Atmospheric Impact Report for Tronox Mineral Sands (Pty) Ltd Mineral Separation Plant in Western Cape Province

Prepared for SRK Consulting (South Africa) (Pty) Ltd on behalf of Tronox Mineral Sands (Pty) Ltd

Report prepared by N Shackleton
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Report No.: 18SRK15 Final v2 | Date: May 2019

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Executive Summary

The Tronox Mineral Sands (Pty) Ltd (Tronox) (trading as Tronox Namakwa Sands (Tronox NS)) Mineral Separation Plant (MSP) is situated near the Olifants River Settlements in the West Coast District Municipality, Western Cape Province. The MSP is an existing facility. The operational dryers on site trigger listed activity sub-category 5.2 (drying), under the National Environmental Management: Air Quality Act (NEM:AQA), Act no. 39 of 2004. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed to compile the Atmospheric Impact Report (AIR) for the variation of the atmospheric emission licence (AEL). The reason for the variation of their AEL is that Tronox NS proposes to improve operations using an alternative fuel source, natural gas (NG), for operating the dryers. NG will replace the use of paraffin for the dryer burners; however, paraffin will need to be used if NG is not available.

The scope of work included:

- A review of regulations, guidelines and standards pertaining to air quality.
- A baseline study of the receiving environment to provide background and context, including:
    - The identification of potential air quality receptors;
    - A study of meteorological parameters governing the dispersion of pollutants in the atmosphere; and
    - Analysis of available baseline air quality data.
- An impact assessment, including:
    - The establishment of a comprehensive emissions inventory for the operations using data from emissions sampling and emission factors published by the United States (US) Environmental Protection Agency (EPA) and the Australian Government's Department of the Environment and Energy (ADE) in the estimation of all relevant operations' emissions. Particulate matter (PM), oxides of nitrogen (NO_x), sulphur dioxide (SO_2), and carbon monoxide (CO) were included in the inventory.
    - The comparison of measured emissions and with the national minimum emission standards (MES).
    - Level 2 atmospheric dispersion simulations, as defined in the South African Regulations Regarding Air Dispersion Modelling (Government Notice no. R533, 11 July 2014) to determine "worst case" ambient air quality concentrations for pollutants of relevance to the industry. Level 3 dispersion modelling was done using the BREEZE AERMOD model suite. It calculates worst case 1-hour, 24-hour, monthly and annual average pollutant concentrations as well as the frequency with which ambient air quality criteria are exceeded.
    - The screening of measured and simulated ambient pollutant concentrations and dustfall rates in comparison with national ambient air quality standards (NAAQS) and national dust control regulations (NDCR).
- A comprehensive AIR in the format as set out by the Department of Environmental Affairs (DEA) in support of the AEL variation application.

The main findings of the baseline assessment are that:

- The wind field was dominated by winds from the south-west followed by winds from the south-south-west. During the day, winds occurred more frequently from the south-westerly and south-south-westerly. Night-time airflow had winds from the north-westerly and south-westerly sectors occurring at approximately the same frequency followed by winds from the west-north-westerly and west-south-westerly directions. In general, the wind speeds at night were lower than those occurring during the day.
- The main sources contributing to current background pollutant concentrations and dustfall rates likely include vehicle entrained dust from local roads, agricultural activities, windblown dust from exposed areas, biomass burning, household fuel burning and vehicle exhaust emissions.
- The MSP is located in a fairly remote area in the West Coast District Municipality of the Western Cape Province. The surrounding land use is agricultural activities consisting of mostly livestock (sheep) with some lands used for dryland wheat production. Agricultural activities to the south include vineyards and lands for vegetables (tomatoes, cabbage, etc.). Making the surrounding expanse a sparsely populated rural area. The closest residences to the MSP are few farm houses located within 5 km to the south and north-east of the section 21 listed activities. The Koekenaap School is located 7.4 km to the south of the listed activities.
- On-site dustfall rates was available from January 2017 to December 2018. During 2017, two buckets (DMP05 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months; this would indicate non-compliance with the NDCR. During 2018, three buckets (DMP05, DMP07 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months and one bucket (DMP06) with dustfall rates in excess of the NDCR limit for non-residential areas for two consecutive months (July and August); this would indicate non-compliance with the NDCR.

The main findings of the impact assessment are as follows:

- PM emissions from Tronox NS regulated stacks do not currently comply with the existing plant or new plant national minimum emissions standards (MES). Tronox NS is constructing baghouses for the dryers to enable the facility to comply with the new plant MES.
- NO_x and SO_2 emissions from Tronox Mineral Sands regulated stack does comply with the existing plant and new plant national minimum emissions standards (MES).
- Total suspended particulates (TSP), PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO emissions were quantified and modelled.
- The simulated results of the MSP operations with the dryers fuelled by NG were as follows:
    - Simulated $PM_{2.5}$ and PM_{10} as a result of the Tronox Mineral Sands operations with the dryers emitting the measured emissions exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).
    - Simulated NO_2, SO_2 and CO as a result of the Tronox Mineral Sands operations with the dryers emitting the measured emissions did not exceed the NAAQS.
    - Simulated $PM_{2.5}$, PM_{10}, NO_2, SO_2 as a result of the Tronox Mineral Sands operations with the dryers emitting the existing plant minimum emission standards exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).

- Simulated $PM_{2.5}$, PM_{10}, NO_2, SO_2 as a result of the Tronox Mineral Sands operations with the dryers emitting the new plant minimum emission standards exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).
- Simulated nuisance dustfall rates as a result of the Tronox Mineral Sands operations were found to be above the NDCR limit for residential areas off-site but not at any AQSRs and the NDCR limit for non-residential areas on-site.

- The dryers are currently fuelled by paraffin, the impacts for the current operations are shown in Annexure G. It is expected that emissions (PM, NOx and SO2) will reduce using NG as a fuel source for the dryers. The concentrations as a result of the dryers operations using NG as a fuel source were determined to lower than current operations (using paraffin as a fuel source).

To ensure the lowest possible impact on AQSRs and the environment it is recommended that Tronox NS ensure that the mitigation and monitoring of sources of emission are undertaken as described in the technical sections of the report.

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List of Abbreviations

ADE	Australian Government: Department of the Environment and Energy
AEL	Atmospheric Emission Licence
Airshed	Airshed Planning Professionals (Pty) Ltd
AIR	Air Impact Report
APPA	Air Pollution Prevention Act
AQM	Air Quality Management
AQO	Air Quality Officer
AQSR(s)	Air Quality Sensitive Receptor(s)
ASG	Atmospheric Studies Group
ASTM	American Society for Testing and Materials
CE	Control Efficiency
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
EHS	Environmental, Health and Safety
EMS	Environmental Management Systems
GHG	Greenhouse Gas(es)
GIIP	Good International Industry Practice
GLC(s)	Ground Level Concentration(s)
Tronox NS	Tronox Namakwa Sands/Tronox Mineral Sands (Pty) Ltd
NAAQS	National Ambient Air Quality Standard(s)
NDCR(s)	National Dust Control Regulation(s)
NEM:AQA	National Environmental Management: Air Quality Act 2004
MES	National Minimum Emission Standards
NPI	National Pollutant Inventory
NS	Namakwa Sands
PM	Particulate Matter
SABS	South African Bureau of Standards
SAWS	South African Weather Service
tpa	Tonnes per annum
TSP	Total Suspended Particulates
US EPA	United States Environmental Protection Agency
WHO	World Health Organisation
WRF	Weather Research and Forecasting

Atmospheric Impact Report

1 ENTERPRISE DETAILS

The Tronox Mineral Sands (Pty) Ltd (Tronox) (trading as Tronox Namakwa Sands [Tronox NS]) Mineral Separation Plant (MSP) is situated near the Olifants River Settlements in the West Coast District Municipality, Western Cape Province. The MSP is an existing facility. The operational dryers on site trigger listed activity sub-category 5.2 (drying), under the National Environmental Management: Air Quality Act (NEM:AQA), Act no. 39 of 2004. Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed to compile the Atmospheric Impact Report (AIR) for the variation of the atmospheric emission licence (AEL). The reason for the variation of their AEL is that Tronox NS proposes to improve operations using an alternative fuel source, natural gas (NG), for operating the dryers. NG will replace the use of paraffin for the dryer burners; however, paraffin will need to be used if NG is not available

1.1 Enterprise Details

The details of Tronox Mineral Sands (Pty) Ltd (hereby referred to as Tronox Namakwa Sands [Tronox NS]) are summarised in Table 1. The contact details of the responsible person are provided in Table 2.

Table 1: Enterprise details

Enterprise Name	Tronox Mineral Sands (Pty) Ltd
Trading As	Tronox Namakwa Sands
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc	Company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture)	1998/001039/07
Registered Address	PO Box 435, Vredenburg, 7380
Postal Address	PO Box 435, Vredenburg, 7380
Telephone Number (General)	027 217 3911
Fax Number (General)	027 217 3529
Industry Type/Nature of Trade	Mining of other non-ferrous metal ores (SIC 0729)
Land Use Zoning as per Town Planning Scheme	Industrial
Land Use Rights if outside Town Planning Scheme	Not Applicable

Table 2: Contact details of responsible person

Responsible Person Name or Emission Control Officer (where appointed)	Marius Vlok
Telephone Number	027 217 3911/3042
Cell Phone Number	083 709 6556
Fax Number	027 217 3100

E-mail Address	marius.vlok@tronox.com
After Hours Contact Details	083 709 6556

1.2 Location and Extent of the Plant

The details of the Mineral Separation Plant (MSP) location and extent are summarised in Table 3. The location of operations in relation to the surrounding environment (regional setting) is shown in Figure 1; in this image, the yellow circle depicts a 50 km area surrounding the MSP, while the red circle depicts a 5°km area surrounding the MSP. The location of the MSP in relation to the surrounding land use and individual air quality sensitive receptors (AQSRs) is shown in Figure 2.

Table 3: Location and extent of the plant

Physical Address of the Plant	Tronox Namakwa Sands: MSP (Mineral Separation Plant) Gryskoppies Koekenaap 8146
Description of Site (Where no Street Address)	Tronox Namakwa Sands: MSP at Gryskoppies near Koekenaap on the R363
Coordinates (decimal degrees) of Approximate Centre of Operations	Latitude: 31.46166667° S Longitude: 18.28694444° E
Coordinates (UTM) of Approximate Centre of Operations	UTM reference – Grid Zone: 34S Northing: 6 516 044.88 mN Easting: 242 207.24 mE
Property Registration Number (Surveyor-General Code)	C07800070000142000000
Extent (km^2)	~ 6.03
Elevation Above Mean Sea Level (m)	74
Province	Western Cape
Metropolitan/District Municipality	West Coast
Local Municipality	Matzikama
Designated Priority Area	No

1.2.1 Description of Surrounding Land Use (within 5 km radius)

The MSP is located in a fairly remote, sparsely populated area in the West Coast District Municipality of the Western Cape Province. The surrounding land use is agricultural activities consisting of mostly livestock (sheep) with some lands used for dryland wheat production. Agricultural activities to the south include vineyards and lands for vegetables (tomatoes, cabbage, etc.). The closest residences to the MSP are a few farm houses located within 5 km to the south and north-east of the MSP. The Koekenaap School is located 7.4 km to the south of the MSP.

1.3 Atmospheric Emission Licence and other Authorisations

The operation had an existing Provisional Atmospheric Emission Licence (PAEL). The details of the PAEL can be found in Table 4.

Table 4: Tronox NS MSP PAEL details

Name of Licensing Authority	Department of Environmental Affairs
Atmospheric Emission Licence Number	AEL/WCP/TRONOX/16/03/2016
Atmospheric Emission Licence Issue Date	01 September 2016
Atmospheric Emission Licence Type	*Provisional*
Renewal Date, not later than	30 June 2017

The MSP was constructed and commissioned in 1993. The existing operations at the MSP did/do not require an environmental authorisation in terms of National Environmental Management Act 107 of 1998 (NEMA) Environmental Impact Assessment (EIA) Regulations, 2014, as confirmed by the Department of Mineral Resources (DMR) (reference 30/5/1/2/3/2/1 (113 and 114) EM). It is the opinion of SRK Consulting (South Africa) (Pty) Ltd (SRK) as the Environmental Assessment Practitioner (EAP), that the proposed changes to the MSP will require a Basic Assessment (BA)[1] process to apply for environmental authorisation as the proposed project (only) triggers LN1 (51) in terms of the NEMA EIA Regulations, 2014. A copy of the letter from SRK to the Department of Mineral Resources: Western Cape Region is included in Appendix C.

[1] An AQIA has been compiled for the BA

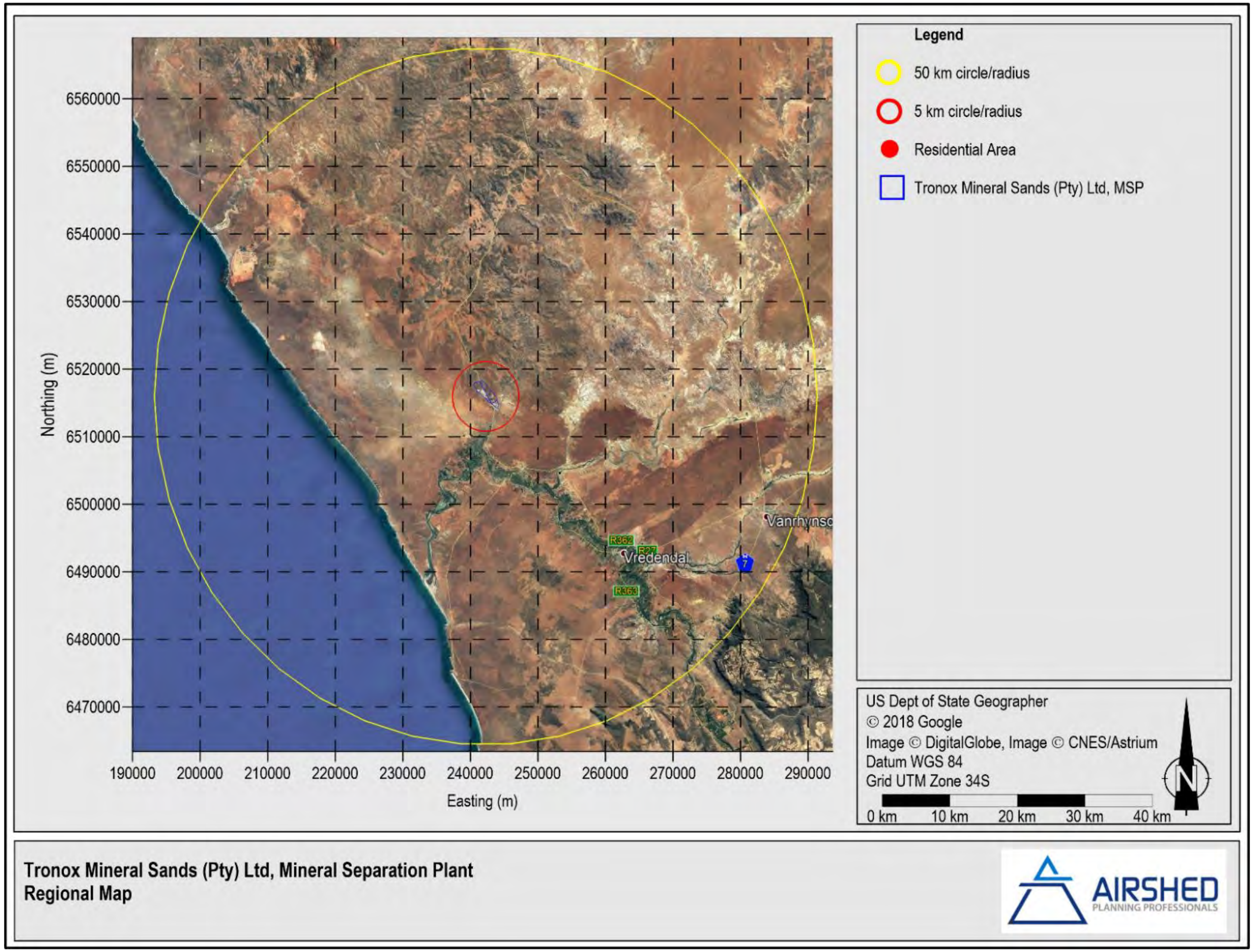

Figure 1: Location of Tronox NS MSP in relation to the surrounding environment (regional setting); yellow circle depicts 50 km radius and the red circle depicts 5 km radius

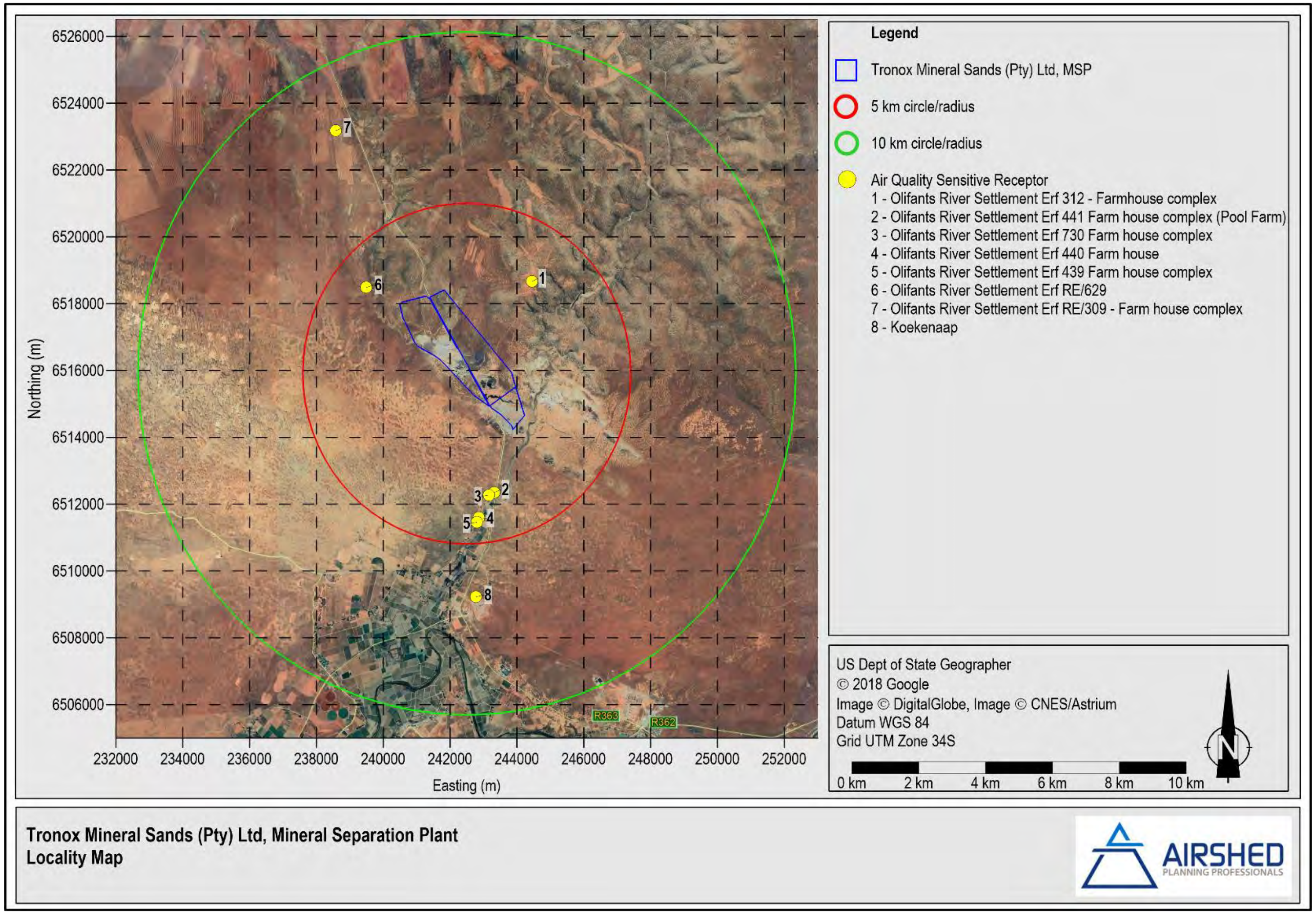

Figure 2: Location of Tronox NS MSP in relation to the surrounding AQSRs

2 NATURE OF THE PROCESS

2.1 Listed Activity A

A summary of the National Environmental Management: Air Quality Act (NEM:AQA) listed activities undertaken at the MSP is provided in Table 5.

