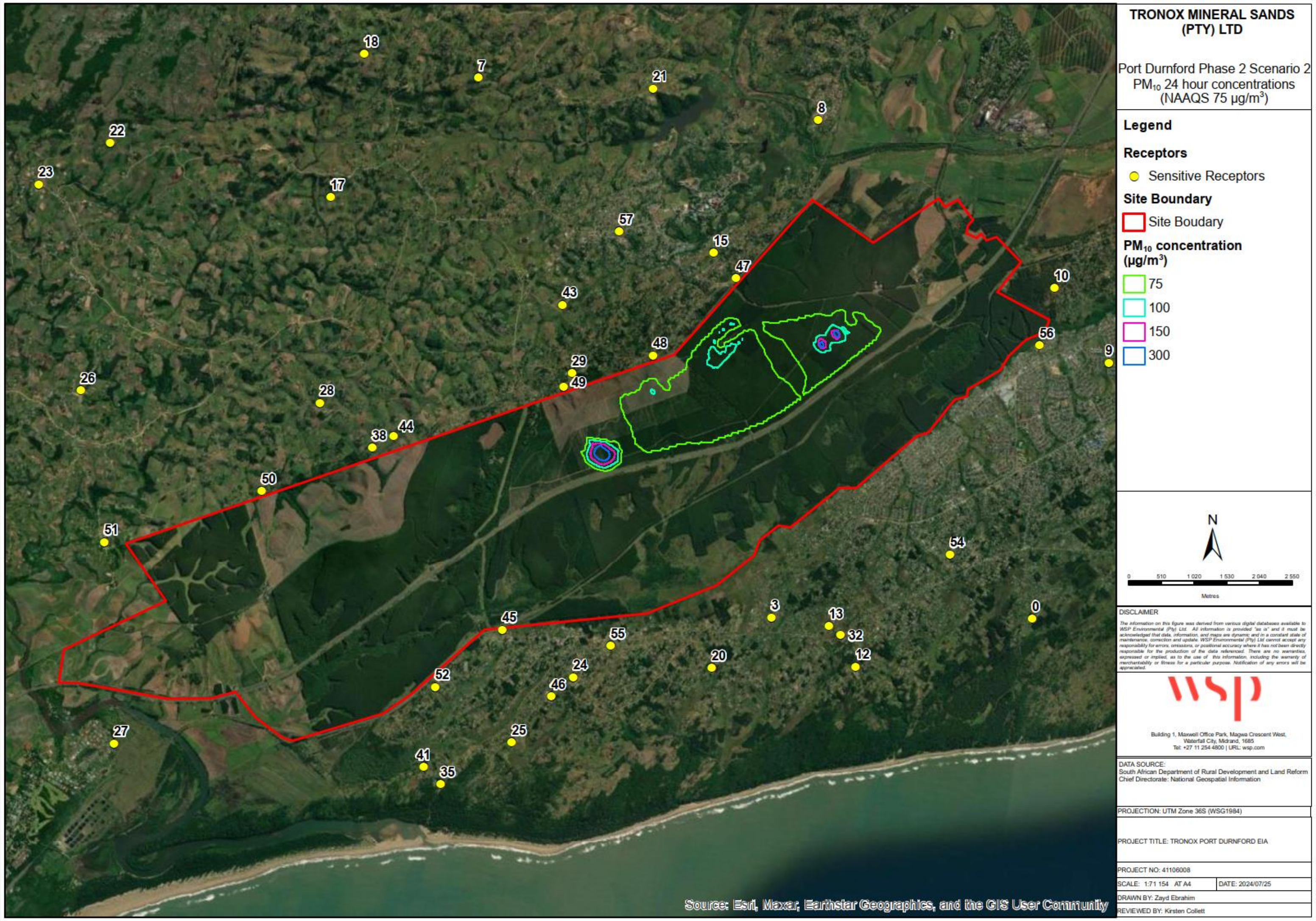


Figure 8-8: Scenario 2 predicted maximum 24-hour PM_{10} concentrations (P99)

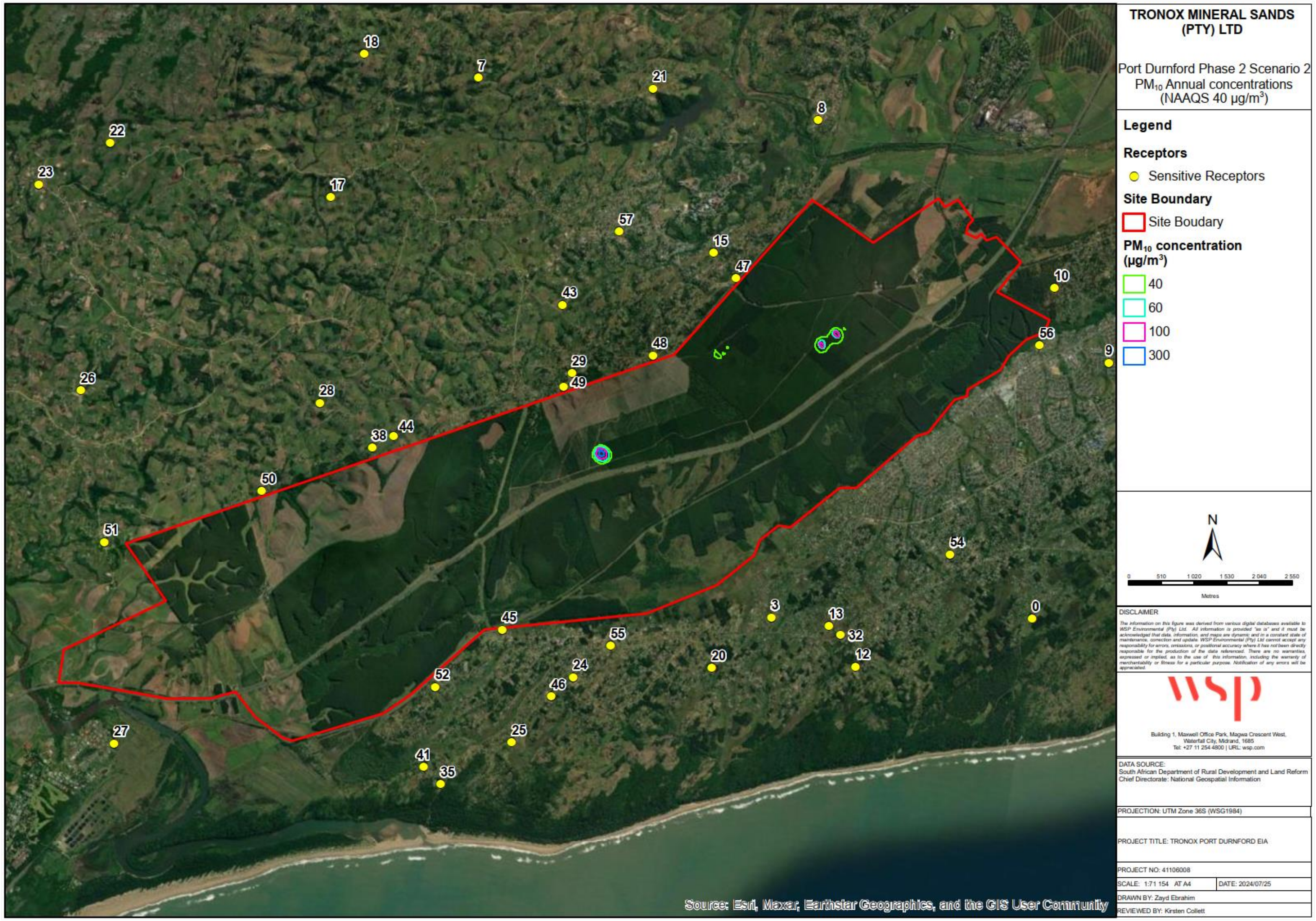


Figure 8-9: Scenario 2 predicted long-term average PM_{10} concentrations

Dust Fallout Predictions

Table 8-6 presents predicted 30-day average dust fallout rates at representative receptors for the proposed operations at Port Durnford, while **Figure 8-10** illustrates the dust fallout predicted rates. Key findings include:

- Exceedances of the residential standard are predicted to occur outside of the proposed fenceline boundary at thirteen identified representative receptors:
  - Mhlanga Primary School (706.65 mg/m^2/day).
  - Mvuzemvuze Primary School (637.89 mg/m^2/day).
  - Njomane Home (1,721.44mg/m^2/day).
  - Nyembe predicted (711.29 mg/m^2/day).
  - PD Seventh Day Adventist Church (1,440.05 mg/m^2/day).
  - Port Dunford (1,178.83 mg/m^2/day).
  - Qantayi High School (690.04mg/m^2/day).
  - Residential Area 1 (671.50 mg/m^2/day).
  - Residential Area 2 (1,259.00 mg/m^2/day).
  - Residential Area 3 (760.92 mg/m^2/day).
  - Residential Area 4 (1,683.85 mg/m^2/day).
  - Residential Area 6 (2,162.82 mg/m^2/day).
  - The Church of Jesus Christ (uMhlathuze City) (672.83 mg/m^2/day).
- The maximum predicted fenceline dust fallout rate was 3,250.20 mg/m^2/day, which occurs on the northern fenceline, exceeding the non-residential standard. Notably, the area of predicted exceedances is in close proximity to the fenceline.
- Highest predicted concentrations are predicted to occur in proximity to the PWP and DTMU's within the proposed development fenceline.

Table 8-6: Scenario 2 predicted dust fallout rates at representative receptors within 2km of the site boundary

ID	Representative Receptor Name	Non-Residential Standard (mg/m^2/day)	Residential Standard (mg/m^2/day)	Dust Fallout Rate (mg/m^2/day)
5	Church of Jesus Christ of Latter Day Saints		600	302.78
6	Dube			52.85
10	Eniwe			129.87
11	eSikhawini H			81.70
12	Gobandlovu			91.00
15	Isikhalasenkosi High School			204.48
17	Khandisa			401.21
22	Mahunu			277.96
26	Mhlanga Primary School			**706.65**
27	Mntokhona Primary School			522.35
29	Mtunzini			232.16
30	Muntonokudla Secondary School			586.03
31	Mvuzemvuze Primary School			**637.89**

ID	Representative Receptor Name	Non-Residential Standard (mg/m²/day)	Residential Standard (mg/m²/day)	Dust Fallout Rate (mg/m²/day)
34	Ndabenkulu Temple			180.03
37	Nelisiwe Temple			473.02
40	Njomane Home			**1,721.44**
43	Nyembe			**711.29**
45	Ongoye			328.12
46	PD Seventh Day Adventist Church			**1,440.05**
47	Port Dunford			**1,178.83**
48	Qantayi High School			**690.04**
49	Residential Area 1			**671.50**
50	Residential Area 2			**1,259.00**
51	Residential Area 3			**760.92**
52	Residential Area 4			**1,683.85**
53	Residential Area 5			216.02
54	Residential Area 6			**2,162.82**
56	Sikhalasenkosi			131.80
57	The Church of Jesus Christ (uMhlathuze City)			**672.83**
58	Uzimgwenya			109.27
59	Vulindlelaa			206.99
	Highest Fence line Concentration [X: 390410m; Y: 6807555m]	1,200		**3,250.20**

Note: **Bold, red highlight** indicates exceedance of the National Dust Control Regulations Standard.

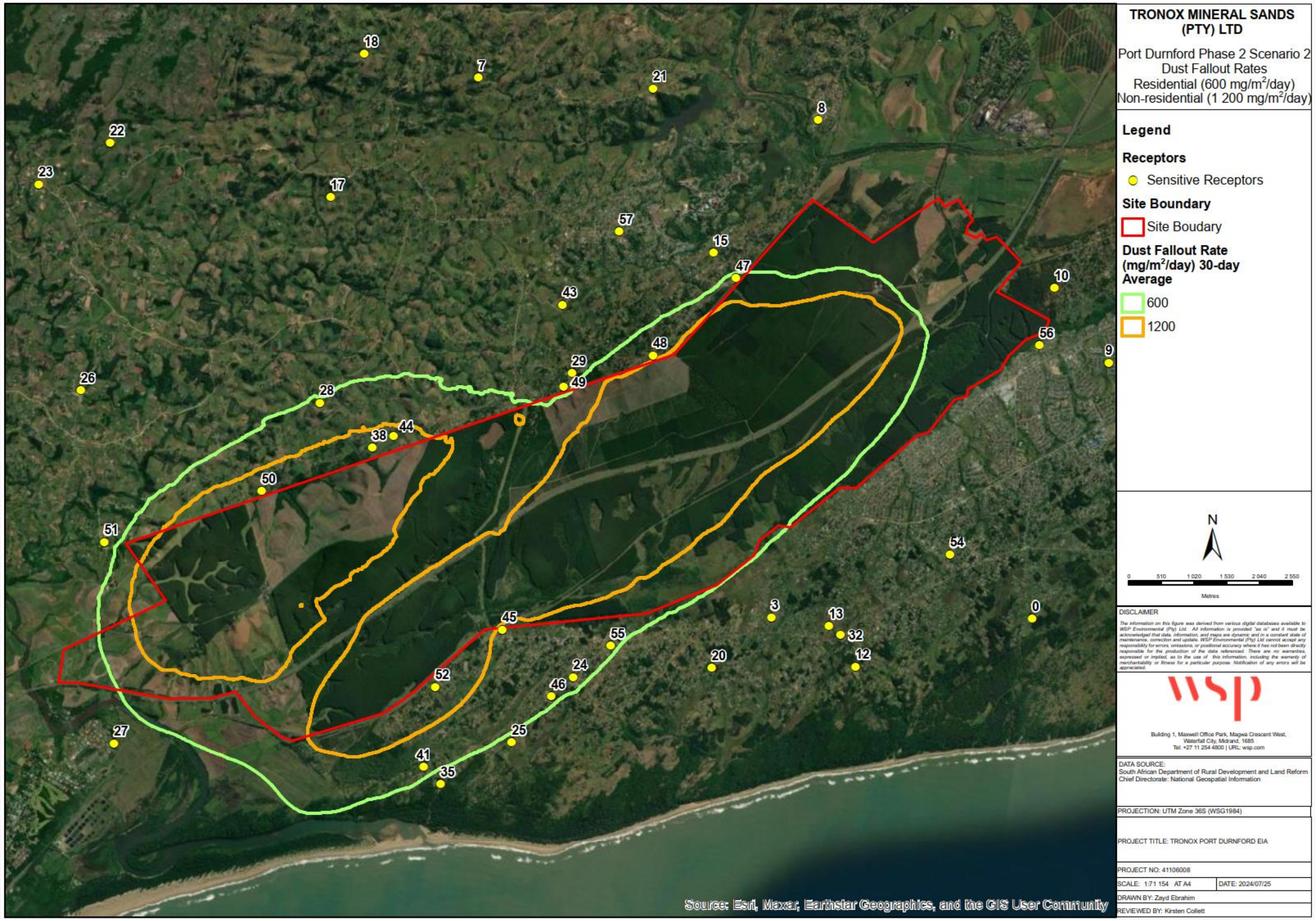


Figure 8-10: Scenario 2 predicted dust fallout rates

PHASE 2 SCENARIO 3

$PM_{2.5}$ Concentration Predictions

Table 8-7 presents predicted $PM_{2.5}$ concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-11** illustrates the maximum 24-hour $PM_{2.5}$ concentrations (P99) and **Figure 8-12** illustrates long-term average $PM_{2.5}$ concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_48 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 3 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline remaining below the relevant NAAQS.