Table 5: Listed activities

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
Category 5 – Mineral processing, storage and handling	Sub-category 5.2 – Drying	The drying of mineral solids including ore, using dedicated combustion installations

2.2 Process Description

Below is a description of the entire production process including reference to inputs, outputs and emissions at the site of the works.

2.2.1 General Process Description

Tronox Namakwa Sands undertakes the mining and beneficiation of heavy minerals. Facilities are based at three geographically separated sites situated at:

- Brand-se-Baai: East Mine, West Mine, Primary Concentration Plants (PCP) East and West and the Secondary Concentration Plant (SCP);
- Koekenaap: MSP; and
- Saldanha Bay: Smelter facility and Receiving and Dispatch area.

Heavy mineral sands are extracted and concentrated into magnetic and non-magnetic concentrate at the Mine. These magnetic and non-magnetic concentrate streams are transported to the MSP where the magnetic material is treated in the magnetic (ilmenite separation) Dry Mill Circuit to produce ilmenite and the non-magnetic material is treated in the Non-Magnetic Circuit to produce zircon and rutile related products. The ilmenite, zircon and rutile related products are transported to the Smelter, where the ilmenite is further processed, while the zircon and rutile related products are packaged and forwarded to customers.

2.2.2 Mineral Separation Plant Process Description

2.2.2.1 Feed Reception

Moist (~4-5% moisture) magnetic (~1600t/d) and non-magnetic (~950 t/d) materials are transported from the SCP to the MSP by truck (80t trucks). At the MSP, the magnetic material and non-magnetic material is unloaded into dedicated reception hoppers. The magnetic material is fed through a conveyor belt and feed bin (~1250 t) system into the Magnetic Circuit at about 70t/h and the non-magnetic material is fed through a conveyor belt and feed bin (~1 250 t) system into the Non-Magnetic Circuit at about 42t/h.

2.2.2.2 Magnetic (Ilmenite Separation) Dry Mill Circuit

In the Magnetic Circuit, the magnetic material is first dried by the NG or paraffin fired ilmenite fluidbed dryer and then treated through four stages (mini circuits): the rougher, cleaner, middlings and scavenger circuits. The ilmenite fluidbed dryer off-gas is being diverted to the Baghouse B plant (previously known as the proposed mineral separation baghouse) to be commissioned by December 2019.

The rougher circuit, consisting of a bank of drum magnetic separators, is the first stage of the circuit during which most of the coarse garnet and non-magnetic material is rejected from the magnetic feed. The rejected material goes to the scavenger circuit and the magnetic feed goes to the second stage of the circuit - the cleaner circuit.
Within the cleaner circuit, banks of High Tension Roll (HTR) separators are used to further separate the conductor fraction of the material (ilmenite) from the less conductive fraction through electrostatic separation. The highly conductive material (final ilmenite product) goes to the ilmenite product bins and the less conductive fraction goes to the middlings circuit.

The middlings circuit, consisting of HTRs, receives ilmenite containing material from the cleaner and scavenger circuits and concentrates this to final ilmenite product that goes to the ilmenite product bin. The rejected material from this circuit goes to the scavenger circuit.

The scavenging circuit, consisting of drum magnetic separators and HTR separators, receives the rejected material from the rougher and middling circuits and regains the ilmenite containing material and feeds it into the middlings circuit. The rejected material from the scavenger circuit goes to the ilmenite rejects bunker and then to the ilmenite rejects stockpile.

2.2.2.3 Non-magnetic circuit

The non-magnetic process consists of five circuits (Figure 4). These are:

- the Induced Roll Magnetic Separator (IRMS) Circuit;
- the Hot (or Hepworth) Acid Leach (HAL) Circuit;
- the Wet Gravity Circuit;
- Wet Gravity Extension (WGE) circuit; and
- the Dry Mill Circuit.

The Primary Dryer, HAL A Dryer, HAL B Dryer and Secondary Concentrate Dryer off-gas is being diverted to the Baghouse A plant (previously known as the proposed feedprep baghouse) to be commissioned by December 2019. The Secondary Dryer off-gas is being diverted to the Baghouse B plant.

Induced Roll Magnetic Separator (IRMS) Circuit

The IRMS circuit is the first circuit within the Non-magnetic process. The objective of the IRMS circuit is to remove as much magnetic minerals as possible which, if not removed, uses additional sulphuric acid and is troublesome for the final separation process at the MSP.

The Non-magnetic material in the reception bin, which still contains a low percentage of moisture, is discharged onto a screen to remove tramp material. The screen discharges onto a feed conveyor at a specified rate and material feeds into a fluidized bed NG or paraffin dryer (Primary Dryer). The dryer combusts NG or paraffin with ambient air to heat the Non-magnetic material entering via a feed chute. The dry Non-magnetic material exits the dryer at a temperature exceeding 120°C. The stream is then screened dry to remove coarse particulates. The screened Non-magnetic material is fed to the IRMS (that uses magnetic separation) and screens (that uses size classification) via a series of elevators to remove magnetic and coarse minerals, known as IRMS rejects. The IRMS rejects mainly consists of ilmenite, garnet and monazite but still contains low amounts of zircon, rutile and leucoxene. The removal of monazite through this circuit ahead of the leaching process in the Hot Acid Leach (HAL) circuit plays an important role to prevent the dissolution of this radioactive mineral and thereby avoiding the creation of a radioactive effluent.

The IRMS rejects are discharged onto a conveyor which then discharges the material onto a temporary stockpile at the IRMS Rejects Bunker. The product from the IRMS Circuit is discharged dry into the HAL feed bin from where it is fed into the HAL Circuit.

Hot (or Hepworth) Acid Leach (HAL) and Mineral Washing Circuit

The purpose of the HAL Circuit is to remove an iron-rich mineral coating, which affects separation and contributes to iron contamination of zircon products from the IRMS product.

The HAL Circuit is basically two identical slurry circuits that are operated in parallel with a combined water supply circuit. The original circuit named HAL A, with a nameplate capacity of 16t/h, has been complemented with a larger circuit named HAL B with a nameplate capacity of 28t/h.

The IRMS product stored in the HAL Feed Bins is discharged onto feed conveyers and then discharged into dryers (HAL A and B Dryer) to increase the temperature of the minerals to above 140°C. The heated minerals are discharged into the feed pipes of the HAL A and B Reactors which have been modified with acid resistant bricks. While the material flows through the feed pipes it is being mixed with a sulphuric acid solution with a predetermined strength and flow rate. The mixed slurry is discharged into the reactors, with a residence time of ~45 minutes. The minerals fed to the reactors are coated naturally with iron oxide and the sulphuric acid is used to react to the coating to produce precipitated iron sulphates. The reaction between the sulphuric acid and iron oxide is exothermic which releases water (moisture) into the atmosphere via the HAL A and B Reactor stacks.

The product from the reactors, at an approximate temperature of 90°C, discharges into quench sumps where water is added to produce pumpable slurry. When the reactor product is quenched with water, it releases iron sulphate precipitate. The iron sulphate concentration is the highest at this point in the process and must be removed while the slurry solution is still at a low pH. Slurry from the quench sumps is pumped to dewatering cyclones with a cut-point of 15 micron. The overflow product from the dewatering cyclones is collected and pumped to the Effluent Neutralization Circuit while the underflow product is gravity fed into up-flow classifiers.

The up-flow classifiers' aim is to remove additional iron sulphate still in the solution. The overflow of the up-flow classifiers is gravity fed to the water circuit used to supply makeup water for the quench sumps. The underflow of the up-flow classifiers is gravity discharged into attritioners at a high solids content (70-80% concentration by solids). The aim of the attritioners is to induce high inter-particle abrasion of the minerals by means of agitators. The abrasion removes precipitated iron sulphate on the mineral surfaces.

From the attritioners, the material is pumped to a series of dewatering cyclones and up-flow classifiers that use water in a counter current system (i.e. water proceeds to the beginning of the circuit while solids are moved toward the end of the circuit) to "wash" the material (Mineral washing sub-circuit) to remove the precipitated and dissolved iron sulphate. The effluent is forwarded back to the quench sump and eventually exits the HAL Circuit at the dewatering cyclone. The material is forwarded to a mixer where the pH of the material is then increased to approximately 5 by using 40% concentrated caustic soda to prevent/reduce equipment corrosion/damage and to ensure that the product produced further down the line can adhere to product specifications. The material is then forwarded to the Wet Gravity Circuit.

<u>Wet Gravity Circuit</u>

The purpose of this circuit is to separate the material originating from the HAL and Mineral Wash Circuit into the less dense non-valuable minerals (like quartz, siliceous leucoxene, kyanite, garnet, pyriboles and other non-valuable minerals) and valuable zircon rich material.

Within the wet gravity circuit, the material first goes through a hydrosizer which separates the material on size and weight into coarse and fine material which is then fed and treated in parallel processes in the circuit. The coarser, heavier materials that report to the underflow of the hydrosizer are processed using a 5-stage spiral system ("rougher circuit) which aims to produce the bulk of the wet gravity primary concentrate. The lighter minerals that report to the hydrosizer overflow are processed using a two-stage spiral and wet table system producing concentrate, middling and tailing streams. The wet gravity concentrate originating from the rougher sub-circuit is either sent to drying bays or diverted to the vacuum belt filter from where it is conveyed to a fluidized dryer (Secondary Concentrate dryer) and stored in bins prior to being fed into the Dry Mill Circuit as primary concentrate, while the wet gravity concentrate originating from the fines sub-circuit is introduced as secondary concentrate/side door feed to the Rutile Plate Circuit of the Dry Mill Circuit. The middling streams are reprocessed within the sub-circuits to either produce a concentrate or tailings. The tailings (rejects) from the last spiral stage, known as quartz rejects is dewatered and then either forwarded to the Wet Gravity Extension (WGE Circuit) to further process the material or, when this circuit is down, forwarded to the drying bays from where it is either fed into the WGE Circuit for further processing or taken to be stockpiled on the quartz reject stockpile from where it can either be sold as is or forwarded to the WGE Circuit for further processing.

<u>Wet Gravity Extension Circuit</u>

The purpose of this circuit is to process the quartz reject material to remove the remaining valuable zircon and other by-products from the material. The circuit consists of 3 stages: the feed preparation, magnetic rejection and mineral separation stages. The circuit also has a water recovery and treatment system.

At the feed preparation stage, the circuit receives approximately 7 t/h of quartz rejects pumped directly from the Wet Gravity Circuit. This is supplemented from the existing quartz rejects stockpile with about 8t/h to reach approximately 15 tons per hour. The quartz reject material is transported from the stockpile with articulated dump trucks, loaded into a feed hopper and fed into the circuit at a measured rate with a feeder and conveyor system. The material is then pumped into a hydrosizer which splits the material into fines (overflow) and coarse (underflow) material which is then treated in parallel processes in the circuit starting with magnetic rejection.

During the magnetic rejection stage the hydrosizer under- and overflow are collected and pumped separately to high intensity wet magnetic separator banks that separate the magnetic material from the non-magnetic material by rejecting approximately 95% of the magnetic material, with a mass split of 80% to the non-magnetic streams. The non-magnetic material from the two (coarse and fines) streams are forwarded to spiral banks for further processing in the mineral concentration stage. The magnetic stream is collected as waste in a tailings tank for final disposal in the West Mine as final quartz rejects.

Within the mineral concentration stage, the non-magnetic streams from the coarse and fines magnetic rejection circuits are pumped to two separate spiral banks to separate the heavy concentrate from the lighter rejects using centrifugal forces exerted on the particles. Within the spirals banks, the material is split into concentrate, middlings (particles of intermediate size and density) and tailings streams, with the concentrate and middling streams gravitating into shaking table feed sumps, from where it is pumped to shaking tables and the tailings stream is pumped to a belt filter. This is added to the final quartz rejects for disposal to the West Mine or returned to the stockpile for retreatment.

The shaking tables separate the materials further into primary concentrate, secondary concentrate and tailings streams, with the primary and secondary concentrates then being pumped to the Wet Gravity primary and secondary concentrate collection sumps respectively and the tailings being pumped to a belt filter. The primary concentrate streams are then pumped to the rougher stage of the Dry Mill Circuit and the secondary concentrates streams to the middlings stage of the Dry Mill Circuit.

Process water needed for dilution pumping in the process is recovered by dewatering cyclones and sent to a thickener tank where an agitator mixes flocculent into the water to keep solid particles in suspension. The resulting slurry generated then flows to a thickener. At the thickener, the overflow of the thickener (clean process water) is collected in a sump and is returned to the WGE as process water (to be used as separation water in the hydrosizer, washing water on the shaking tables and dilution water for each of the dilution pumping stages), while the low moisture sludge from the thickener is pumped to the filter press at the Effluent Treatment Plant where it is separated into water and solids, with the solids becoming part of the Effluent Plant’s gypsum waste, which is disposed of in the West Mine.

Dry Mill Circuit

The purpose of this circuit is to separate the feed it receives into the products zircon, zirkwa, rutile and tiokwa.

The circuit consists of a complex combination of multiple stages of mainly electrostatic separators complemented by magnetic separators and can be divided into five mini circuits: rougher, middlings, zircon plate, rutile plate and zirkwa circuits.

The wet gravity primary concentrate originating from the wet gravity rougher sub-circuit and the wet gravity extension circuit is first dried out in drying bays and/or through a vacuum belt filter. This dried (but still moist) material is then loaded and/or conveyed to a fluidized dryer (Secondary dryer) and stored in bins prior to being fed into the Dry Mill's rougher circuit.

The rougher and middlings circuits, consisting mainly of CoronaStats, HTRs and Electrostatic Plate Separators (EPS) have the objective of performing the initial separation of the material they receive based on the material's conductivity. The conductive (rutile rich) material containing less than 10.0% zircon coming from these circuits is fed to the rutile plate circuit, while the non-conductive (zircon rich) material containing less than 1.00% TiO_2 coming from these circuits are fed to the zircon plate circuit. A conductive/magnetic stream rich in zircon is also produced in the middlings circuit and this is either fed to the zirkwa circuit or the secondary concentrate circuit and fed into the rutile circuit again.

Within the rutile plate circuit, the conductive rutile rich concentrate, containing less than 10% zircon, originating from the rougher and middling circuits is first heated with an electric reheater and then fed through a set of HTRs to separate the material into conductive material that is to be treated further within the circuit, non-conductive material that is recycled back to the middlings circuit and a middlings stream that is recycled to the start of the rutile plate circuit. The secondary concentrate from the fines sub-circuit of the Wet Gravity Circuit is fed into the rutile plate circuit where it is first dried with a fluidized dryer (Secondary concentrate dryer) and then separated into magnetic and non-magnetic material through IRMS. The magnetic material is rejected and stored in the spillage bunker area as rutile rejects. The non-magnetic material is further separated with CoronoStats based on its conductivity, with the non-conductive material being fed to the zirkwa circuit, the conductive material forwarded for further treatment within the rutile plate circuit and the middlings stream being rejected and stored in the spillage bunker area as rutile rejects.

The conductive rutile rich concentrate separated for further treatment in the rutile plate circuit is again heated with an electric reheater and then fed through various sets of EPSs, HTRs and High Force Magnets (HFM) within the following sub-circuits of the rutile plate circuit: coarse zircon removal circuit, the fine zircon removal circuit, the tin removal circuit (to remove cassiterite), and the silica removal circuit (to remove leucoxene) to produce the two TiO_2 final products, rutile and tiokwa, that are conveyed and stored in product bins, and various rejects material that is stockpiled in the spillage bunker as rutile rejects.

The non-conductive (zircon rich) material containing less than 1% TiO_2 originating from the rougher and middling circuits is separated based on both its conductive and magnetic properties within the zircon circuit through a process that uses a combination of EPS, Electrostatic Screen Plate Separators (ESPS), High Force Magnets (HFM) and IRMS to produce:

- A conductive material that is recycled back to the middlings circuit;

- A primary grade zircon that is stored in the zircon product bins;
- A rejects material that is recycled back to the HAL Circuit for retreatment; and
- A reject material that gets combined with the middlings circuit reject stream and fed into the zirkwa circuit.

Within the zirkwa circuit, the magnetic rejects from both the middlings and the zircon plate circuits is treated with Coronastats (electrostatic), EPSs and IRMS technology to produce a secondary zircon product, zirkwa, that is stored in the zirkwa product bins, and a final zircon reject that is diverted to the zircon reject bunker.

2.2.2.4 Rejects and Effluent Management

The MSP produces several rejects streams (e.g. IRMS rejects, quartz rejects, rutile rejects, zircon rejects and ilmenite rejects) that are stockpiled in large stockpiles or reject bunkers. An acidic effluent is also generated, treated and the "products" (treated effluent water and gypsum) from the treatment process disposed.

<u>IRMS rejects</u>

The IRMS rejects is a magnetic reject and is largely made up of ilmenite and garnets. The presence of monazite, which is a magnetic rare earth mineral containing uranium and thorium, results in this material being considered as a low level Natural Occurring Radioactive Material.

The IRMS rejects is produced within the IRMS Circuit from where it is transported with a conveyor belt to an intermediate stockpile area, which has a live capacity of 500 tons. From this intermediate stockpile, a front-end loader is used to load the rejects onto an articulated dump truck, which transports the rejects to the IRMS rejects stockpile area.

The IRMS rejects is currently not beneficiated and the stockpile will be rehabilitated in situ at closure if no future beneficiation of it will occur. Wind breaks and manual wetting of the roads on the stockpile area is used to minimise the dispersion of the stockpile by wind.

<u>Quartz rejects</u>

Quartz rejects is largely made up of quartz and fine TiO_2 bearing mineral (leucoxene). The presence of metamic zircon results in this material being considered a low level Natural Occurring Radioactive Material.

Quartz rejects is produced within the last spiral stage of the Wet Gravity Circuit from where it is either retreated within the WGE Circuit or dewatered, forwarded to the drying bays and then loaded with a front-end loader onto an articulated dump trunk and transported to the quartz reject stockpile area.

Quartz rejects has a number of avenues for further beneficiation. The material produced in the plant will, as far as possible, no longer be stockpiled, but be treated in the WGE Circuit. The material from the quartz reject stockpile is used in the following ways:

- Treated within the WGE Circuit (majority of the material will be treated in this way) through loading the material with a front-end loader onto an articulated dump truck which will transport it to and offload it into the WGE Circuit day stockpile.

- Reprocessing the material during strategic campaigns and/or at the SCP by loading the material with a front-end loader onto trucks which will transport it to and offload it within the quartz rejects bunker at the SCP.
- Selling the quartz rejects in its current state as Zircon Ti Concentrate (ZTC), a medium grade product, by screening it in a prepared area next to the stockpile by loading it with a front-end loader into the screen and then, by means of a conveyor system, loading it into containers to be transported to the ports via road or railway.

Wind dispersion of the material from the stockpile is managed by way of windbreaks and manual wetting.

<u>Final Quartz rejects</u>

All the rejected material from the WGE Circuit is known as final quartz rejects. It largely consists of quartz and fine TiO_2 bearing mineral (leucoxene). The presence of metamic zircon results in this material being considered a low level Natural Occurring Radioactive Material.

Within the WGE Circuit, the rejects is dewatered by means of a belt filter, stockpiled in an intermediate bunker and then loaded with a front-end loader onto a truck which transports it to the large stockpile where it is stored for further treatment or is disposed in the West Mine, either as part of the West Mine tailings by way of the rejects disposal system at the SCP or as pure final quartz rejects with the gypsum in the dedicated gypsum area.

<u>Rutile rejects</u>

Rutile rejects originating from the rutile plate circuit of the Dry Mill is stored in the spillage bunker area at the MSP, an area with high wind break walls (nets) to minimise dispersion of the material. From here, it is either mixed with the zircon rejects and retreated by feeding it into the IRMS Circuit during reject campaigns or sold in its current state as Rutile Zircon Concentrate (RZC), which is a medium grade product, through feeding it with a front-end loader onto a screening system, screening it and then loading it via a conveyor system into containers that are transported to Cape Town harbour via road and/or railway.

<u>Zircon rejects</u>

The zircon rejects generated in the non-magnetic product stream of the Dry Mill consist largely of zircon and TiO_2 bearing mineral. The presence of significant quantities of metamic zircon results in the material being considered a low level Natural Occurring Radioactive Material. The zircon rejects is temporarily stored in the spillage bunker area at the MSP, an area with high wind break walls (nets) to minimise dispersion of the material. From here it is either mixed with the rutile rejects and retreated by feeding it into the IRMS Circuit during reject campaigns at the MSP or sold in its current state as ZTC, RZC or Medium Zircon Concentrate (MZC), through feeding it with a front-end loader onto a screening system, screening it and then loading it via a conveyor system into containers that are transported to Cape Town harbour via road and/or railway.

<u>Ilmenite rejects</u>

The rejected material produced in the Magnetic (Ilmenite Separation) Dry Mill Circuit is largely made-up out of TiO_2 bearing mineral and garnets and is considered a low level Natural Occurring Radioactive Material due to the presence of low radiation levels in the garnet.

After production in the Magnetic (Ilmenite Separation) Dry Mill Circuit, the ilmenite rejects is transported with a conveyor belt to an intermediate stockpile area (ilmenite rejects bunker) with a live capacity of 500 tons. A front-end loader is used to load the rejects from here onto an articulated dump truck, which transports the rejects to the ilmenite rejects stockpile area.

The ilmenite rejects are currently not beneficiated and the stockpile will be rehabilitated in situ at closure if no future beneficiation of it will occur. Wind breaks and manual wetting of the roads on the stockpile area is used to minimise the dispersion of the stockpile by wind.

Effluent and Gypsum

Acidic effluent is generated within the HAL and Mineral Washing Circuit and pumped to the Effluent Treatment Plant. Within the Effluent Treatment Plant, the acidic effluent is neutralized by treating it with the reagents limestone and lime. The reaction of the acidic effluent with these reagents produces gypsum with a high percentage of precipitated iron. The slurry (gypsum and neutralized water) is pumped to a filter press which in turn separates the gypsum from the neutralized water. The neutralized water is pumped to one of nine unlined dams to the east of the MSP where it evaporates into the atmosphere. The gypsum cakes produced by the filter press are loaded by a front-end loader onto a truck that transports it to a dedicated disposal area in the West Mine at Brand-se-Baai for disposal.

During emergency situations, untreated industrial effluent is pumped to one of the three Emergency Dams (lined holding facility). The untreated effluent is returned to the Effluent Treatment Plant as soon as it is operational again and there is capacity available to treat the effluent.

2.2.2.5 Product Storage and Dispatch

The MSP's primary products (e.g. ilmenite, zircon, zirkwa, rutile and tiokwa) are all stored in product bins from where the products are loaded by means of measuring flasks and funnels into custom-made fully enclosed rail trucks. The products are transported to the Tronox NS Smelter premises by Transnet using a fleet of 90 custom-made rail trucks, with train dispatches taking place once a day, seven days a week. The trucks are weighed on a weighbridge upon leaving the MSP. At the Smelter, products are offloaded and stored in silos or dedicated storage sheds from where zircon, zirkwa, rutile and tiokwa are sold as either bulk, bag or containerised shipments and ilmenite fed into the Smelter process.

ZTC, RZC and MZC are loaded from the rutile and zircon reject stockpiles within the reject bunkers at the MSP with front-end loaders onto a screening system that screens it and then conveys it into containers that are then transported by road and/or rail to Cape Town harbour for export.

2.2.2.6 Liquified Natural Gas (LNG) Related Facilities

Tronox proposes to install and operate the following infrastructure on a ~ 450 m^2 concrete pad on a portion of vacant land within the current MSP operational area:

- Five LNG storage tanks (with a maximum combined storage capacity of 500 m^3);
- An LNG regasification plant; and
- A pump and control station.

The natural gas will be used as fuel for the existing dryers.

<u>Transportation of LNG Along Access Roads and Loading</u>

No new roads will be constructed. The existing MSP internal road network will be used to transfer LNG to the storage tanks. A dedicated loading bay is required on the pad for a truck and trailer. The loading bay is positioned so that the truck can drive onto the pad, transfer the LNG into the storage vessels and drive off the pad without requiring access into the fenced area of the LNG facility.

<u>LNG Storage</u>

LNG storage tanks are cryogenic as they store LNG at very low temperatures (-162° C) to maintain the LNG in its liquid form. The temperature is maintained by sustaining a constant pressure and allowing the <u>boil off gas</u> to escape from the tank and be fed to the vaporizers which feed natural gas as fuel to fire the burners. This is known as auto-refrigeration. The tanks have double containers - the inner vessel contains the LNG and the outer vessel contains insulation materials. The LNG storage tanks can be orientated horizontally or vertically (depending on their required application). Initially, three 100 m^3 vertical LNG storage tanks will be installed on the concrete pad. Two additional 100 m^3 vertical LNG storage tanks may be installed at a later stage. The LNG storage tanks will be loaded onto the pad with a mobile crane. The tanks will be bolted to the concrete slab and connected to the LNG regasification plant. The LNG storage tanks will be within the fenced area.

<u>Regasification Plant</u>

The Regasification Plant converts the LNG at -162° C to natural gas (NG) at atmospheric temperature suitable for the gas burners in the dryers. LNG is fed (pumped) through the vaporisers in the regasification plant. Using ambient air flow, the LNG is converted to natural gas. Cold, dry air and water are by-products of the conversion process. The natural gas will be fed to the dryers through a metering device on the boundary of the LNG Plant. The pumping/control station and regasification plant will be located on the concrete pad within the fenced area. The regasification plant will be equipped with instrumentation to monitor all process conditions and report the data to the MSP central control room. Monitoring systems and lockable isolation and bleed off systems will allow for maintenance work during operations (i.e. while the regassification plant is still pressurised).

<u>Pipelines and Dryer Burner Conversion</u>

Associated pipelines, less than 250 m in length, will be installed to convey the LNG from the regasification plant to the burner heads of each of the six dryers. The pipe will be bolted (with pipe brackets) to existing structures. The dryers will be re-equipped to allow for flexible conversion between paraffin and NG. The burner gas control system will be a dual fuel system using the new NG supply and the existing paraffin supply. The piping system will be equipped with monitoring systems and lockable isolation and bleed off systems to allow for maintenance work during operations (i.e. while other pipes are still pressurised).

2.2.3 Visual Representations of MSP Operations

The following visual representations of the MSP operations are provided:

- Figure 1 is a map indicating location within the region;
- Figure 2 is map indicating the location of Tronox NS MSP in relation to AQSRs and other land use;
- Figure 3 is a process flow diagram for the general Tronox NS operations; and
- Figure 4 is a process flow diagram for the MSP proposed operations

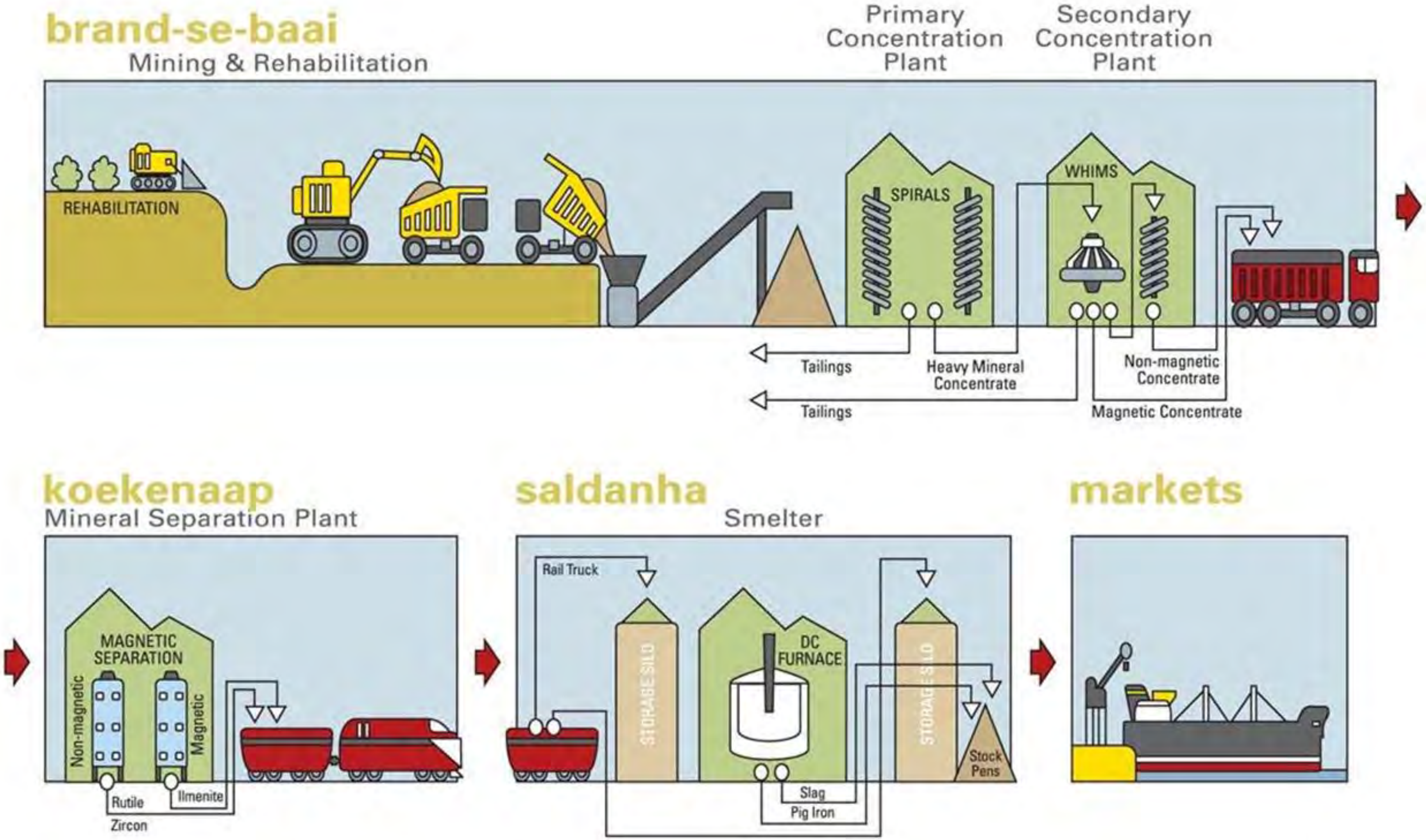

Figure 3: General process flow diagram (created by Tronox NS)

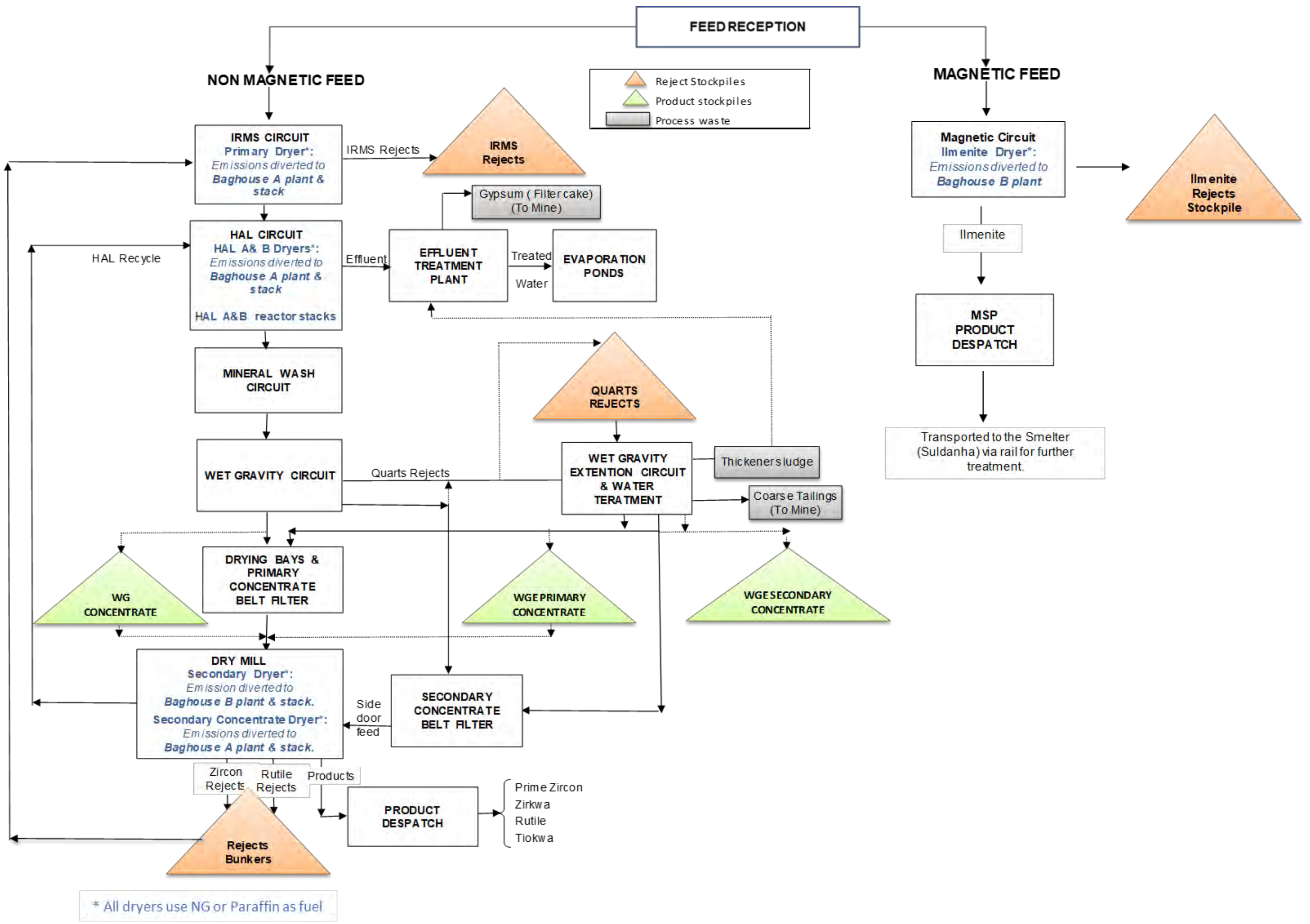

Figure 4: MSP process flow diagram (created by Tronox NS)

2.3 Unit Process or Processes

Unit processes considered listed activities under NEM:AQA are summarised in Table 6. Unit processes not considered listed activities under NEM:AQA are summarised in Table 7.