Table 8-7: Scenario 3 predicted $PM_{2.5}$ concentrations at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
5	Church of Jesus Christ of Latter Day Saints	40	1.1517	20	0.2136
6	Dube		0.7353		0.0866
10	Eniwe		1.3250		0.1449
11	eSikhawini H		0.8615		0.1207
12	Gobandlovu		1.2707		0.1681
15	Isikhalasenkosi High School		1.1227		0.1714
17	Khandisa		1.7677		0.2531
22	Mahunu		0.9897		0.2043
26	Mhlanga Primary School		1.2200		0.2543
27	Mntokhona Primary School		0.9052		0.1905
29	Mtunzini		0.6944		0.1160
30	Muntonokudla Secondary School		1.0603		0.1402
31	Mvuzemvuze Primary School		2.2721		0.3811
34	Ndabenkulu Temple		1.0526		0.1597
37	Nelisiwe Temple		0.8604		0.1701
40	Njomane Home		1.7704		0.2587
43	Nyembe		0.8355		0.1770
45	Ongoye		1.5966		0.2278
46	PD Seventh Day Adventist Church		1.9293		0.2854
47	Port Dunford		1.5253		0.3573
48	Qantayi High School		1.3091		0.2342
49	Residential Area 1		3.0843		0.4548

ID	Representative Receptor Name	24-Hour NAAQS ($\mu g/m^3$)	24-Hour Maximum ($\mu g/m^3$)	Annual NAAQS ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
50	Residential Area 2		1.4956		0.2953
51	Residential Area 3		2.7569		0.4973
52	Residential Area 4		1.1647		0.1892
53	Residential Area 5		0.7771		0.0858
54	Residential Area 6		1.2324		0.2881
56	Sikhalasenkosi		0.9620		0.1539
57	The Church of Jesus Christ (uMhlathuze City)		1.3484		0.2778
58	Uzimgwenya		1.0490		0.1719
59	Vulindlelaa		1.0349		0.1529
	Maximum Fence line Concentration [X: 389904m; Y: 6807803m] – 24-Hour		5.3325		-
	Maximum Fence line Concentration [X: 390410m; Y: 6807555m] – Long Term		-		1.0625

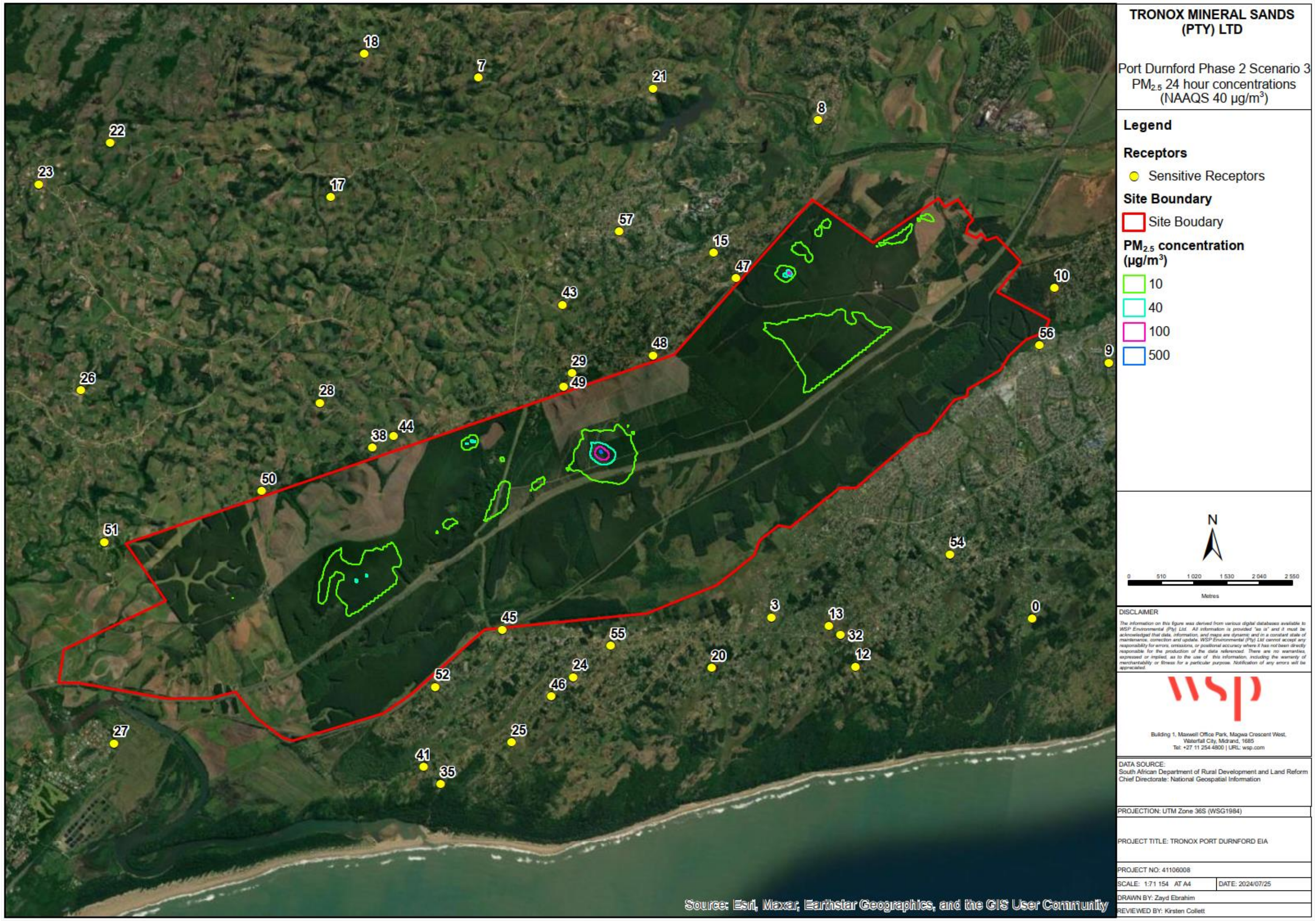


Figure 8-11: Scenario 3 predicted maximum 24-hour $PM_{2.5}$ concentrations (P99)

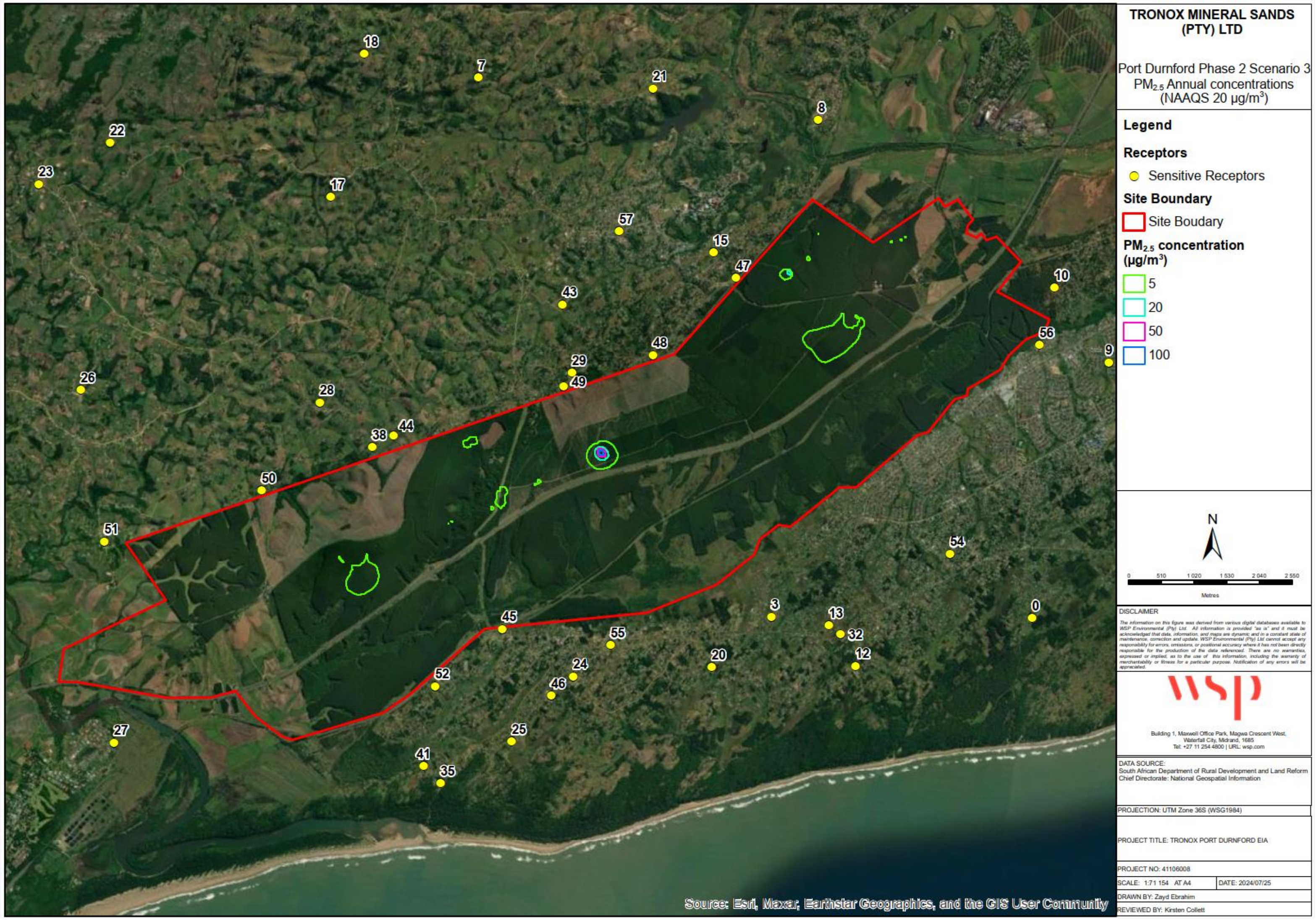


Figure 8-12: Scenario 3 predicted long-term average $PM_{2.5}$ concentrations

PM_{10} Concentration Predictions

Table 8-8 presents predicted PM_{10} concentrations at representative receptors for the proposed operations at Port Durnford. **Figure 8-13** illustrates the maximum 24-hour PM_{10} concentrations (P99) and **Figure 8-14** illustrates long-term average PM_{10} concentrations. Key findings include:

- All representative receptor concentrations are well below the 24-hour average and annual standards for the proposed operations, with highest concentrations predicted at the R_49 receptor, although remaining well below the relevant NAAQS.
- The maximum fenceline concentrations predicted for Scenario 3 are well below the 24-hour average and annual standards for the proposed operations.
- Exceedances of the NAAQS are predicted to occur within the fenceline of the proposed development.
- Highest predicted concentrations are in close proximity of the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline remaining below the relevant NAAQS.

Table 8-8: Scenario 3 predicted PM_{10} concentrations at representative receptors within 2km of the site boundary

ID	Representative Receptor Name	24-Hour NAAQS ($\mu g/m^3$)	24-Hour Maximum ($\mu g/m^3$)	Annual NAAQS ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
5	Church of Jesus Christ of Latter Day Saints	75	6.9174	40	1.2685
6	Dube		4.5819		0.5516
10	Eniwe		8.7849		0.9243
11	eSikhawini H		5.3702		0.7699
12	Gobandlovu		8.3865		1.0844
15	Isikhalasenkosi High School		6.7355		1.0236
17	Khandisa		11.4756		1.5827
22	Mahunu		5.6840		1.2110
26	Mhlanga Primary School		7.9119		1.5002
27	Mntokhona Primary School		5.8456		1.1586
29	Mtunzini		4.3351		0.7479
30	Muntonokudla Secondary School		6.6796		0.8825
31	Mvuzemvuze Primary School		11.3998		2.2908
34	Ndabenkulu Temple		6.3859		0.9550
37	Nelisiwe Temple		5.4721		1.0517
40	Njomane Home		10.7208		1.6410
43	Nyembe		5.3778		1.1020
45	Ongoye		8.7665		1.3654
46	PD Seventh Day Adventist Church		11.4638		1.8053
47	Port Dunford		9.9168		2.1844
48	Qantayi High School		7.7220		1.3973
49	Residential Area 1		20.0331		2.9063
50	Residential Area 2		8.8405		1.6821

ID	Representative Receptor Name	24-Hour NAAQS (µg/m³)	24-Hour Maximum (µg/m³)	Annual NAAQS (µg/m³)	Annual Average (µg/m³)
51	Residential Area 3		13.8739		3.0420
52	Residential Area 4		7.2201		1.2197
53	Residential Area 5		5.0897		0.5493
54	Residential Area 6		7.8623		1.8187
56	Sikhalasenkosi		5.9433		0.9481
57	The Church of Jesus Christ (uMhlathuze City)		7.7068		1.6314
58	Uzimgwenya		6.9377		1.1054
59	Vulindlelaa		6.3315		0.9265
	Maximum Fence line Concentration [X: 389904m; Y: 6807803m] – 24-Hour		34.9159		-
	Maximum Fence line Concentration [X: 390410m; Y: 6807555m] – Long Term		-		7.0452

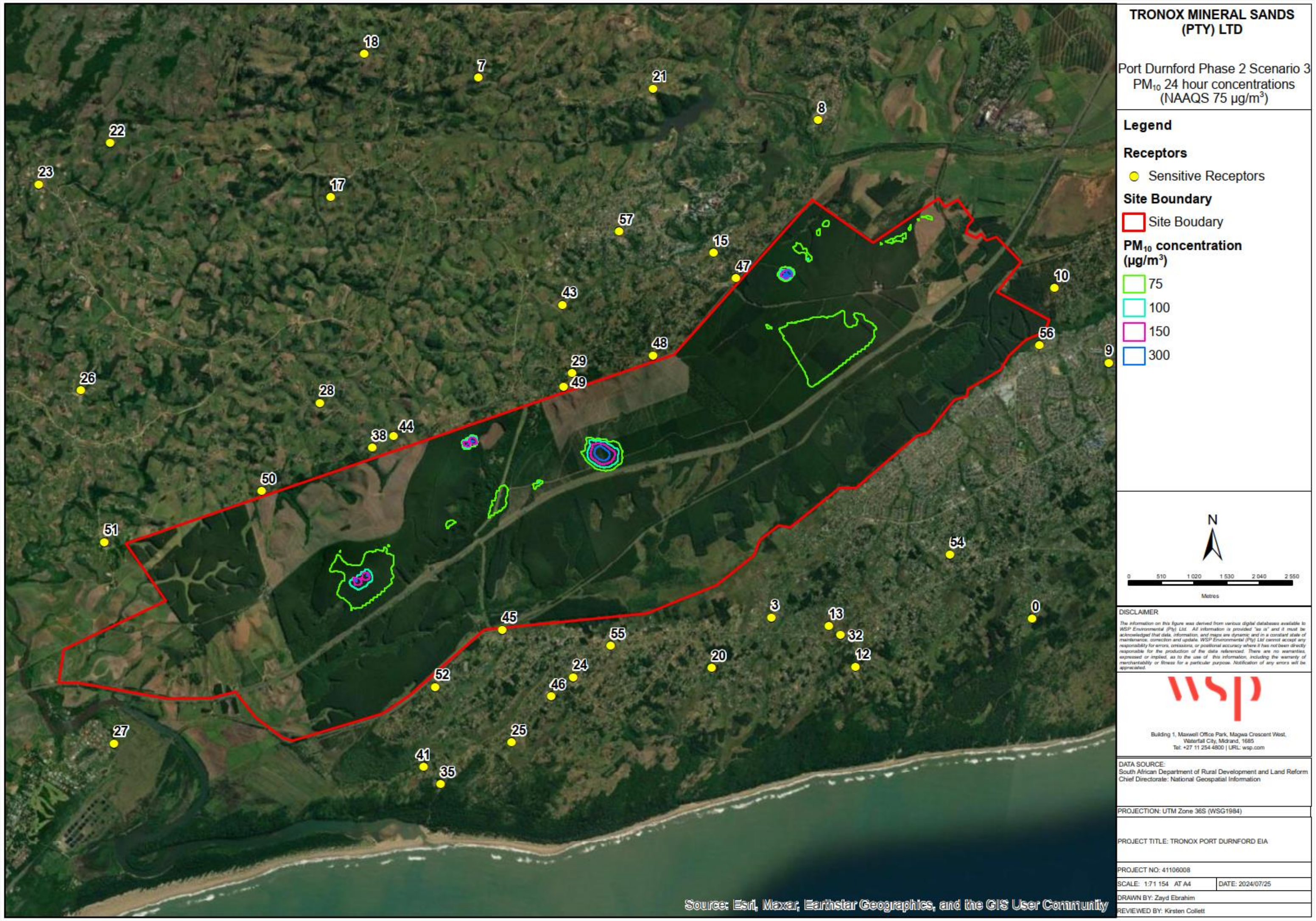


Figure 8-13: Scenario 3 predicted maximum 24-hour PM_{10} concentrations (P99)