Table 6: List of unit processes considered listed activities under NEM:AQA

Name of the Unit Process	Unit Process Function	Listed Activity Sub-category	Batch or Continuous Process	Hours of Operation
Magnetic (Ilmenite Separation) Circuit	To process the magnetic material and produce the product ilmenite.	5.2 (SA0502)	Continuous	00:00 to 23:59 365 days per year
IRMS Circuit	To separate the moderately to strongly magnetic material from most of the garnet, ilmenite, monazite and the only slightly magnetic minerals.	5.2 (SA0502)	Continuous	00:00 to 23:59 365 days per year
HAL and Mineral Wash Circuit	To remove an iron-rich mineral coating, which affects separation and contributes to iron contamination of zircon products, from the upgraded non-magnetic feed originating from the IRMS Circuit.	5.2 (SA0502)	Continuous	00:00 to 23:59 365 days per year
Zircon, Zirkwa, Rutile and Tiokwa Separation Dry Mill Circuit	To process the feed it receives into the products zircon, zirkwa, rutile and tiokwa.	5.2 (SA0502)	Continuous	00:00 to 23:59 365 days per year

Table 7: List of unit processes not considered listed activities under NEM:AQA

Name of the Unit Process	Unit Process Function	Batch or Continuous Process	Hours of Operation
Feed reception	Reception of Magnetic and Non-magnetic material originating from the SCP at Brand-se-Baai as feed to the MSP.	Continuous	00:00 to 23:59 365 days per year
Wet Gravity Circuit	To separate the material originating from the HAL and Mineral Wash Circuit into the less dense non valuable minerals (like quartz, siliceous leucoxene, kyanite,	Continuous	00:00 to 23:59 365 days per year

Name of the Unit Process	Unit Process Function	Batch or Continuous Process	Hours of Operation
	garnet, pyriboles and other non-valuable minerals) and valuable zircon rich material.		
WGE Circuit	To process the quartz reject material to remove the remaining valuable zircon and other by-products from the material.	Continuous	00:00 to 23:59 365 days per year
By-product and mineral waste storage and disposal	To store material.	Continuous	00:00 to 23:59 365 days per year
Product storage & dispatch	To store and dispatch products.	Continuous	00:00 to 23:59 365 days per year
Effluent Treatment Plant	To neutralise acidic effluent.	Continuous	00:00 to 23:59 365 days per year
Regasification plant	Converts the LNG at -162° C to NG at atmospheric temperature suitable for the gas burners in the dryers.	Continuous	00:00 to 23:59 365 days per year
Other services	To provide various other services like electricity, parking, domestic effluent treatment, domestic waste disposal, LNG storage, NG to the burners, etc. essential to operation.	Continuous	00:00 to 23:59 365 days per year

3 TECHNICAL INFORMATION

Raw material consumption and production rates are included in Table 8 and Table 11 respectively. The pollution abatement technologies employed at the MSP for the point sources, and technical specifications thereof, are provided in Table 9. The mitigation measures applied to fugitive sources at the MSP are provided in Table 10.

3.1 Raw Material Used

Table 8: Raw materials used

Raw Material Type	Maximum Permitted Consumption Rate (Quantity)	Design Consumption Rate (Quantity)	Actual Average Consumption Rate (Quantity)	Unit (Quantity per Period)
Magnetic Feed	100	100	100	tonnes per hour
Non-magnetic Feed	60	60	60	tonnes per hour

3.2 Appliances and Abatement Equipment Control Technology

Table 9: Appliances and abatement equipment control technology for point sources

Appliances					Abatement Equipment Control Technology							
ID	Source Name	Appliance / Process Equipment Number	Appliance Type / Description	Appliance Serial Number	Abatement Equipment Manufacture Date	Abatement Equipment Name, Model and Number	Abatement Equipment Technology Type/ Name/ Description	Commission Date	Date of Significant Modification / Upgrade	Design Capacity	Minimum Control Efficiency (%)	Minimum Utilization (%)
SV000/ CD001	HAL A Dryer	5320-301	Dryer, unknown if direct or indirect	unknown	06/2019	CFW BC-MPGEC (fan)	Baghouse Filter Baghouse A Plant (Proposed Feedprep Baghouse) Emission abatement for HAL A Dryer, HAL B Dryer, Primary Dryer and Secondary Concentrate Dryer	31/12/2019	Not applicable	PM - 50 mg/Nm³	90	100
SV000/ CD001	HAL B Dryer	5320-302	Dryer, unknown if direct or indirect	unknown								
SV000/ CD001	Primary Dryer	5220-201	Dryer, unknown if direct or indirect	unknown								
SV000/ CD001	Secondary Concentrate Dryer	5520-542	Dryer, unknown if direct or indirect	unknown								
SV00/ CD004	Ilmenite Dryer	5820-801	Dryer, unknown if direct or indirect	unknown	06/2019	CFW BC-MPGEC (fan)	Baghouse Filter Baghouse B Plant (Proposed Mineral Separation Baghouse) Emission abatement for Ilmenite Dryer and Secondary Dryer	31/12/2019	Not applicable	PM - 50 mg/Nm³	90	100
SV00/ CD004	Secondary Dryer	5520-501	Dryer, unknown if direct or indirect	unknown								
SV0014/ CD007	Ilmenite Building Dust Extraction System and Baghouse Clean Air Outlet	5509-804	Dust extraction system	unknown	Unknown	58-22-801	Baghouse Ilmenite Section Dust Extraction System Ilmenite Building Dust Extraction System and Baghouse Clean Air Outlet	31/01/2002	31/12/2015	PM - 20 mg/Nm³	90	90
SV0015/ CD008	Rougher Circuit (Drymill) Dust Baghouse 1 Clean Air Outlet	5509-501	Dust extraction system	unknown	Unknown	55-22-501	Baghouse Rougher Dust Extraction Baghouse Rougher Circuit (Drymill) Dust Baghouse 1 Clean Air Outlet	31/01/2002	31/12/2015	PM - 20 mg/Nm³	90	90

Appliances					Abatement Equipment Control Technology							
ID	Source Name	Appliance / Process Equipment Number	Appliance Type / Description	Appliance Serial Number	Abatement Equipment Manufacture Date	Abatement Equipment Name, Model and Number	Abatement Equipment Technology Type/ Name/ Description	Commission Date	Date of Significant Modification / Upgrade	Design Capacity	Minimum Control Efficiency (%)	Minimum Utilization (%)
SV0016/ CD009	Rutile Circuit (Drymill) Dust Baghouse 2 Clean Air Outlet	5509-502	Dust extraction system	unknown	Unknown	55-22-502	Baghouse Rutile Circuit Dust Extraction System 2 Rutile Circuit (Drymill) Dust Baghouse 2 Clean Air Outlet	31/01/2002	31/12/2015	PM - 20 mg/Nm³	90	90
SV0017/ CD010	Zircon Circuit (Drymill) Dust Baghouse 2 Clean Air Outlet	5509-503	Dust extraction system	unknown	Unknown	55-22-503	Baghouse Zircon Circuit Dust Extraction System Zircon Circuit (Drymill) Dust Baghouse 2 Clean Air Outlet	31/01/2002	31/12/2015	PM - 20 mg/Nm³	90	90
SV0018/ CD011	IRMS Circuit (Drymill) Dust Extraction System with Baghouse Clean Air Outlet	5209-201	Dust extraction system	unknown	Unknown	55-22-201	Baghouse IRMS Circuit Dust Extraction System IRMS Circuit (Drymill) Dust Extraction System with Baghouse Clean Air Outlet	31/01/2002	31/12/2015	PM - 20 mg/Nm³	90	90

Table 10: Area and/or line source – management and mitigation measures

ID	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
EU1001/A01	Windbreaks on inactive parts of stockpile	Once up - Continuous	Maintenance & Housekeeping Inspections Fall-out dust monitoring (ASTM D1739)	Remedial actions based on root cause(s) identified during incident investigation
	Dust suppression with Water on road	Once a day		
	Dorbank cover layer on older sections of the dump	Continuous		
EU1002/A02	Windbreaks on inactive parts of stockpile	Within 1 Months of an area of stockpile becoming inactive Once up - Continuous		
	Dust suppression with Water on road	Once a day		
	Processing of stockpile to Reduce stockpile size	Continuous		

EU1003/A03	Windbreaks on the South and Western side Hard padding area	Continuous		
EU1004/A04	Windbreaks around bunker	Continuous		
EU1005/A05	No topsoil tipping during windy conditions Topsoil kept in borrow-pit, ensuring no heap higher than the walls of borrow pit.	Continuous		
EU1006/A06	Product moist (5%) Dust suppression with Water - Road and Parking area	Continuous		
EU1007/A07	No stockpiling of material outside of demarcated bunkers Windbreaks around bunkers Material removal/clean-up from stockpile bunkers and surrounding area	Continuous		
EU1008/A08	Enclosures around areas	Continuous		
EU1009/A09	Clean-up of loose material Hard padded area	Once a week		
EU1010/A10	No stockpiling of material outside of demarcated bunkers Wetting of open areas accessible by truck and / roads	Continuous		
EU1011/A11	No stockpiling of material outside of demarcated bunkers Wetting of open areas accessible by truck and / roads	Continuous		
EU1012/A12	Windbreaks around bunkers No stockpiling of material outside of demarcated bunker	Continuous		
EU1013/A13	Windbreaks around bunkers No stockpiling of material outside of demarcated bunkers	Continuous		
EU1014/A14	Dorbank cover layer	Continuous		
EU1015/A15	Hard padding of area	Continuous		
EU1016/A16	Semi-enclosed area around sandblasting yard Sandblasting to occur within Semi-enclosed area	Continuous		
EU1017/A17	Dust suppression with water	Continuous		
EU1018/A18	Hard padding (compaction) of area	Continuous		
EU1019/A19	Dust suppression with water on road Hard padding of area with dorbank	Continuous		
EU1020/A20	Hardpadding of area with dorbank Carpark shade netting	Continuous		
EU1021/A21	Windbreaks on inactive parts of stockpile	Once up - Continuous		
	Dust suppression with Water on road	Once a day		

EU1022/A22	No material handling during windy conditions	Continuous		
EU1023/A23	No measures required	-		
EU2001/L01	Dust suppression with Water	Once a day		
EU2002/L02	Dust suppression with Water	Once a day		
EU2003/L03	Dust suppression with Water	Once a day		
EU2004/L04	Doghousesheeting (Wind protection enclosure) around conveyor	Continuous		
EU2005/L05	Doghousesheeting (Wind protection enclosure) around conveyor	Continuous		
EU2006/L06	No measures required	-		
EU2007/L07	Dust suppression with Water	Once a day		
EU2008/L08	Clean-up of loose material Tarred road	Once a week		
EU2009/L09	No measures required Tarred road	-		
EU2010/L10	Dust suppression with Water	Once a day		
EU2011/L11	Dust suppression with Water	Once a day		
EU2012/L12	Dust suppression with Water	Once a day		
EU2013/L13	Dust suppression with Water	Once a day		

3.3 Production Rates

Table 11: Production Rates

Product Name	Maximum Permitted Production Rate (Quantity)	Design Production Rate (Quantity)	Actual Average Production Rate (Quantity)	Unit (Quantity per Period)
Non-Magnetic products (Zircon, Zirkwa, Rutile, Tiokwa)	400 000	400 000	400 000	tonnes per annum
Magnetic products (Ilmenite)	630 000	630 000	630 000	tonnes per annum

3.4 Fuel Use

Table 12: Fuel usage

Raw Material Type	Maximum Permitted Consumption Rate (Quantity)	Design Consumption Rate (Quantity)	Actual Average Consumption Rate (Quantity)	Unit (Quantity per Period)
NG	803	803	712	cubic metres per hour
Paraffin	8 100 000	8 100 000	8 100 000	litres per annum

Notes: the two fuel types will not be used simultaneously; NG is the preferred fuel while the paraffin is a backup fuel

3.5 Assumptions, Limitations and Exclusions

The following important assumptions, exclusions and limitations to the specialist study should be noted:

1. All information required to calculate emissions for the operations were provided by SRK Consulting (South Africa) (Pty) Ltd and Tronox Mineral Sand (Pty) Ltd.
2. The impact of the MSP operations using NG as the fuel source was determined quantitatively through emissions calculation, provided baghouse A and B plant stack parameters and simulation.
3. Meteorology:
    a. The National Code of Practice for Air Dispersion Modelling prescribes the use of a minimum of 1-year on-site data or at least three years of appropriate off-site data for use in Level 2 assessments. It also states that the meteorological data must be for a period no older than five years to the year of assessment.
    b. In the absence of on-site meteorological data, use was made of the Weather Research and Forecasting (WRF) data.
    c. The meteorological data used was for the period 1 January 2015 to 31 December 2017. Therefore, the data set applied in this study complies with the requirements of the code of practice.
4. The estimation of greenhouse gas (GHG) emissions was included even though under the listed activity pertaining to this Atmospheric Emission Licence (AEL) application, no Minimum Emission Standards (MES) are specified for GHG pollutants. Reference is made to GHG emission reporting regulations as all

existing facilities are required to report emissions on the National Atmospheric Emission Inventory System (NAEIS).

5. Emissions:
    a. The impact assessment was limited to airborne particulates (including total suspended particulates (TSP), inhalable particulate matter (PM) less than 10 µm in diameter (PM_{10}) and inhalable PM less than 2.5 µm in diameter ($PM_{2.5}$) and gaseous pollutants from the baghouse stacks included oxides of nitrogen (NO_x) and sulphur dioxide (SO_2). These pollutants are either regulated under MES or National Ambient Air Quality Standards (NAAQS).
    b. There are no other industries adjacent to the MSP operations thus the estimation of air emissions from other industries were not included.
    c. The point sources (baghouse stacks) emissions were based on the design PM emission and emission calculations using emission factors provided in the Unites States Environmental Protection Agency (US EPA) AP42 emission estimation technique manual for Natural Gas combustion.
    d. As site specific silt content data was not available, use was made of the average provided in the US EPA AP42 emission estimation technique manual for unpaved roads.
    e. Emissions for other activities in the area, such as agricultural activities, biomass burning, residential fuel burning, wind erosion from open areas, vehicles travelling on public and private roads (comprising of vehicle entrainment on the roads and vehicle exhaust) were not estimated due to their complexity and lack of information on these sources.
6. Dispersion simulations:
    a. All significant fugitive sources were simulated with the current mitigation measures applied.
    b. Estimated stack emissions (using US EPA AP42 emission estimation technique manual for Natural Gas combustion) were included in the dispersion simulation task.
    c. It was assumed that all NO_x emitted is converted to NO_2.

4 ATMOSPHERIC EMISSIONS

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from MSP operations on the receiving environment. The MSP generates fugitive emissions as well as process emissions including the dryers operating using NG as a fuel source, emitting through Baghouse A plant and Baghouse B plant. Fugitive emissions (discussed in Section 4.4) refer to emissions that are distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (discussed in Section 4.1).

Point source (dryers via the baghouse stacks) emissions are included as single point sources since these are captured and vented to the atmosphere via stacks. Source parameters and emission rates are included in Table 13 and Table 14. Methods used in the estimation of these emissions are included in Table 15.

4.1 Point Source Parameters

Table 13: Point source parameters

ID	Source Name	Stack Orientation	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m^3/hr)	Actual Gas Exit Velocity (m/s)
SV0001	HAL A dryer (stack to be decommissioned by 2020)	Vertical	-31.461242	18.286501	32.2	0.0	0.63	-	-	-
SV0002	HAL B dryer (stack to be decommissioned by 2020)	Vertical	-31.461287	18.286500	37.2	1.2	0.75	-	-	-
SV0003	HAL A reactor	Vertical	-31.460000	18.280000	12.0	0.0	0.63	55	2076	5.01
SV0004	HAL B reactor	Vertical	-31.330000	18.330000	12.0	1.2	0.75	68	2338	5.62
SV0005	Primary dryer (stack to be decommissioned by 2020)	Vertical	-31.461206	18.286523	36.4	0.0	0.39	-	-	-
SV0006	Secondary dryer (stack to be decommissioned by 2020)	Vertical	-31.461283	18.287184	37.3	0.0	0.39	-	-	-
SV0007	Ilmenite dryer (stack to be decommissioned by 2020)	Vertical	-31.461276	18.287258	38.7	0.4	0.60	-	-	-
SV0008	Secondary concentrate dryer (stack to be decommissioned by 2020)	Vertical	-31.461484	18.286852	30.3	1.3	0.76	-	-	-
SV000[a]	Baghouse A plant (stack to be commissioned end 2019)	Vertical	-31.461708	18.286577	27.0	-5.0	1.1	72	108794	31.8
SV00[b]	Baghouse B plant (stack to be commissioned end 2019)	Vertical	-31.461443	18.287592	27.0	-5.0	1.1	75	78003	22.8
SV0009[c]	Laboratory sample preparation room 1 mill dust extraction outlet	Horizontal	-31.461776	18.287457	4.0	0.0	1.20	29	36	1.2
SV0010[c]	Laboratory sample preparation room 1 acid fume extraction outlet	Horizontal	-31.461702	18.287608	3.0	0.0	0.24	25	1836	11.0
SV0011[c]	Laboratory sample preparation room 1 heat extraction fan outlet	Horizontal	-31.461703	18.287583	2.5	0.0	0.30	unknown	unknown	unknown
SV0012[c]	Laboratory sample preparation room 2 dust extraction outlet	Horizontal	-31.461823	18.287668	2.5	0.0	0.30	unknown	unknown	unknown
SV0013[c]	Laboratory fusion room heat and fume extraction outlet	Horizontal	-31.461835	18.287663	2.5	0.0	0.30	unknown	unknown	unknown
SV0014	Ilmenite building dust extraction baghouse clean air outlet	Horizontal	-31.461452	18.287482	5.5	0.0	1.60	20	53640	7
SV0015	Rougher circuit (drymill) dust extraction baghouse 1 clean air outlet	Horizontal	-31.461101	18.287216	5.5	0.0	1.60	20	45360	6
SV0016	Rutile circuit (drymill) dust extraction baghouse 2 clean air outlet	Horizontal	-31.461073	18.287128	5.5	0.0	1.60	20	49680	7
SV0017	Zircon dust extraction baghouse clean air outlet	Horizontal	-31.461010	18.286881	4.2	0.0	1.10	20	45000	6
SV0018	IRMS dust extraction baghouse clean air outlet	Horizontal	-31.460988	18.286721	5.5	0.0	1.60	56	42800	5
SV0019[c]	Ilmenite heat extraction fan outlet	Horizontal	-31.461553	18.287262	40.0	5.0	1.52	unknown	unknown	unknown
SV0020[c]	Dry mill heat extraction fan outlet	Horizontal	-31.461504	18.287006	40.0	5.0	0.79	unknown	unknown	unknown
SV0021[c]	IRMS heat and dust extraction fan outlet	Horizontal	-31.461456	18.286794	40.0	5.0	1.26	unknown	unknown	unknown
SV0022[c]	Ilmenite heat extraction fan 2 outlet	Horizontal	-31.461600	18.287135	40.0	5.0	1.52	unknown	unknown	unknown
SV0023[c]	Dry mill heat extraction fan 2 outlet	Horizontal	-31.461544	18.286880	40.0	5.0	1.50	unknown	unknown	unknown
SV0024[c]	IRMS heat extraction fan 2 outlet	Horizontal	-31.461501	18.286684	40.0	5.0	0.78	unknown	unknown	unknown
SV0025[c]	HAL heat extraction 1	Horizontal	-31.461480	18.286587	40.0	5.0	unknown	unknown	unknown	unknown
SV0026[c]	HAL heat extraction 2	Horizontal	To be provided	To be provided	40.0	5.0	unknown	unknown	unknown	unknown

Notes:

(a) Proposed dryers stack abatement equipment, to be commissioned by end of 2019: Abatement for HAL A Dryer, HAL B Dryer, Primary Dryer and Secondary Dryer. This will replace SV0001, SV0002, SV0005 and SV0008 as point of emission.

(b) Proposed dryers stack abatement equipment, to be commissioned by end of 2019: Abatement for Ilmenite Dryer and Secondary Concentrate Dryer. This will replace SV0007 and SV0006 as point of emission.

(c) Emissions of pollutants are expected to be negligible (immaterial in relation to the other sources) or non-existent.

4.2 Point Source Maximum Emission Rates (Normal Operating Conditions)

Table 14: Point source emissions

ID	Pollutant Name	MES[(a)]		Maximum Release Rate			Average Release Rate				Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		Existing (mg/Nm³)	New (mg/Nm³)	mg/Nm³	g/s	t/a	mg/Nm³	mg/Am³	g/s	t/a		
SV0003/ EU0003	H_2SO_4	-	-	121.06	$6.17x10^{-02}$	1.94	121.06	100.78	$6.17x10^{-02}$	1.94	24 hours/day	Continuous
SV0004/ EU0004	H_2SO_4	-	-	22.16	$3.34x10^{-02}$	1.05	22.16	17.74	$3.34x10^{-02}$	1.05	24 hours/day	Continuous
SV000[(b)]	PM (1462)	100	50	50	1.20	37.7	30.0	23.7	0.717	22.6	24 hours/day	Continuous
	NOx expressed as NO_2 (1310)	1 200	500	500	12.0	377	9.75	7.71	0.233	7.35	24 hours/day	Continuous
	SO_2 (1593)	1 000	1 000	1 000	23.9	754	0.023	0.018	$5.39x10^{-04}$	0.017	24 hours/day	Continuous
	CO	-	-	1.376	$3.29x10^{-02}$	1.04	1.376	1.09	$3.29x10^{-02}$	1.04	24 hours/day	Continuous
	CO_2	-	-	6881	165	5 189	6 881	5 445	165	5 189	24 hours/day	Continuous
	N_2O	-	-	0.126	$3.02x10^{-03}$	0.095	0.126	0.100	$3.02x10^{-03}$	0.095	24 hours/day	Continuous
	CH_4	-	-	0.132	$3.15x10^{-03}$	0.099	0.132	0.104	$3.15x10^{-03}$	0.099	24 hours/day	Continuous
	Pb	-	-	$2.87x10^{-05}$	$6.86x10^{-07}$	$2.16x10^{-05}$	$2.87x10^{-05}$	$2.27x10^{-05}$	$6.86x10^{-07}$	$2.16x10^{-05}$	24 hours/day	Continuous
SV00[(c)]	PM (1462)	100	50	50	0.850	26.8	30.0	23.5	0.510	16.1	24 hours/day	Continuous
	NOx expressed as NO_2 (1310)	1 200	500	500	8.50	268	22.0	17.3	0.374	11.8	24 hours/day	Continuous
	SO_2 (1593)	1 000	1 000	1 000	17.0	536	$5.09x10^{-02}$	$3.99x10^{-02}$	$8.65x10^{-04}$	$2.73x10^{-02}$	24 hours/day	Continuous
	CO	-	-	3.11	$5.28x10^{-02}$	1.66	3.11	2.44	$5.28x10^{-02}$	1.66	24 hours/day	Continuous
	CO_2	-	-	15 526	264	8 323	15 526	12 180	264	8 323	24 hours/day	Continuous
	N_2O	-	-	0.285	$4.84x10^{-03}$	0.153	0.285	0.223	$4.84x10^{-03}$	0.153	24 hours/day	Continuous
	CH_4	-	-	0.298	$5.06x10^{-03}$	0.160	0.298	0.233	$5.06x10^{-03}$	0.160	24 hours/day	Continuous
	Pb	-	-	$6.47x10^{-05}$	$1.10x10^{-06}$	$3.47x10^{-05}$	$6.47x10^{-05}$	$5.07x10^{-05}$	$1.10x10^{-06}$	$3.47x10^{-05}$	24 hours/day	Continuous

ID	Pollutant Name	MES(a)		Maximum Release Rate			Average Release Rate				Emissions Hours	Type of Emissions (Continuous / Routine but Intermittent / Emergency Only)
		Existing (mg/Nm^3)	New (mg/Nm^3)	mg/Nm^3	g/s	t/a	mg/Nm^3	mg/Am^3	g/s	t/a		
SV0009/ EU0009	PM (1462)	-	-	-			Expected to be negligible (immaterial in relation to the other sources)				24 hours/day	Continuous
SV0010/ EU0010	H_2SO_4	-	-	-			Expected to be negligible (immaterial in relation to the other sources)				24 hours/day	Continuous
SV0011/ EU0011	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0012/ EU0012	PM (1462)	-	-	-			Expected to be negligible (immaterial in relation to the other sources)				24 hours/day	Continuous
SV0013/ EU0013	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0014/ EU0014	PM (1462)	-	-	-			20	18.63	2.78×10^{-01}	8.76	24 hours/day	Continuous
SV0015/ EU0015	PM (1462)	-	-	-			20	18.63	2.35×10^{-01}	7.40	24 hours/day	Continuous
SV0016/ EU0016	PM (1462)	-	-	-			20	18.63	2.57×10^{-01}	8.11	24 hours/day	Continuous
SV0017/ EU0017	PM (1462)	-	-	-			20	18.63	2.33×10^{-01}	7.35	24 hours/day	Continuous
SV0018/ EU0018	PM (1462)	-	-	-			20	16.60	1.97×10^{-01}	6.22	24 hours/day	Continuous
SV0019/ EU0019	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0020/ EU0020	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0021/ EU0021	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0022/ EU0022	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0023/ EU0023	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0024/ EU0024	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0025/ EU0025	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous
SV0026/ EU0026	(d)	-	-	-			-	-	-	-	24 hours/day	Continuous

Notes:

(a) Existing plants had to comply with minimum emission standards for existing plant since 01 April 2015. Extension on the date was applied for by Tronox Mineral Sands due to inability to achieve this date; however, no authorisation or consultation from Authorities on this application was ever issued.

Existing plants must comply with minimum emission standards for new plant by 01 April 2020.

(b) Proposed dryers stack abatement equipment, to be commissioned by end of 2019: Abatement for HAL A Dryer, HAL B Dryer, Primary Dryer and Secondary Dryer. This will replace SV0001, SV0002, SV0005 and SV0008 as point of emission.

(c) Proposed dryers stack abatement equipment, to be commisioned by end of 2019: Abatement for Ilmenite Dryer and Secondary Concentrate Dryer. This will replace SV0007 and SV0006 as point of emission.

(d) These are outlets associated with heat extraction and may contain small amounts of PM (1462) from process operations.

4.2.1 Point Source Emission Estimation Methods (Normal Operating Conditions)

Mainly measured emissions were used for the MSP operations. These are summarised, per source, in Table 15.

Table 15: Point source emission estimation information

ID	Basis for Emission Rates
SV0003/ EU0003	H_2SO_4 - Average of isokinetic sampling undertaken by Earth and Occupational Health Sciences in March 2016
SV0004/ EU0004	H_2SO_4 - Average of isokinetic sampling undertaken by Earth and Occupational Health Sciences in November 2016
SV000[(a)]	PM (Maximum) – New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2 PM (Average) – Baghouse design emissions
	NO_x expressed as NO_2 (Maximum) - New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2 NO_x expressed as NO_2 (Average) -
	SO_2 - New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2
	CO - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 309 m³/h
	CO_2 - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 309 m³/h
	N_2O - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 309 m³/h
	CH_4 - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 309 m³/h
	Pb - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 309 m³/h
SV00[(b)]	PM – New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2
	NO_x expressed as NO_2 - New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2
	SO_2 - New plant Minimum Emission Standards (MES) for listed activity subcategory 5.2
	CO - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 495 m³/h
	CO_2 - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 495 m³/h
	N_2O - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 495 m³/h

ID	Basis for Emission Rates
	CH_4 - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 495 m³/h
	Pb - US EPA single valued emission factor for uncontrolled NG combustion emissions (US EPA, 1998); total associated dryers NG fuel usage of approximately 495 m³/h
SV0009/ EU0009[c]	Not Applicable
SV0010/ EU0010[c]	Not Applicable
SV0011/ EU0011[d]	Not Applicable
SV0012/ EU0012[c]	Not Applicable
SV0013/ EU0013[d]	Not Applicable
SV0014/ EU0014	PM - Design Capacity
SV0015/ EU0015	PM - Design Capacity
SV0016/ EU0016	PM - Design Capacity
SV0017/ EU0017	PM - Design Capacity
SV0018/ EU0018	PM - Design Capacity
SV0019/ EU0019[d]	Not Applicable
SV0020/ EU0020[d]	Not Applicable
SV0021/ EU0021[d]	Not Applicable
SV0022/ EU0022[d]	Not Applicable
SV0023/ EU0023[d]	Not Applicable
SV0024/ EU0024[d]	Not Applicable
SV0025/ EU0025[d]	Not Applicable
SV0026/ EU0026[d]	Not Applicable

Notes:

(a) Proposed dryers stack abatement equipment, to be commissioned in 2019: Abatement for HAL A Dryer, HAL B Dryer, Primary Dryer and Secondary Dryer. This will replace SV0001, SV0002, SV0005 and SV0008.

(b) Proposed dryers stack abatement equipment, to be commissioned by end of 2019: Abatement for Ilmenite Dryer and Secondary Concentrate Dryer. This will replace SV0007 and SV0006.

(c) Expected to be negligible (immaterial in relation to the other sources)

(d) These are outlets associated with heat extraction and may contain small amounts of PM (1462) from process operations.

4.3 Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down

The scope of this study did not include the quantification of emissions during start-up, maintenance or shut down. Tronox NS only conducts periodic measurements which makes it difficult to establish maximum emissions during start-up, shut-down, maintenance or upset conditions, since periodic measurements cannot pin-point exactly when the maximum emission rate will occur. The main reason maximum values cannot be predicted with periodic sampling, in this case, is that the sampling methods prescribe fixed time periods during which a sample must be taken. In addition, the timing of specific conditions leading to an absolute maximum emission rate is not predictable, meaning that the sampling period and the conditions resulting in the upsets are unlikely to occur concurrently; hence it cannot be guaranteed that a maximum emission rate will be reached at a specific condition. Potential start up, maintenance, shut down, upset conditions and associated responses related to the operations at the site of the works are however qualitatively discussed in Table 16.

Table 16: Emission during start-up, maintenance, upset and/or shut-down

Unit Process	ID	Description of Occurrence of Potential Releases	Pollutants and associated amount of emissions	
			Pollutant	mg/Nm³
HAL A Reactor	SV0003/ EU0003	Start-up	H_2SO_4	Likely higher than normal operations emissions
		Shut-down	H_2SO_4	Likely lower than normal operations emissions
		Maintenance	No emission generated during maintenance	
		Upset/emergency	H_2SO_4	Higher than normal operations emissions
HAL B Reactor	SV0004/ EU0004	Start-up	H_2SO_4	Likely higher than normal operations emissions
		Shut-down	H_2SO_4	Likely lower than normal operations emissions
		Maintenance	No emission generated during maintenance	
		Upset/emergency	H_2SO_4	Higher than normal operations emissions
Baghouse A plant **including the following dryers' operations**: HAL A dryer HAL B dryer Primary dryer Secondary concentrate dryer	SV000	Start-up and shut-down	PM	Likely similar to normal operations emissions
			NO_x expressed as NO_2	
			SO_2	
		Maintenance	No emission generated during maintenance	
		Upset/Emergency	PM	Likely higher than normal operations emissions
			NO_x expressed as NO_2	
			SO_2	
Baghouse B plant **including the following dryers' operations**: Ilmenite dryer Secondary dryer	SV00	Start-up and shut-down	PM	Likely similar to normal operations emissions
			NO_x expressed as NO_2	
			SO_2	
		Maintenance	No emission generated during maintenance	
		Upset/Emergency	PM	Likely higher than normal operations emissions
			NO_x expressed as NO_2	
			SO_2	
Laboratory sample preparation room 1 mill dust extraction outlet	SV0009/ EU0009[(c)]	Start-up, shut-down Upset/Emergency	PM (1462)	Expected to be negligible (immaterial in relation to the other sources)

Unit Process	ID	Description of Occurrence of Potential Releases	Pollutants and associated amount of emissions	
			Pollutant	mg/Nm³
Laboratory sample preparation room 1 acid fume extraction outlet	SV0010/ EU0010[c]	Start-up, shut-down Upset/Emergency	H_2SO_4	Expected to be negligible (immaterial in relation to the other sources)
Laboratory sample preparation room 1 heat extraction fan outlet	SV0011/ EU0011[d]	Start-up, shut-down Upset/Emergency	[d]	-
Laboratory sample preparation room 2 dust extraction outlet	SV0012/ EU0012[c]	Start-up, shut-down Upset/Emergency	PM (1462)	Expected to be negligible (immaterial in relation to the other sources)
Laboratory fusion room heat and fume extraction outlet	SV0013/ EU0013[d]	Start-up, shut-down Upset/Emergency	[d]	-
Ilmenite building dust extraction baghouse clean air outlet	SV0014/ EU0014	Start-up, shut-down Upset/Emergency	PM (1462)	20
Rougher circuit (drymill) dust extraction baghouse 1 clean air outlet	SV0015/ EU0015	Start-up, shut-down Upset/Emergency	PM (1462)	20
Rutile circuit (drymill) dust extraction baghouse 2 clean air outlet	SV0016/ EU0016	Start-up, shut-down Upset/Emergency	PM (1462)	20
Zircon dust extraction baghouse clean air outlet	SV0017/ EU0017	Start-up, shut-down Upset/Emergency	PM (1462)	20
IRMS dust extraction baghouse clean air outlet	SV0018/ EU0018	Start-up, shut-down Upset/Emergency	PM (1462)	20
Ilmenite heat extraction fan outlet	SV0019/ EU0019[d]	Start-up, shut-down Upset/Emergency	[d]	-
Dry mill heat extraction fan outlet	SV0020/ EU0020[d]	Start-up, shut-down Upset/Emergency	[d]	-
IRMS heat and dust extraction fan outlet	SV0021/ EU0021[d]	Start-up, shut-down Upset/Emergency	[d]	-
Ilmenite heat extraction fan 2 outlet	SV0022/ EU0022[d]	Start-up, shut-down Upset/Emergency	[d]	-
Dry mill heat extraction fan 2 outlet	SV0023/ EU0023[d]	Start-up, shut-down Upset/Emergency	[d]	-
IRMS heat extraction fan 2 outlet	SV0024/ EU0024[d]	Start-up, shut-down Upset/Emergency	[d]	-
HAL heat extraction 1	SV0025/ EU0025[d]	Start-up, shut-down Upset/Emergency	[d]	-
HAL heat extraction 2	SV0026/ EU0026[d]	Start-up, shut-down Upset/Emergency	[d]	-

Notes:

(a) Proposed dryers stack abatement equipment, to be commissioned in 2019: Abatement for HAL A Dryer, HAL B Dryer, Primary Dryer and Secondary Dryer. This will replace SV0001, SV0002, SV0005 and SV0006.

(b) Proposed dryers stack abatement equipment, to be commissioned by end of 2019: Abatement for Ilmenite Dryer and Secondary Concentrate Dryer. This will replace SV0007 and SV0008.

(c) Expected to be negligible (immaterial in relation to the other sources)

(d) These are outlets associated with heat extraction and may contain small amounts of PM (1462) from process operations.