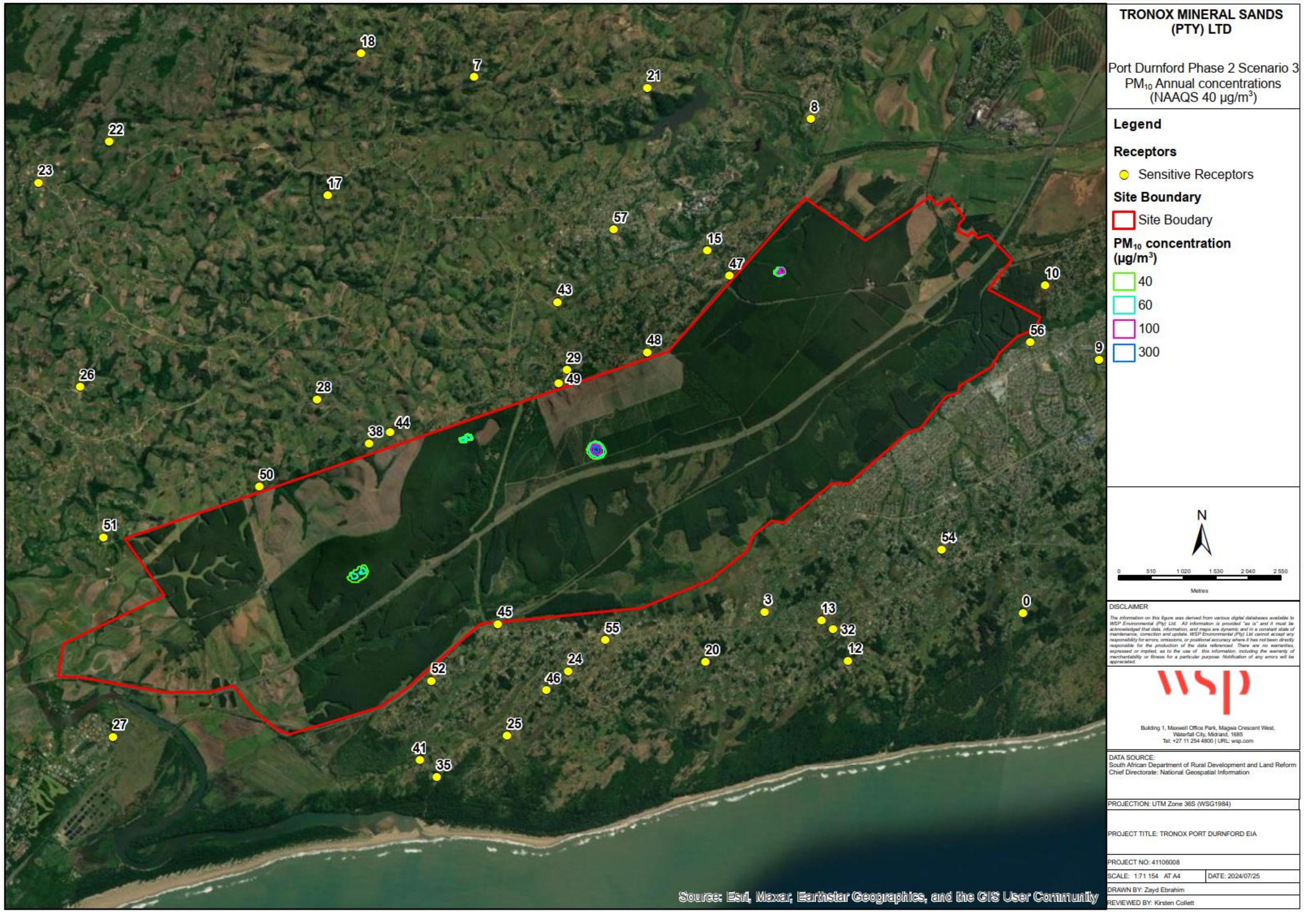


Figure 8-14: Scenario 3 predicted long-term average PM_{10} concentrations

Dust Fallout Predictions

Table 8-9 presents predicted 30-day average dust fallout rates at representative receptors for the proposed operations at Port Durnford, while **Figure 8-15** illustrates the dust fallout predicted rates. Key findings include:

- Exceedances of the residential standard are predicted to occur outside of the proposed fenceline boundary at three identified representative receptors:
  - Mvuzemvuze Primary School (839.48 mg/m^2/day).
  - Residential Area 1 (885.93 mg/m^2/day).
  - Residential Area 3 (1,249.42 mg/m^2/day).
- The maximum predicted fenceline dust fallout rate was 2,831.45 mg/m^2/day, which occurs on the northern fenceline, exceeding the non-residential standard. Notably, the area of predicted exceedances is in close proximity to the fenceline.
- Highest predicted concentrations are predicted to occur in proximity to the PWP and DTMU's within the proposed development fenceline.

Table 8-9: Scenario 3 predicted dust fallout rates at representative receptors within 2 km of the site boundary

ID	Representative Receptor Name	Non-Residential Standard (mg/m^2/day)	Residential Standard (mg/m^2/day)	Dust Fallout Rate (mg/m^2/day)
5	Church of Jesus Christ of Latter Day Saints		600	190.81
6	Dube			78.92
10	Eniwe			177.67
11	eSikhawini H			113.21
12	Gobandlovu			191.06
15	Isikhalasenkosi High School			128.59
17	Khandisa			345.75
22	Mahunu			188.04
26	Mhlanga Primary School			237.32
27	Mntokhona Primary School			187.47
29	Mtunzini			312.59
30	Muntonokudla Secondary School			197.66
31	Mvuzemvuze Primary School			**839.48**
34	Ndabenkulu Temple			117.39
37	Nelisiwe Temple			176.90
40	Njomane Home			430.27
43	Nyembe			216.59
45	Ongoye			283.05
46	PD Seventh Day Adventist Church			474.95
47	Port Dunford			460.14
48	Qantayi High School			213.53
49	Residential Area 1			**885.93**

ID	Representative Receptor Name	Non-Residential Standard (mg/m²/day)	Residential Standard (mg/m²/day)	Dust Fallout Rate (mg/m²/day)
50	Residential Area 2			561.35
51	Residential Area 3			**1,249.42**
52	Residential Area 4			559.00
53	Residential Area 5			271.55
54	Residential Area 6			400.37
56	Sikhalasenkosi			122.74
57	The Church of Jesus Christ (uMhlathuze City)			258.15
58	Uzimgwenya			196.21
59	Vulindlelaa			173.06
	Highest Fence line Concentration [X: 390410m; Y: 6807555m]	1,200		**2,831.45**
Note: **Bold, red highlight** indicates exceedance of the National Dust Control Regulations Standard.				

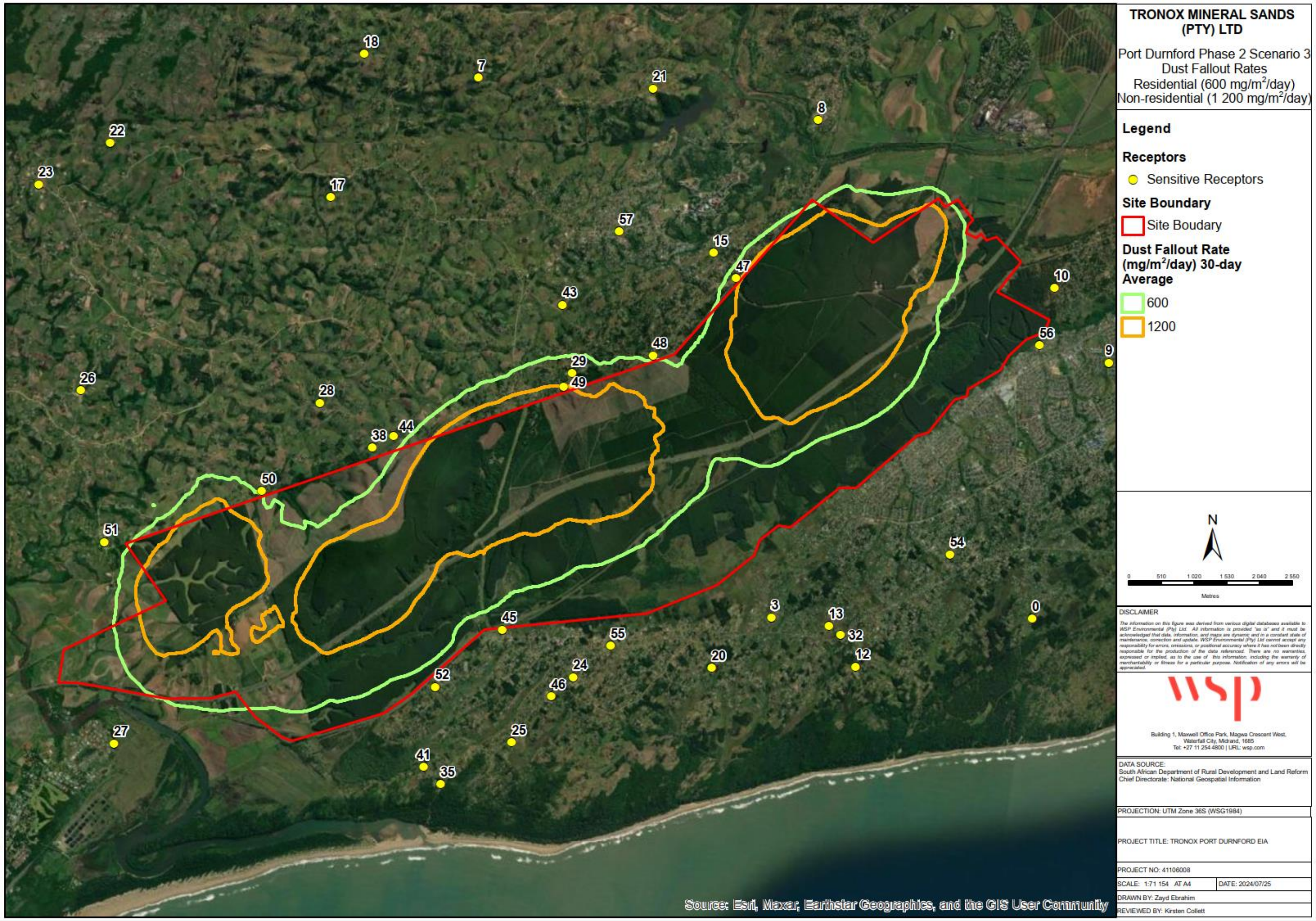


Figure 8-15: Scenario 3 predicted dust fallout rates

CUMULATIVE ASSESSMENT

The National Framework for Air Quality Management in South Africa calls for air quality assessment in terms of cumulative impacts rather than the contributions from an individual facility. Compliance with the NAAQS is to be determined by considering all local and regional contributions to background concentrations. For each averaging time, the sum of the model predicted concentration (C_P) and the background concentration (C_B) must be compared with the NAAQS. The background concentration must be the sum of contributions from non-modelled local sources and regional background air quality. If the sum of background and predicted concentrations ($C_B + C_P$) is more than the NAAQS, the design of the facility must be reviewed (including pollution control equipment) to ensure compliance with NAAQS. Compliance assessments must provide room for future permits to new emissions sources, while maintaining overall compliance with NAAQS. For the different facility locations and averaging times, the comparisons with NAAQS must be based on recommendations in **Table 8-10**.

Table 8-10: Summary of recommended procedures for assessing compliance with NAAQS

Facility Location	Annual NAAQS	Short-term NAAQS (24 hours or less)
Isolated facility not influenced by other sources, C_B insignificant*	Highest C_P must be less than the NAAQS, no exceedances allowed.	99th percentile concentrations must be less than the NAAQS. Wherever on year is modelled, the highest concentrations shall be considered.
Facilities influenced by background sources e.g. in urban areas and priority areas.	Sum of the highest C_P and background C_B must be less than the NAAQS, no exceedances allowed.	Sum of the 99th percentile concentrations and background C_B must be less than the NAAQS. Wherever one year is modelled, the highest concentrations shall be considered.

*For an isolated facility influenced by regional background pollution C_B must be considered.

Given the scale of the Phase 1 operations and the local vegetation surrounding the proposed operations, it is conservatively assumed that there will be negligible impact from the Phase 1 operations occurring at significant distance from the operations. As such, emissions from Phase 1 were not quantified and a cumulative impact of Phase 1 is not assessed here.

Given that the Phase 2 operational period will succeed the Fairbreeze and Phase 1 operations, and commence in 2036, it has been deemed that the current ambient (background) concentrations are not representative of that period. As such a cumulative assessment has not been undertaken. A cumulative assessment should be conducted closer to the start of Phase 2 operations to determine the predicted impact.

Since only dust fallout is predicted to exceed across Port Durnford's boundary, further insight into potential cumulative impacts is provided here. Based on the Fairbreeze dust monitoring data, the nearest representative monitoring location (Town Park) is approximately 5.3 km southwest of the proposed Phase 2 operations, within the Mtunzini estate. The average recorded dust fallout rate for the period of 2022 – 2024 was 469.03 mg/m^2/day. The maximum predicted dust fallout rate from the modelling results at that monitoring location is 41.36 mg/m^2/day. Given this, the average cumulative dust fallout rate at this location is predicted to be 510.39 mg/m^2/day, below the National Dust Control Regulations Residential limit of 600 mg/m^2/day. It is important to note that Phase 2 operations will succeed the Fairbreeze operations, with no mining activity occurring at the Fairbreeze facility. As such, this current monitored baseline value may be lower and will not apply in the future.

MITIGATION RECOMMENDATIONS

Given the impact of the operation of the proposed Port Durnford Mine on the surrounding ambient air quality, mitigation interventions are required. Below are mitigation interventions proposed by Tronox:

- Wetting of material prior to feeding into the DTMUs.
- Hydraulically transferred material will be deposited wet on relevant stockpiles and pits during backfilling.
- Use of water sprayers in the PWP screening and crushing processes.
- Rehabilitation and vegetation of legacy stockpiles and backfilled areas.

Additional recommended mitigation measures include:

- Identification of exposed areas not used for operations and revegetate these to reduce the amount of dust available for wind entrainment.
- Ensure access control to exposed areas reducing activity and wind entrainment.
- Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment.
- Where possible do not undertake material handling activities during windy conditions, considered to occur when constant wind speed is greater than 6 m/s (Kurosaki & Mikami, 2006).
- Where possible undertake dust producing activities as far as practically possible from receiving receptors.
- Developing a mechanism to record and respond to complaints.
- Development of a dust fallout monitoring network to identify areas of concern.

It is recommended that Tronox establish a dust fallout monitoring network around the proposed development fenceline to determine dust emissions from the proposed operations at the surrounding receptors. **Figure 8-16** below, represents the proposed dust fallout monitoring network. Due to the sensitive nature of the surrounding areas, monitoring locations at/near sensitive receptors (residential monitoring) were prioritized over fenceline receptors (non-residential monitoring). The monitoring locations were determined by the predicted dust fallout dispersion for each proposed phase assessed in previous sections; potential location security such as schools, gated communities, government buildings; and facilities with pre-existing security measures, such as electrical terminals. Non-residential monitoring may be conducted, in the event that exceedances of the National Dust Control Residential standards are identified at the proposed monitoring locations.

Given that the dominant winds occur in a south-west to north-east direction, it is further recommended that an active particulate matter monitoring station, with a meteorological station, is placed to the southwest of the proposed development fenceline. The most suitable location identified is within the Mtunzini estate. **Figure 8-16** below, represents the proposed location of the monitoring stations.