4.3.1 Point Source Emission Estimation Methods (Start-up, Maintenance, Upset and/or Shut-down)

Tronox NS only conducts periodic measurements which makes it difficult to establish maximum emissions during start-up, shut-down, maintenance or upset conditions, since periodic measurements cannot pin-point exactly when the maximum emission rate will occur. The main reason maximum values cannot be predicted with periodic sampling, in this case, is that the sampling methods prescribe fixed time periods during which a sample must be taken. In addition, the timing of specific conditions leading to an absolute maximum emission rate is not predictable, meaning that the sampling period and the conditions resulting in the upsets are unlikely to occur concurrently; hence it cannot be guaranteed that a maximum emission rate will be reached at a specific condition.

4.4 Fugitive Emissions (Area and Line Sources)

All quantifiable (significant) fugitive emissions are included in this section. The most significant fugitive source emissions are included as line sources. Source parameters and emission rates are included in Table 17 and Table 18. Methods used in the estimation of these emissions are included in Table 19.

4.4.1 Fugitive Source Parameters

Table 17: Area and volume source parameters

ID	Source Name	Source Description	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
EU1001/ A01	IRMS Stockpile	IRMS stockpile: sources of particulate matter are wind disturbance (erosion) and material handling	-31.457045	18.276987	2	380	245	0
EU1002/ A02	Quartz reject stockpile	Quartz reject stockpile: sources of particulate matter are wind disturbance (erosion) and material handling	-31.458072	18.280455	3	240	190	0
EU1003/ A03	Truck waiting area	Truck waiting area: where trucks collecting quartz rejects park; sources of particulate matter are wind disturbance (erosion) and vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of unpaved area dust)	-31.458296	18.279724	0.5	85	39	135
EU1004/ A04	Separation rejects bunker no. 3	Separation bunker 3: Netted bunker where rejects material is stored; sources of particulate matter are wind disturbance (erosion) and material handling	-31.455442	18.279661	2	150	92	135
EU1005/ A05	Topsoil storage area	Topsoil storage area: where topsoil for rehabilitation of disturbed areas and stockpiles is stored; sources of particulate matter are wind disturbance (erosion) and material handling	-31.450618	18.281797	2	200	55	135
EU1006/ A06	Reception hopper area	Reception hopper area: delivery of raw material (magnetic and non-magnetic) from SCP; sources of particulate matter are the offloading of material, vehicle movement and wind disturbance (erosion)	-31.459659	18.286258	0.5	240	75	45
EU1007/ A07	Plant rejects bunkers	Plant rejects bunkers: partially protected bunkers for temporary storage of all plant reject materials prior to removal for final storage; sources of particulate matter include materials handling, vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of unpaved area dust) and wind disturbance (erosion)	-31.460826	18.286419	2	165	107	45

ID	Source Name	Source Description	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
EU1008/ A08	Eskom yard area	Eskom yard area: Eskom and related infrastructure; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of unpaved area dust) and wind disturbance (erosion)	-31.461147	18.287465	0.5	150	70	22
EU1009/ A09	Office and workshop complex	Office and workshop area: most of the area is tarred and paved; sources of particulate matter include vehicle movement (re-entrainment of surface material) and disturbance of surface material by wind	-31.462474	18.287264	0.5	200	130	0
EU1010/ A10	MSP plant area	MSP plant area: MSP plant and surrounding open areas; sources of particulate matter include materials handling, vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.462005	18.286083	0.5	160	150	0
EU1011/ A11	Effluent plant area	Effluent plant area: Effluent plant and surrounding open areas; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.461650	18.284997	0.5	100	85	0
EU1012/ A12	Non-magnetic spillage bunker	Non-magnetic materials bunker area: partially protected, netted bunkers for the storage of reject materials; sources of particulate matter include materials handling, vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.461169	18.284380	2	63	6	225
EU1013/ A13	Separation rejects bunker	Separation rejects bunker area: partially protected, netted bunkers for the storage of reject materials; sources of particulate matter include materials handling, vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.459476	18.281013	2	310	95	135
EU1014/ A14	Ilmenite rejects bunker - covered	Covered ilmenite rejects stockpile: covered stockpile; sources of particulate matter include wind disturbance (erosion)	-31.461822	18.283817	0.5	120	80	0
EU1015/ A15	Contractors yard area 1	Contractors yard area 1: office and workshop area for contactors; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.462554	18.284769	0.5	130	40	135
EU1016/ A16	Contractors yard area 2 - sandblasting area	Contractors yard area 2: office and workshop area for sandblasting contactors; sources of particulate matter include sandblasting, vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.463263	18.285600	1	45	25	315
EU1017/ A17	Contractors yard area 3 - Africana	Contractors yard area 3: office and workshop area for EMV contactors; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of	-31.462680	18.286392	0.5	45	35	270

ID	Source Name	Source Description	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
		surface as well as re-entrainment of area dust) and wind disturbance (erosion)						
EU1018/ A18	Salvage yard	Salvage yard: unpaved yard for storage of salvageable equipment; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.462874	18.286861	0.5	110	50	90
EU1019/ A19	Bus parking/sewage plant area	Bus parking/ sewage plant area: unpaved area; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.463229	18.286888	0.5	170	45	90
EU1020/ A20	Employee parking area	Employee parking area: unpaved area; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area material) and wind disturbance (erosion)	-31.462863	18.289410	0.5	95	25	22.5
EU1021/ A21	Ilmenite reject stockpile	Ilmenite reject stockpile: stockpile for the storage of ilmenite reject materials; sources of particulate matter are wind disturbance (erosion) and material handling	-31.459779	18.291869	2	750	580	0
EU1022/ A22	Landfill	Landfill: open surface for the disposal of waste; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of area dust) and wind disturbance (erosion)	-31.463297	18.296398	0.5	320	130	22
EU1023/ A23	Emergency toe dam	Emergency toe dam: effluent emergency toe dam; sources of particulate matter include wind disturbance (erosion)	-31.467404	18.299457	0.5	110	70	0
EU2001/ L01	Road to IRMS reject stockpile	Road to IRMS reject stockpile: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.460528	18.285045	0.5	1220	10	315
EU2002/ L02	Road to quarts reject stockpile	Road to quarts reject stockpile: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.460703	18.285107	0.5	1344	10	0
EU2003/ L03	Rail road	Rail road: unpaved road adjacent to railway line; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.461474	18.288583	0.5	750	10	135
EU2004/ L04	Feed conveyor 1	Feed conveyor 1: covered (with doghouse sheeting) conveyor from reception hoppers to plant; sources of particulate matter are and disturbance of fine material by wind and material transfer points along conveyor	-31.461030	18.286757	0.5	270	10	135
EU2005/	Feed conveyor 2	Feed conveyor 2: covered (with doghouse sheeting) conveyor from reception hoppers to plant; sources of	-31.461107	18.287273	0.5	190	10	135

ID	Source Name	Source Description	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
L05		particulate matter are and disturbance of fine material by wind and material transfer points along conveyor						
EU2006/ L06	Road to Eskom yard	Road to Eskom yard: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.461104	18.287393	0.5	390	10	90
EU2007/ L07	Road to contractor yards	Road to contractor yards: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.462714	18.288501	0.5	485	10	270
EU2008/ L08	Road to offices, workshops and plant	Road to offices, workshops and plant: paved road; sources of particulate matter include vehicle movement (re-entrainment of material on the road surface) and disturbance of loose material on the road surface by wind	-31.462714	18.288501	0.5	365	10	270
EU2009/ L09[a]	Entrance road from R363	Road to/from R363: paved road entering the site; sources of particulate matter include vehicle movement (re-entrainment of material on the road surface) and disturbance of loose material on the road surface by wind	-31.462702	18.290702	0.5	210	10	225
EU2010/ L10	Stores delivery road	Stores delivery road: unpaved road to/from stores entrance for large delivery vehicles; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.462401	18.291442	0.5	390	10	270
EU2011/ L11	Road to ilmenite reject stockpile	Road to ilmenite reject stockpile: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.458226	18.287934	0.5	500	10	90
EU2012/ L12	Road to domestic waste site	Road to domestic waste site: unpaved road; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.462446	18.291417	0.5	1235	10	90
EU2013/ L13	Effluent evaporation dams road	Effluent evaporation dams road: unpaved road to and around effluent evaporation dams; sources of particulate matter include vehicle movement (vehicle wheel pulverisation of surface as well as re-entrainment of material on road) and disturbance of loose surface material by wind	-31.462446	18.291417	0.5	1680	10	0

Notes:

(a) Private/service vehicles travel on these roads as well.

4.4.2 *Fugitive Sources Maximum Emission Rates during Normal Operating Conditions*

Table 18: Area and volume source emissions

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
EU1001	$PM_{2.5}$ – Materials Handling	3.11x10^{-01}	1.96	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10} – Materials Handling	2.06	12.96	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP – Materials Handling	4.34	27.39	00h00 – 23h59 365 days per year	Intermittent	Yes
	$PM_{2.5}$ – Wind Erosion	4.53x10^{-02} (2015) 1.33x10^{-01} (2016) 1.44 (2017)	1.43 (2015) 4.21 (2016) 45.4 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10} – Wind Erosion	9.73x10^{-02} (2015) 2.86x10^{-01} (2016) 3.08 (2017)	3.07 (2015) 9.03 (2016) 97.2 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP – Wind Erosion	1.07x10^{-01} 3.16x10^{-01} 3.40	3.39 (2015) 10.0 (2016) 107 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1002	$PM_{2.5}$ – Materials Handling	1.76x10^{-03}	0.014	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10} – Materials Handling	1.16x10^{-02}	0.092	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP – Materials Handling	2.46x10^{-02}	0.194	00h00 – 23h59 365 days per year	Intermittent	Yes
	$PM_{2.5}$ – Wind Erosion	0.00	0.00	None	Intermittent	Yes
	PM_{10} – Wind Erosion	0.00	0.00	None	Intermittent	Yes
	TSP – Wind Erosion	0.00	0.00	None	Intermittent	Yes
EU1003[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1004	$PM_{2.5}$ – Materials Handling	5.63x10^{-02}	0.444	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10} – Materials Handling	3.68x10^{-01}	2.90	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP – Materials Handling	7.86x10^{-01}	6.20	00h00 – 23h59 365 days per year	Intermittent	Yes
	$PM_{2.5}$ – Wind Erosion	1.60x10^{-02} (2015) 4.20x10^{-02} (2016) 3.61x10^{-01} (2017)	0.504 (2015) 1.33 (2016) 11.4 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10} – Wind Erosion	3.36x10^{-02} (2015)	1.06 (2015)	When wind speeds are >12.8 m/s	Intermittent	Yes

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
		8.85x10^{-02} (2016) 7.60x10^{-01} (2017)	2.79 (2016) 24.0 (2017)			
	TSP – Wind Erosion	3.71x10^{-02} (2015) 9.75x10^{-02} (2016) 8.37x10^{-01} (2017)	1.17 (2015) 3.07 (2016) 26.4 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1005	PM$_{2.5}$	6.00x10^{-02}	0.022	13h00 – 14h59 1 day per week	Intermittent	Yes
	PM$_{10}$	4.10x10^{-01}	0.154	13h00 – 14h59 1 day per week	Intermittent	Yes
	TSP	8.68x10^{-01}	0.325	13h00 – 14h59 1 day per week	Intermittent	Yes
EU1006	PM$_{2.5}$	1.00x10^{-03}	0.032	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM$_{10}$	1.00x10^{-02}	0.315	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	2.00x10^{-02}	0.631	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1007	PM$_{2.5}$ – Materials Handling	0.317	2.50	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM$_{10}$ – Materials Handling	2.09	16.50	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP – Materials Handling	4.43	34.90	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM$_{2.5}$ – Wind Erosion	1.02x10^{-06} (2015) 2.70x10^{-06} (2016) 2.33x10$_{-05}$ (2017)	3.22x10^{-05} (2015) 8.52x10^{-05} (2016) 7.35x10^{-04} (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM$_{10}$ – Wind Erosion	2.18x10^{-06} (2015) 5.77x10^{-06} (2016) 4.98x10^{-05} (2017)	6.88x10^{-05} (2015) 1.82x10^{-04} (2016) 1.57x10^{-03} (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP – Wind Erosion	2.41x10^{-06} (2015) 6.36x10^{-06} (2016) 5.48x10^{-05} (2017)	7.59x10^{-05} (2015) 2.00x10^{-04} (2016) 1.73x10^{-03} (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1008[(a)]	PM$_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM$_{10}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1009[(a)]	PM$_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM$_{10}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1010[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1011[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1012	$PM_{2.5}$	$2.32x10^{-02}$ (2015) $6.12x10^{-02}$ (2016) $5.28x10^{-01}$ (2017)	0.730 (2015) 1.93 (2016) 16.7 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10}	$4.94x10^{-02}$ (2015) $1.31x10^{-01}$ (2016) 1.13 (2017)	1.56 (2015) 4.12 (2016) 35.6 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP	$5.45x10^{-02}$ (2015) $1.44x10^{-01}$ (2016) 1.24 (2017)	1.72 (2015) 4.54 (2016) 39.2 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1013	$PM_{2.5}$	$3.76x10^{-02}$ (2015) $9.88x10^{-02}$ (2016) $8.49x10^{-01}$ (2017)	1.18 (2015) 3.12 (2016) 26.8 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10}	$7.90x10^{-02}$ (2015) $2.08x10^{-01}$ (2016) 1.79 (2017)	2.49 (2015) 6.56 (2016) 56.3 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP	$8.71x10^{-02}$ (2015) $2.29x10^{-01}$ (2016) 1.97 (2017)	2.75 (2015) 7.23 (2016) 62.0 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1014	$PM_{2.5}$	$1.13x10^{-02}$ (2015) $2.98x10^{-02}$ (2016) $2.56x10^{-01}$ (2017)	0.357 (2015) 0.938 (2016) 8.07 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10}	$2.38x10^{-02}$ (2015) $6.27x10^{-02}$ (2016) $5.38x10^{-01}$ (2017	0.750 (2015) 1.98 (2016) 17.0 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP	$2.62x10^{-02}$ (2015) $6.90x10^{-02}$ (2016) $5.92x10^{-01}$ (2017)	0.827 (2015) 2.18 (2016) 18.7 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
EU1015[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1016	$PM_{2.5}$	$2.20x10^{-02}$	0.068	00h00 – 23h59 3 days per week	Intermittent	Yes
	PM_{10}	$2.20x10^{-01}$	0.684	00h00 – 23h59 3 days per week	Intermittent	Yes
	TSP	$9.20x10^{-01}$	2.86	00h00 – 23h59 3 days per week	Intermittent	Yes
EU1017[(a)]	$PM_{2.5}$	-	-	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU1018[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU1019[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU1020[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU1021	$PM_{2.5}$ – Materials Handling	$7.10x10^{-01}$	5.60	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10} – Materials Handling	4.70	37.0	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP – Materials Handling	9.93	78.3	00h00 – 23h59 365 days per year	Intermittent	Yes

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
	$PM_{2.5}$ – Wind Erosion	0.100 (2015) 0.264 (2016) 2.27 (2017)	3.16 (2015) 8.32 (2016) 71.5 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	PM_{10} – Wind Erosion	0.211 (2015) 0.555 (2016) 4.77 (2017)	6.65 (2015) 17.5 (2016) 150 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
	TSP – Wind Erosion	0.233 (2015) 0.612 (2016) 5.25 (2017)	7.34 (2015) 19.3 (2016) 166 (2017)	When wind speeds are >12.8 m/s	Intermittent	Yes
EU1022[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU1023[(a)]	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	Yes
EU2001	$PM_{2.5}$	$1.09x10^{-03}$	0.01	09h00 – 14h59 365 days per year	Intermittent	No
	PM_{10}	$1.09x10^{-02}$	0.09	09h00 – 14h59 365 days per year	Intermittent	No
	TSP	$3.96x10^{-02}$	0.31	09h00 – 14h59 365 days per year	Intermittent	No
EU2002	$PM_{2.5}$	$2.53x10^{-03}$	0.02	09h00 – 14h59 365 days per year	Intermittent	No
	PM_{10}	$2.53x10^{-02}$	0.20	09h00 – 14h59 365 days per year	Intermittent	No
	TSP	$9.16x10^{-02}$	0.72	09h00 – 14h59 365 days per year	Intermittent	No
EU2003[(b)]	$PM_{2.5}$	Negligible	Negligible	09h00 – 14h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	09h00 – 14h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	09h00 – 14h59 365 days per year	Intermittent	No
EU2004	$PM_{2.5}$	$1.92x10^{-03}$	0.06	00h00 – 23h59 365 days per year	Intermittent	No

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
	PM_{10}	1.92×10^{-02}	0.61	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	5.25×10^{-02}	1.66	00h00 – 23h59 365 days per year	Intermittent	No
EU2005	$PM_{2.5}$	3.21×10^{-03}	0.10	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	3.21×10^{-02}	1.01	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	9.00×10^{-02}	2.84	00h00 – 23h59 365 days per year	Intermittent	No
EU2006(b)	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU2007	$PM_{2.5}$	8.63×10^{-03}	0.07	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	8.63×10^{-02}	0.68	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	3.13×10^{-01}	2.47	00h00 – 23h59 365 days per year	Intermittent	No
EU2008(b)	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU2009	$PM_{2.5}$	6.45×10^{-04}	0.01	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	6.45×10^{-03}	0.05	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	2.33×10^{-02}	0.18	00h00 – 23h59 365 days per year	Intermittent	No
EU2010(b)	$PM_{2.5}$	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	Negligible	Negligible	00h00 – 23h59 365 days per year	Intermittent	No
EU2011	$PM_{2.5}$	3.50×10^{-02}	0.28	00h00 – 23h59 365 days per year	Intermittent	No

ID	Pollutant Name	Maximum Release Rate (grams per second)	Average Annual Release Rate (tonnes per year)	Emission Hours	Type of Emission (Continuous / Intermittent)	Wind Dependent (Yes / No)
	PM_{10}	$3.50x10^{-01}$	2.76	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	1.27	10.01	00h00 – 23h59 365 days per year	Intermittent	No
EU2012	$PM_{2.5}$	$3.59x10^{-03}$	0.03	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	$3.59x10^{-02}$	0.28	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	$1.30x10^{-01}$	1.03	00h00 – 23h59 365 days per year	Intermittent	No
EU2013	$PM_{2.5}$	$7.19x10^{-03}$	0.06	00h00 – 23h59 365 days per year	Intermittent	No
	PM_{10}	$7.19x10^{-02}$	0.57	00h00 – 23h59 365 days per year	Intermittent	No
	TSP	$2.60x10^{-01}$	2.05	00h00 – 23h59 365 days per year	Intermittent	No

Notes:

(a) Expected to be negligible in comparison to other area sources.