8.3 DECOMMISSIONING PHASE

Since similar equipment used during the construction phase will be utilised during the decommissioning phase, the same impacts and mitigation recommendations provided for the construction phase are applicable to the decommissioning phase.

Figure 8-16: Proposed monitoring network

9 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are applicable to this AQIA:

- Unless otherwise stated, operational information was provided by Tronox. Any errors, limitations, or assumptions inherent in these datasets extend to this study.
- This AQIA assumes that the meteorological data is representative of the site.
- Measured ambient concentrations are representative of the background conditions in and around the Tronox Port Durnford site.
- Due to lack of construction phase specifications and the erratic nature of such a phase, a qualitative assessment of construction phase air quality impacts was rather undertaken.
- Given that the proposed operations involve mining operations, only particulate related pollutants are of concern, and therefore assessed in this AQIA, namely Particulate Matter (PM as PM_{10}, $PM_{2.5}$ and dust fallout [calculated as Total Suspended Particulates (TSP)]).
- At the time of reporting, the layout of the Phase 2 operations had not been finalised. Minor changes to the topsoil stockpile locations would occur, however, emissions from such a source are negligible and would not have affected the dispersion model results.
- During Phase 1, all process material is to be transported to Fairbreeze PWP. It is assumed that emissions relating to the processing and handling of the material is accounted for in the Fairbreeze mine emissions quantification.
- The exact locations of equipment in each active mining pit or RSF or sand tails area were assumed. Where feasible, sources were placed in closest proximity to the Project boundary nearest to a sensitive receptor in order to represent a worst-case situation.
- It is assumed that material handled will be wet when deposited on open surfaces. An assumed mitigation factor of 50% was applied as per the Australian Government National Pollutant Inventory.
- Assumed emissions from offloading of tailings will be negligible as the material will be wet when handled and pumped to the discharge stockpiles.
- It is proposed that stockpile and mined out areas will be rehabilitated as the operations progress. It was assumed that legacy operations will have a dust mitigation factor of 99% for vegetated areas.
- It was indicated by Tronox that the normal operating period of Phase 1 is proposed to be five days per week per month for twelve hours a day. Given the intermittent and short operating period, it is assumed that emissions from Phase 1 operations are negligible and as such dispersion model simulations were not conducted for Phase 1.
- Port Durnford operations will include the backfilling of mined out areas. It was assumed that backfilling will occur up to the original topographical height. It was assumed that wind erosion will occur at ground level.
- Assumed material handling emissions from backfilling of mined out areas will be negligible as the material will be wet when handled.
- During Phase 2, all process material is to be transported to Empangeni MSP. It is assumed that emissions relating to the processing and handling of the material at MSP is accounted for in the Empangeni emissions quantification.

- Unpaved roads during phase 2 will consist of the service roads, which will not be traversed by haul trucks. It is assumed that the roads will be used intermittently and that resulting emissions will be negligible and as such have not been included in the dispersion model.
- Given that the paved road network consists of National public roads, it is assumed that the addition to traffic from the Port Durnford proposed operations will be negligible and as such, emissions from paved roads were not included in the dispersion model.
- A cumulative impact assessment could not be conducted as current ambient data was deemed to not be representative of the operational phase.
- It was conservatively assumed that 15% of PM_{10} related emissions from area sources, will comprise $PM_{2.5}$ as per the US EPA database.

10 ASSESSMENT OF IMPACTS

The purpose of this Air Quality Impact Assessment is to identify the potential impacts and associated risks posed by the operation of the proposed Port Durnford Project on the air pollution of the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward in order to ensure that these risks do not result in unacceptable social or environmental risk.

All impacts of the operation of the proposed Project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the nature, significance, consequence, extent, reversibility, duration and probability of occurrence. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix A**. Key localised air quality impacts associated with the project include:

- Construction phase impacts of air emissions on sensitive receptors.
- Phase 1 operational impacts of air emissions on sensitive receptors.
- Phase 2 operational impacts of air emissions on sensitive receptors.
- Decommissioning phase impacts of air emissions on sensitive receptors.

Outcomes of the Air Quality Impact Assessment are contained within **Table 10-1** outlining the impact of each parameter and the resulting risk level.

Table 10-1: Impact assessment of risks associated with the Port Durnford Project

Activity	Potential Impact	Aspects Affected	Phase in which impact is anticipated	Size and Scale of Disturbance	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance without Mitigation	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type	Standards to be Achieved
Construction activities	Air pollution on surrounding sensitive receptors	Ambient air quality	Construction Phase	Onsite	1	1	1	2	1	**8**	Low	1	1	1	1	1	**4**	Low	- Planning construction activities in consultation with local communities. - When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible. - Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment. - Ensure access control to exposed areas reducing activity and wind entrainment. - Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment. - Where possible do not undertake material handling activities during windy conditions. - Development of a dust fallout monitoring network to identify areas of concern.	Minimise and control through emission (source) management and mitigation.	Compliance with NAAQS and dust control regulations at receptors.

Activity	Potential Impact	Aspects Affected	Phase in which impact is anticipated	Size and Scale of Disturbance	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance without Mitigation	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type	Standards to be Achieved
Phase 1 Operational Activities	Air pollution on surrounding sensitive receptors	Ambient air quality	Operational Phase	Onsite	1	1	1	2	1	**8**	**Low**	1	1	1	1	1	**4**	**Low**	- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible. - Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment. - Ensure access control to exposed areas reducing activity and wind entrainment. - Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment. - Where possible do not undertake material handling activities during windy conditions. - Development of a dust fallout monitoring network to identify areas of concern. - Developing a mechanism to record and respond to complaints.	Minimise and control through emission (source) management and mitigation.	Compliance with NAAQS and National Dust Control Regulations at receptors. A dust fallout monitoring network to be established at the onset of Phase 2.The method to be used for measuring dust fall rate and the guideline for locating sampling points shall be ASTM D1739:1970, or equivalent method approved by any internally recognised body.

Activity	Potential Impact	Aspects Affected	Phase in which impact is anticipated	Size and Scale of Disturbance	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance without Mitigation	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type	Standards to be Achieved
Phase 2 Operational Activities	Impacts of particulate matter emissions on surrounding sensitive receptors	Ambient air quality	Operational Phase	Onsite	2	4	2	2	1	**18**	**Low**	1	4	2	1	1	**8**	**Low**	- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible. - Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment. - Ensure access control to exposed areas reducing activity and wind entrainment. - Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment. - Where possible do not undertake material handling activities during windy conditions. - Developing a mechanism to record and respond to complaints.	Minimise and control through emission (source) management and mitigation.	Compliance with NAAQS at receptors.

Activity	Potential Impact	Aspects Affected	Phase in which impact is anticipated	Size and Scale of Disturbance	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance without Mitigation	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type	Standards to be Achieved
Phase 2 Operational Activities	Impacts of Dust Fallout on surrounding sensitive receptors	Ambient air quality	Operational Phase	Onsite	4	4	2	3	1	**33**	**Medium**	3	4	2	2	1	**20**	**Low**	- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible. - Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment. - Ensure access control to exposed areas reducing activity and wind entrainment. - Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment. - Where possible do not undertake material handling activities during windy conditions. - Development of a dust fallout monitoring network to identify areas of concern. - Developing a mechanism to record and respond to complaints.	Minimise and control through emission (source) management and mitigation.	Compliance with the National Dust Control Regulations. A dust fallout monitoring network to be established at the onset of Phase 2. The method to be used for measuring dust fall rate and the guideline for locating sampling points shall be ASTM D1739:1970, or equivalent method approved by any internally recognised body.

Activity	Potential Impact	Aspects Affected	Phase in which impact is anticipated	Size and Scale of Disturbance	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance without Mitigation	Magnitude	Duration	Physical Extent	Probability	Reversibility	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type	Standards to be Achieved
Decommissioning Activities	Air pollution on surrounding sensitive receptors	Ambient air quality	Decommissioning Phase	Onsite	1	1	1	2	1	**8**	**Low**	1	1	1	1	1	**4**	**Low**	- Planning decommissioning activities in consultation with local communities. - When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible. - Identification of exposed areas not used for operations and revegetate to reduce the amount of dust available for wind entrainment. - Ensure access control to exposed areas reducing activity and wind entrainment. - Reduced speeds of vehicles over exposed surfaces to minimize vehicular entrainment. - Where possible do not undertake material handling activities during windy conditions.	Minimise and control through emission (source) management and mitigation.	Compliance with NAAQS and National Dust Control Regulations at receptors.