(b) Expected to be negligible in comparison to other line sources.

4.4.3 Fugitive Sources Emission Estimation Methods

Table 19: Area and volume source emission estimation information

ID	Basis for Emission Rates
EU1001	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a) For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1002	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a) For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1003	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1004	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 4%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a) For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1005	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a)
EU1006	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a)
EU1007	Emission rates estimated using US EPA AP42 “13.2.4 Aggregate Handling and Storage Piles” emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a) For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)

ID	Basis for Emission Rates
EU1008	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1009	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1010	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1011	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1012	For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1013	For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1014	For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1015	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1016	Emission rates estimated using US EPA AP42 "13.2.6 Abrasive Blasting" emission factor for sand blasting. (US EPA, 1997)
EU1017	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1018	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1019	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1020	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1021	Emission rates estimated using US EPA AP42 "13.2.4 Aggregate Handling and Storage Piles" emission factor for miscellaneous transfer and conveying – based on raw material used; moisture content assumed to be 0.1%; average wind speed of 3.6 m/s, from meteorological data. (US EPA, 2006a) For the estimation of windblown dust emissions, use was made of the ADDAS model and the material specific particle size distribution. (Burger & Held, 1997)
EU1022	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU1023	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU2001	Emission rates estimated using US EPA AP42 "13.2.2 Unpaved Roads" emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2002	Emission rates estimated using US EPA AP42 "13.2.2 Unpaved Roads" emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2003	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU2004	Emission rates estimated using US EPA AP42 "11.19.2 Mineral Processing" emission factor for materials transfer and conveying. (US EPA, 2004)
EU2005	Emission rates estimated using US EPA AP42 "11.19.2 Mineral Processing" emission factor for materials transfer and conveying. (US EPA, 2004)

ID	Basis for Emission Rates
EU2006	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU2007	Emission rates estimated using US EPA AP42 “13.2.2 Unpaved Roads” emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2008	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU2009	Emission rates estimated using US EPA AP42 “13.2.2 Unpaved Roads” emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2010	Not quantified. Not enough information available to be able to quantify emissions. Assumed to be immaterial in relation to the other sources.
EU2011	Emission rates estimated using US EPA AP42 “13.2.2 Unpaved Roads” emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2012	Emission rates estimated using US EPA AP42 “13.2.2 Unpaved Roads” emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)
EU2013	Emission rates estimated using US EPA AP42 “13.2.2 Unpaved Roads” emission factor for vehicle travel on unpaved roads – silt assumed to be 7.1%, average truck weight of 29 tonne. (US EPA, 2006b)

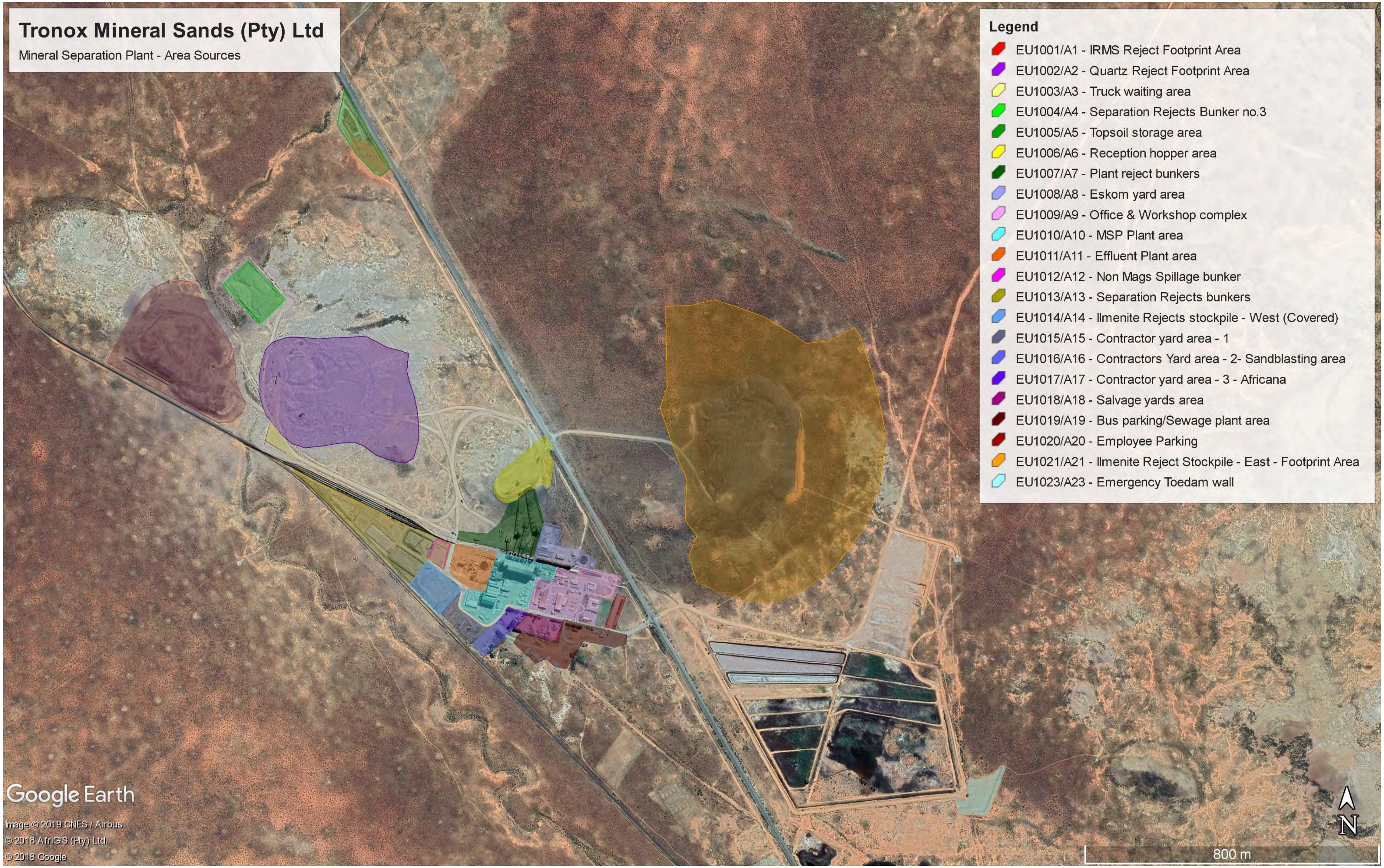

Figure 5: Location of the area sources at MSP

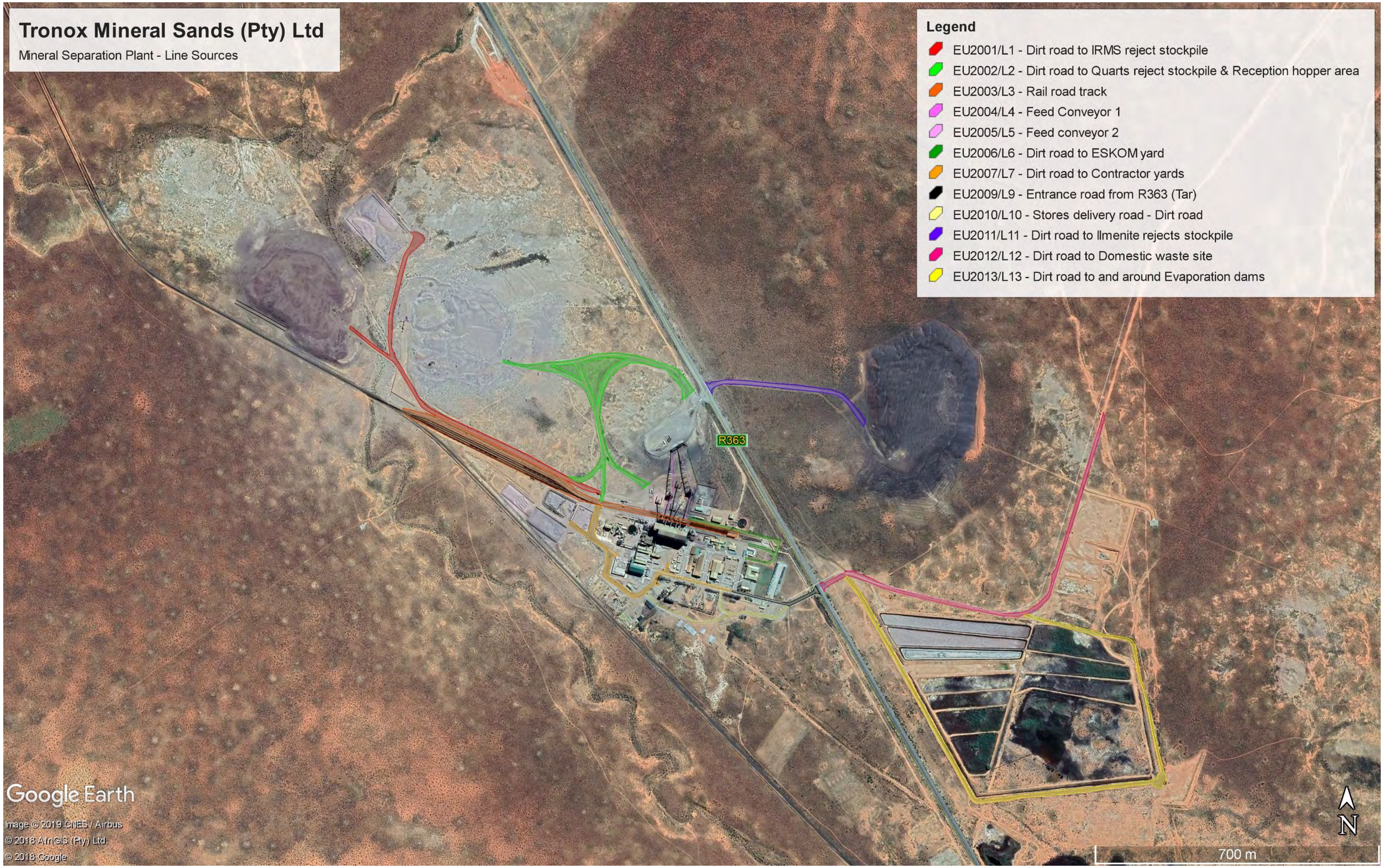

Figure 6: Location of the line sources at MSP

4.5 Emergency Incidents

No air quality related emergency incidents have been reported over the past two years.

5 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

The assessment of the impact of the MSP operations on human health is discussed in this section. The MSP operations will comprise of all the current fugitive sources and the emissions from the two baghouses (to be commissioned by end 2019) where the associated dryers are fuelled by NG. To assess impact on human health and the environment the following important aspects need to be considered:

- The criteria against which impacts are assessed (Section 5.1);
- The potential of the atmosphere to disperse and dilute pollutants emitted by the MSP operations (Section 5.1.2);
- Any available measured ambient pollutant concentrations are discussed in Section 5.1.3; and
- The impacts on human health by $PM_{2.5}$, PM_{10}, NO_2 and SO_2 emissions are discussed in Section 5.1.4.

The dryers are currently fuelled by paraffin, the impacts for the current operations are shown in Annexure G. It is expected that emissions (PM, NO_x and SO_2) will reduce using NG as a fuel source for the dryers. The concentrations as a result of the dryers operations using NG as a fuel source were determined to lower than current operations (using paraffin as a fuel source).

5.1 Analysis of Emissions' Impact on Human Health

5.1.1 Assessment Criteria for Human Health - National Ambient Air Quality Standards

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. South African NAAQS for PM_{10}, NO_2 and SO_2 were published on 24 December 2009. On 29 June 2012 standards for $PM_{2.5}$ were also published. These standards are listed in Table 20.

Table 20: National Ambient Air Quality Standards for criteria pollutants

Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
$PM_{2.5}$	24-hour	40	4	Currently enforceable (1 Jan 2016 – 31 Dec 2029)
	24-hour	25	4	Enforceable from 1 Jan 2030
	1-year	20	-	Currently enforceable (1 Jan 2016 – 31 Dec 2029)
	1-year	15	-	Enforceable from 1 Jan 2030
PM_{10}	24-hour	75	4	Currently enforceable
	1-year	40	-	Currently enforceable
NO_2	1-hour	200	88	Currently enforceable
	1-year	40	-	Currently enforceable
SO_2	10-minute	500	526	Currently enforceable
	1-hour	350	88	Currently enforceable
	24-hour	125	4	Currently enforceable

Pollutant	Averaging Period	Limit Value (µg/m³)	Frequency of Exceedance	Compliance Date
	1-year	50	-	Currently enforceable
CO	1-hour	30 000	88	Currently enforceable
	8-hour	10 000	11	Currently enforceable
Pb	1-year	0.5	-	Currently enforceable

5.1.2 Atmospheric Dispersion Potential

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of land-use and topography as well as hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. The horizontal dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants.

In the absence of on-site meteorological data, meteorological data from the Mesoscale Model Interface (MMIF) for a point on-site was extracted for use in AERMET/AERMOD. The AERMET ready (site specific) Weather Research and Forecasting (WRF) Model data was processed in AERMET to create the input files required for AERMOD. Hourly sequential data from January 2015 to December 2017 was used in dispersion modelling. Parameters useful in describing the dispersion and dilution potential of a site i.e. wind speed, wind direction, temperature and atmospheric stability. The wind field is subsequently discussed. The data described below is as processed by AERMET from the WRF data for a point on-site.

5.1.2.1 Surface Wind Field

The wind field determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is a function of the wind speed, in combination with the surface roughness. The wind field for the study area is described with the use of wind roses.

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 6 and 7 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

A wind rose for the period January 2015 to December 2017 is shown in Figure 7. Day-time and night-time wind roses are included in Figure 8. The wind field was dominated by winds from the south-west followed by winds from the south-south-west. Calm conditions occurred 4.12% of the time. During the day, winds occurred more frequently from the south-westerly and south-south-westerly sectors with 3.52% calm conditions. Night-time airflow had winds from the north-westerly and south-westerly sectors occurring at approximately the same frequency followed by winds from the west-north-westerly and west-south-westerly directions. In general, the wind speeds at night were lower than those occurring during the day. The percentage calm conditions increased to 4.45%.

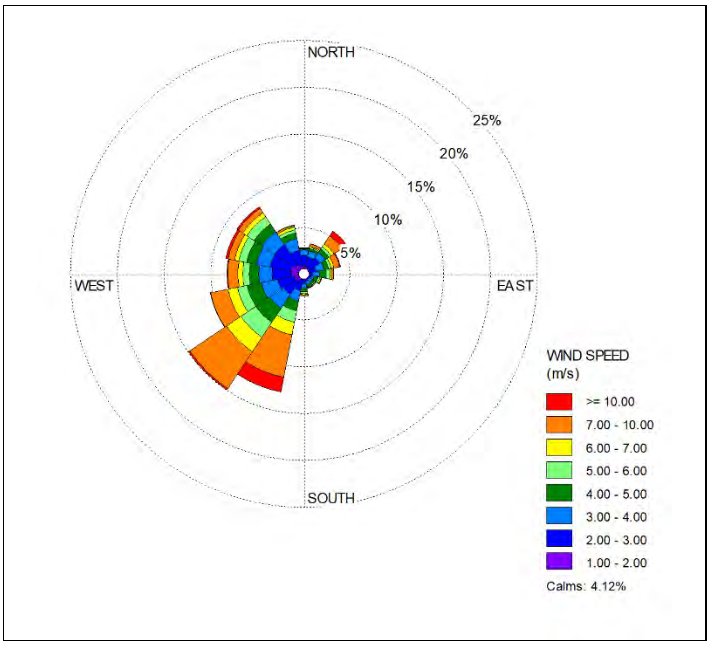

Figure 7: Period average wind rose (AERMET processed WRF data, 2015 to 2017)

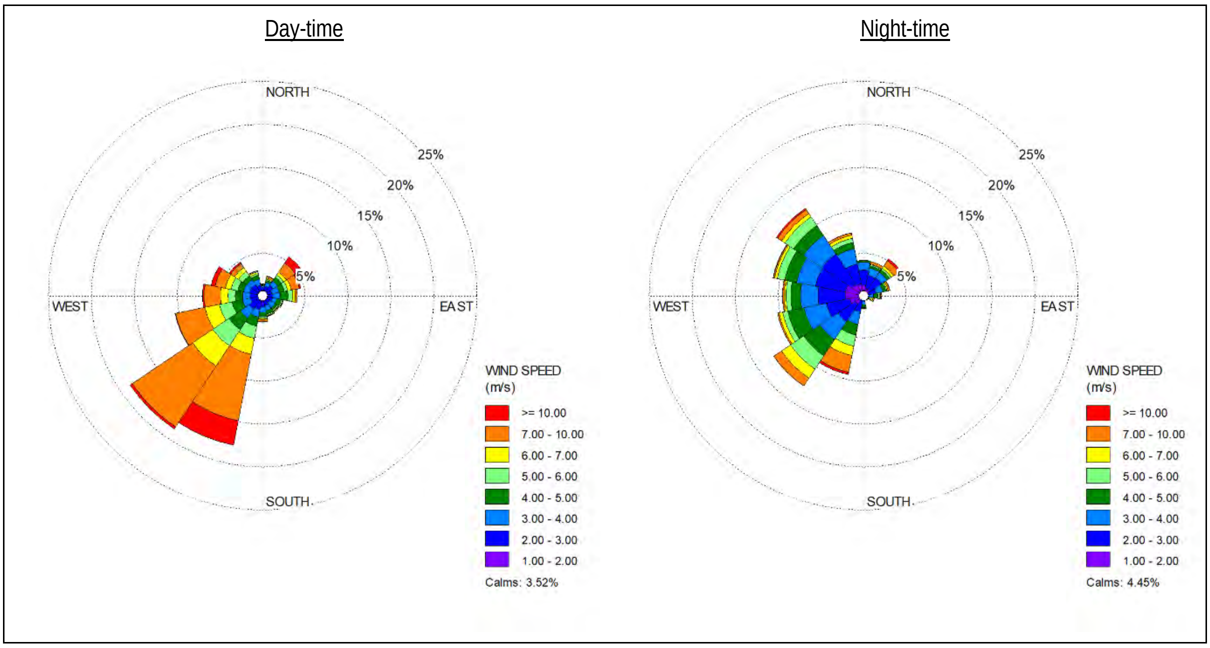

Figure 8: Day-time and night-time wind roses (AERMET processed WRF data, 2015 to 2017)

5.1.2.2 Atmospheric Stability

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes.