11 CONCLUSIONS

This Air Quality Impact Assessment investigated atmospheric emissions associated with the proposed Port Durnford Mining Project. To assess the existing air quality in the area surrounding the proposed Project, ambient monitoring data was obtained from the nearest monitoring stations near the proposed site. An emission inventory was developed to identify all potential sources of atmospheric pollution associated with the proposed Project. The ambient impacts of the operation of the proposed Project during both Phase 1 (100 tph operations) and Phase 2 (3,000 tph operations) were then assessed using the AERMOD dispersion model. It is noted due to the erratic and transient nature of the construction and decommissioning phases, a quantitative assessment of ambient impacts was not undertaken, but rather a qualitative discussion thereof.

Given that the proposed active operational period of Phase 1 operations will be intermittent (active mining will take place five days a week per month, for twelve hours a day) and for the purpose of this report, emissions from this scenario have been quantified, however, the emission sources have not been modelled. For Phase 2, mining is expected to progress across the site (from 2036 – 2069) and as such, the modelling scenarios have been split into key periods (based on location of emission sources) for ease of assessment. For the dispersion modelling, the following scenarios were considered (operational years are indicated in brackets):

- Phase 2 Scenario 1 (3,000 tph) Operations (2036 – 2047)
- Phase 2 Scenario 2 (3,000 tph) Operations (2048 – 2053)
- Phase 2 Scenario 3 (3,000 tph) Operations (2054 – 2069)

For Phase 2 (all scenarios), $PM_{2.5}$ and PM_{10} concentrations are predicted to be well below the relevant NAAQS for the proposed Phase 2 operations. Notably, the maximum fenceline concentrations predicted for Phase 2 are well below the NAAQS. Highest predicted concentrations are in close proximity to the PWP site, with those concentrations predicted to remain near the source and not extend past the proposed fenceline, remaining below the relevant NAAQS.

For Phase 2 (all scenarios), dust fallout rates are predicted to exceed the National Dust Control Regulations residential standard at representative receptors in close proximity (within 1 km) of the site boundary. Notably, the maximum fenceline concentrations exceed the non-residential standard. The predicted exceedances extend up to 500 m north-northwest and south-southwest of the proposed boundary. The nearest sources contributing to the exceedances beyond the site boundary include the sand stockpiles. Notably, Tronox propose to rehabilitate and vegetate legacy stockpiles and backfilled areas during the operational phase.

Based on dust fallout results, impacts of the Phase 2 operations are predicted and dust-related complaints from receptors are anticipated. Notably the highest predicted fallout rates occur in proximity to the PWP and DTMU's. It is recommended that the proposed mitigation methods are adhered to, and various additional mitigation recommendations are provided in this report. It is, however, recommended that a dust fallout monitoring network is established after commissioning of Phase 2 operations to establish dust fallout levels in the surrounding communities and identify the need for additional mitigation. If elevated air pollution levels are detected, then further mitigation measures will need to be considered.

All impacts of the proposed Project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the nature, significance, consequence, extent, reversibility, duration and probability of occurrence. Based on the results of this Air Quality Impact Assessment, the significance of air pollution-related impacts is rated as “low” for the construction, operational and decommissioning phases of the Project, provided mitigation measures are set in place during the operational phase.

From an air quality perspective, it is therefore advised that the Port Durnford Project be authorised, provided mitigation measures are kept in place and dust fallout monitoring is conducted monthly during Phase 2.

12 REFERENCES

- Australian Government: National Pollutant Inventory (2012): Emission Estimation Technique Manual for Mining. Version 3.1.
- Department of Environmental Affairs (2004): National Ambient Air Quality Standards. Government Notice (No. 1210 of 2009), 24 December 2009 (No. 32816).
- Department of Environmental Affairs (2004): National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Micron Metres (PM2.5). Government Notice (No. 486 of 2012), 29 June 2012 (No. 35463).
- Department of Environmental Affairs (2013): National Dust Control Regulations. Government Gazette (No. R 827 of 2013), 01 November 2013 (No. 36974).
- Department of Environmental Affairs (2014): Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa. Regulations Regarding Air Dispersion Modelling. Government Notice (No. R 533 of 2014), 11 July 2014 (No. 37804).
- Kurosaki, Y. & Mikami, M. (2006): Threshold wind speed for dust emission in east Asia and its seasonal variations.
- Synman, K. (2008): Report on the Soils, Sites, Land Capability And Land Use.
- Republic of South Africa (2004): National Environment Management: Air Quality Act, Act No. 39 of 2004.
- South African National Accreditation System (2012): TR 07-03. Supplementary Requirements For The Accreditation Of Continuous Ambient Air Quality Monitoring Stations.
- South African National Standards (2004): SANS 69:2004. Framework for setting and implementing national ambient air quality standards.
- South African National Standards (2005): SANS 1929:2005. Ambient Air Quality – Limits for common pollutants.
- Tyson, P.D. & Preston-Whyte, R.A. (2000): The Weather and Climate of Southern Africa, 2nd Ed, Oxford University Press Southern Africa, Cape Town.
- United States Environmental Protection Agency (1995): Compilation of Air Pollutant Emission Factors (AP-42).
- Zanokhule Environmental Services (2008): Exxaro Sands (Pty) Ltd Port Durnford Project, Air Quality Monitoring.

Appendix A

IMPACT ASSESSMENT METHODOLOGY

Impacts are assessed in terms of the following criteria:

1) The nature; a description of what causes the effect, what will be affected and how it will be affected:

Nature or Type of Impact	Definition
Beneficial / Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of Project).
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

2) The physical extent:

Score	Description
1	the impact will be limited to the site;
2	the impact will be limited to the local area (local study area);
3	the impact will be limited to the region;
4	the impact will be national; or
5	the impact will be international;

3) The duration, wherein it is indicated whether the lifetime of the impact will be:

Score	Description
1	of a very short duration (0 to 1 years)
2	of a short duration (2 to 5 years)
3	medium term (5–15 years)
4	long term (> 15 years)
5	permanent (this is considered permanent if the impact will be experienced post mine closure)

4) Reversibility: An impact is either reversible or irreversible. How long before impacts on receptors cease to be evident:

Score	Description
1	The impact is immediately reversible.
3	The impact is reversible within 2 years after the cause or stress is removed; or
5	The activity will lead to an impact that is in all practical terms permanent.

5) The magnitude of impact on ecological processes, quantified on a scale from 0-10, where a score is assigned:

Score	Description
0	small and will have no effect on the environment.
1	minor and will not result in an impact on processes (to be defined by individual specialist fields).
2	low and will cause a slight impact on processes.
3	moderate and will result in processes continuing but in a modified way.
4	high (processes are altered to the extent that they temporarily cease).
5	very high and results in complete destruction of patterns and permanent cessation of processes.

6) The probability of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale where:

Score	Description
1	very improbable (probably will not happen).
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).
4	highly probable (most likely).
5	definite (impact will occur regardless of any prevention measures).

The significance, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high:

- The status, which is described as either positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The significance is determined by combining the above criteria in the following formula:

Significance = (Extent + Duration + Reversibility + Magnitude) x Probability

[S= (E+D+R+M) ×P]

Where the symbols are as follows:

Symbol	Criteria
S	Significance Weighting
E	Extent
D	Duration
M	Magnitude
P	Probability

The significance weightings for each potential impact are as follows:

Overall Score	Significance Rating (Negative)	Significance Rating (Positive)	Description
< 30 points	Low	Low	where this impact would not have a direct influence on the decision to develop in the area
31 - 60 points	Medium	Medium	where the impact could influence the decision to develop in the area unless it is effectively mitigated
> 60 points	High	High	where the impact must have an influence on the decision process to develop in the area

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

wsp.com