The atmospheric boundary layer properties are therefore described by two parameters; the boundary layer depth and the Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class.

The Monin-Obukhov length (L_{Mo}) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night-times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and lower dilution potential.

Diurnal variation in atmospheric stability, as calculated from measured data, and described by the inverse Monin-Obukhov length and the boundary layer depth is provided in Figure 9. The highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions. For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called *looping* (Figure 9 (c)) and occurs mostly during daytime hours. Neutral conditions disperse the plume fairly equally in both the vertical and horizontal planes and the plume shape is referred to as *coning* (Figure 9 (b)). Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called *fanning* (Figure 9 (a)) (Tiwary & Colls, 2010). For ground level releases such as fugitive dust the highest ground level concentrations will occur during stable night-time conditions.

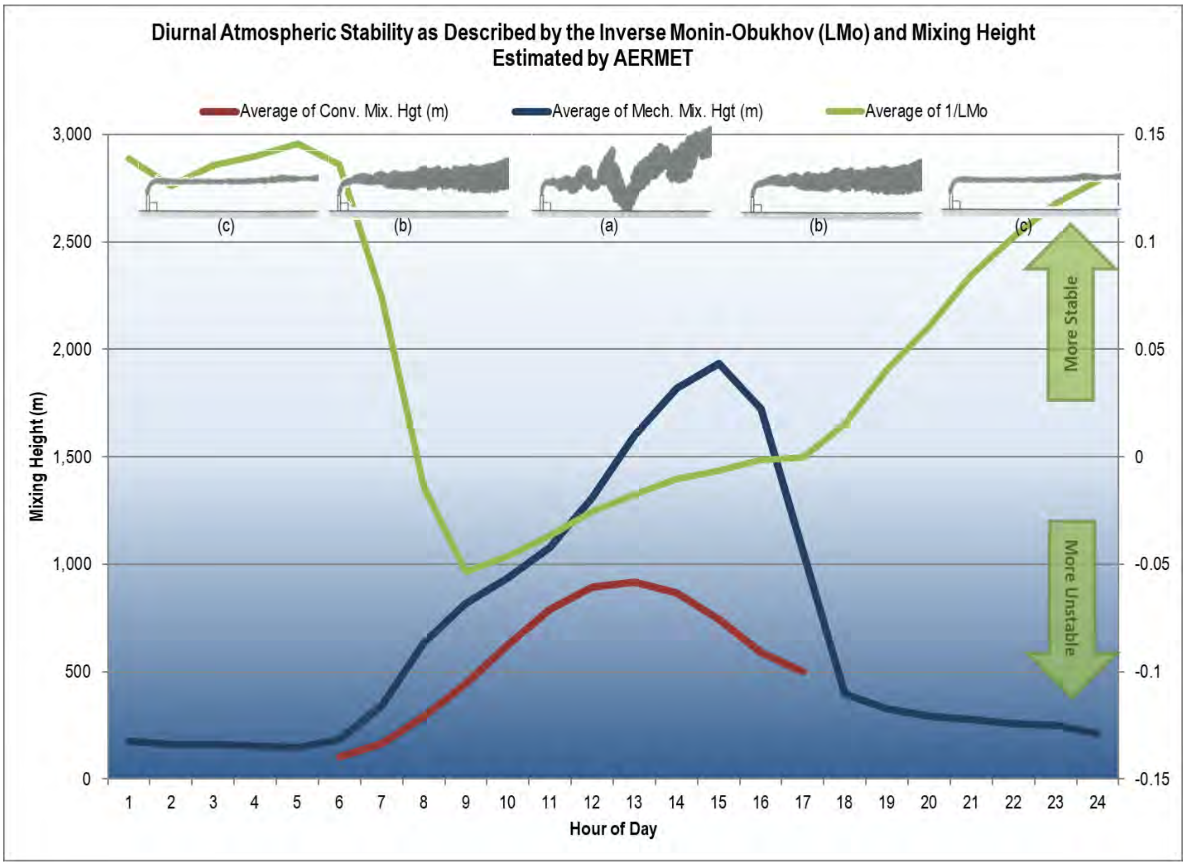

Figure 9: Diurnal atmospheric stability (AERMET processed WRF data, 2015 to 2017)

5.1.3 Measured Air Pollutant Concentrations - Ambient $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and Pb Concentrations

No data for on-site or near site ambient $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and Pb sampling was available.

5.1.4 Screening of Simulated Concentrations for Potential Human Health Impacts (Normal Operating Conditions)

Key pollutants with the potential to result in human health impacts and included in simulations for this study are $PM_{2.5}$, PM_{10}, NO_x, SO_2, CO and Pb. It should be noted that simulated concentrations only reflect those associated with atmospheric emissions from the MSP as quantified in Section 4. The emissions used account for the use of abatement equipment associated with process emission sources and NG as a fuel source. Section 5.1.4.1 are the simulated result for the facility operating at the expected normal operating conditions. Section 5.1.4.2 are the simulated result for the facility operating at the new plant MES. The design PM emissions from the stacks are expected to be slightly lower than the new plant MES and the estimated NO_2 and SO_2 emissions are expected to be significantly lower than the new plant MES.

5.1.4.1 MSP Operations with NG Fuelled Dryers– Design/Estimated Emissions

The dispersion simulation results described below are as a result of the MSP operations with the dryers fuelled by NG. These results include all the operations that will be taking place at the MSP once NG has been approved as a fuel for the dryers. For $PM_{2.5}$ and PM_{10} the sources include the point and fugitive sources discussed in Section 4. The fugitive sources' emissions are estimated based on the operational raw material consumption rates and production rates. The dryers' PM emissions are based on the design emission provided by Tronox NS. For NO_2, SO_2, CO and Pb the sources include the point sources discussed in Section 4. The dryers' NO_2, SO_2, CO and Pb emissions are based on the estimated emission using the US EPA AP-42 emission estimation technique manual for natural gas combustion. Isopleth plots have been included for simulated results where the NAAQS are exceeded (whether it be on-site or off-site).

Simulated Ambient $PM_{2.5}$ Concentrations

The simulated annual average $PM_{2.5}$ concentrations as a result of the MSP operations do not exceed the current NAAQS of 20 µg/m³ or the future NAAQS of 15 µg/m³ off-site or at any residences, schools or clinics (Figure 10). The maximum simulated annual average $PM_{2.5}$ concentration at the boundary is 12 µg/m³. This is at the boundary north-east of the main processing building (where the dryers are located) adjacent to the R363. The current 24-hour NAAQS (4 days of exceedance of 40 µg/m³) is not exceeded off-site or at any residences, schools or clinics (Figure 11). The simulated frequency of exceedance of the 24-hour $PM_{2.5}$ NAAQ limit of 40 µg/m³ at the boundary is 4 days, south-west of the main processing building (where the dryers are located). The future 24-hour NAAQS (4 days of exceedance of 25 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 11). The simulated frequency of exceedance of the 24-hour $PM_{2.5}$ NAAQ limit of 25 µg/m³ at the boundary is 7 days. This occurs south-west of the main processing building (where the dryers are located) and is mostly attributed to the fugitive sources. It has been conservatively assumed that all the PM will be $PM_{2.5}$; however, the $PM_{2.5}$ emissions are likely to be lower than the total PM emissions.

Simulated Ambient PM_{10} Concentrations

The simulated annual average PM_{10} concentrations as a result of the MSP operations do not exceed the NAAQS of 40 µg/m³ off-site or at any residences, schools or clinics (Figure 12). The maximum simulated annual average PM_{10} concentration at the boundary is 28 µg/m³. This occurs north-east of the main processing building (where the dryers are located) adjacent to the R363. The 24-hour NAAQS (4 days of exceedance of 75 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 13). The simulated frequency of exceedance of the 24-hour PM_{10} NAAQ limit of 75 µg/m³ at the boundary is 6 days. This occurs south-west of the main processing building (where the dryers are located) and is mostly attributed to the fugitive sources. It has been conservatively assumed that all the PM will be $PM_{2.5}$; however, the PM_{10} emissions are likely to be lower than the total PM emissions.

Simulated Ambient NO_2 Concentrations

The simulated NO_x concentrations were compared to the NO_2 NAAQS. The simulated annual average NO_x concentrations as a result of the MSP operations did not exceed the NO_2 NAAQS of 40 µg/m³ off-site or at any residences, schools or clinics. The 1-hour NAAQS (88 hours of exceedance of 200 µg/m^3) is not exceeded off-site or at any residences, schools or clinics.

Simulated Ambient SO_2 Concentrations

The simulated annual average SO_2 concentrations as a result of the MSP operations do not exceed the NAAQS of 50 µg/m^3. The 24-hour NAAQS (4 days of exceedance of 125 µg/m^3) is not exceeded off-site or at any residences, schools or clinics. The 1-hour NAAQS (88 hours of exceedance of 350 µg/m^3) is not exceeded off-site or at any residences, schools or clinics.

Simulated Ambient CO Concentrations

The 8-hour NAAQS (11 exceedance of 10 000 µg/m^3) is not exceeded off-site or at any residences, schools or clinics. The 1-hour NAAQS (88 hours of exceedance of 30 000 µg/m^3) is not exceeded off-site or at any residences, schools or clinics.

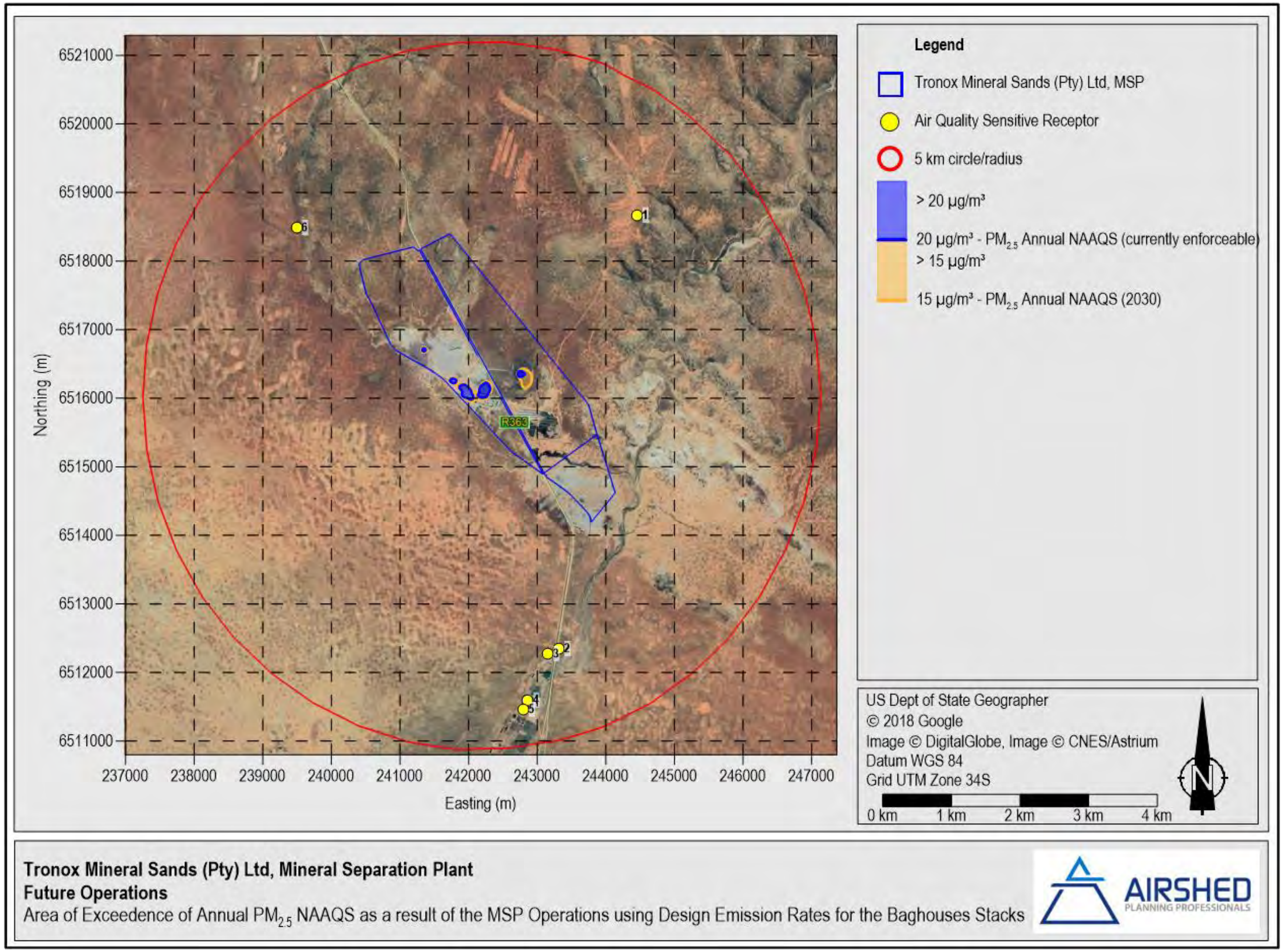

Figure 10: MSP operations with stacks design emissions: simulated exceedance area of the 1-year average $PM_{2.5}$ NAAQS

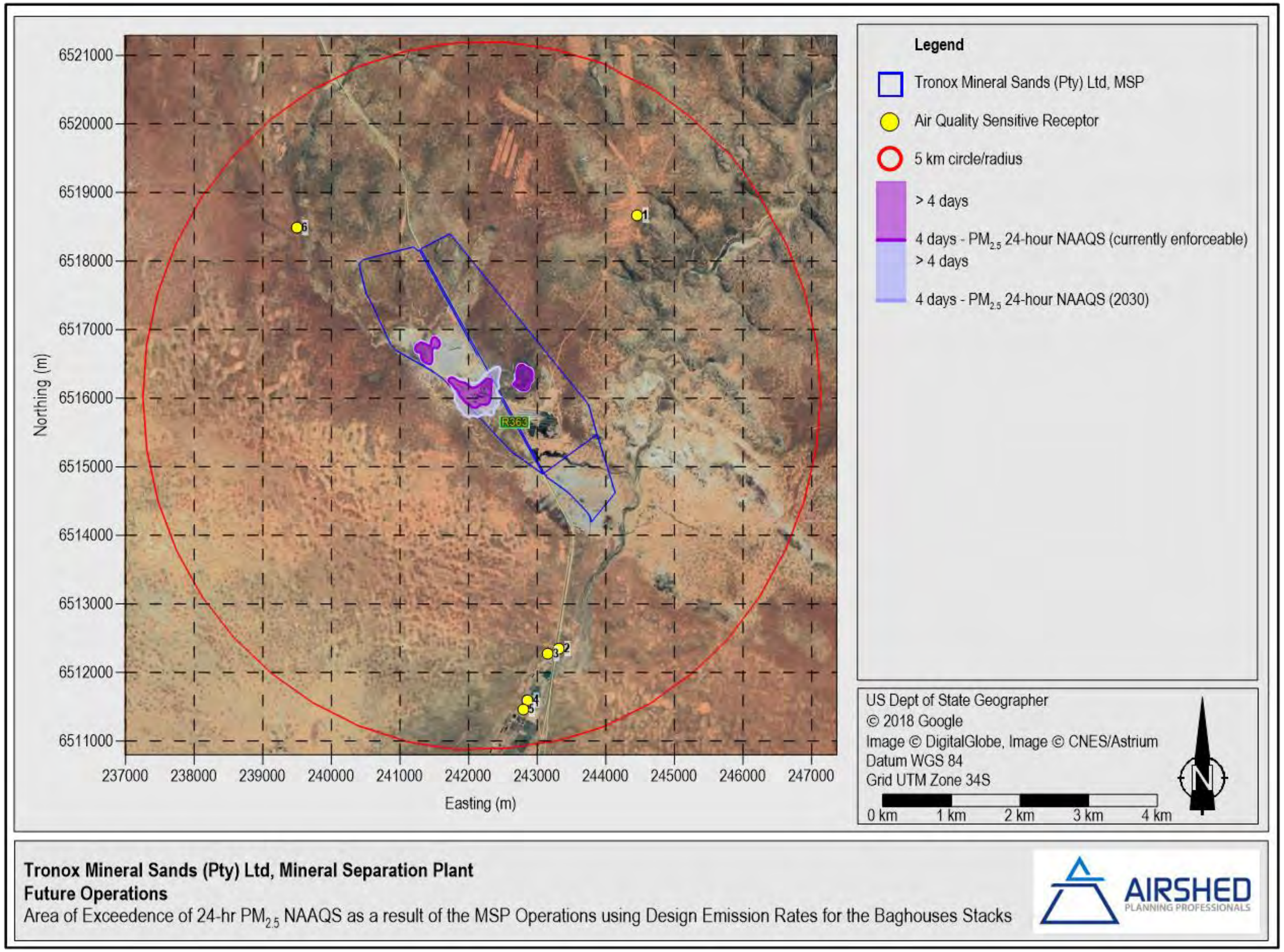

Figure 11: MSP operations with stacks design emissions: simulated exceedance area of the 24-hour average $PM_{2.5}$ NAAQS

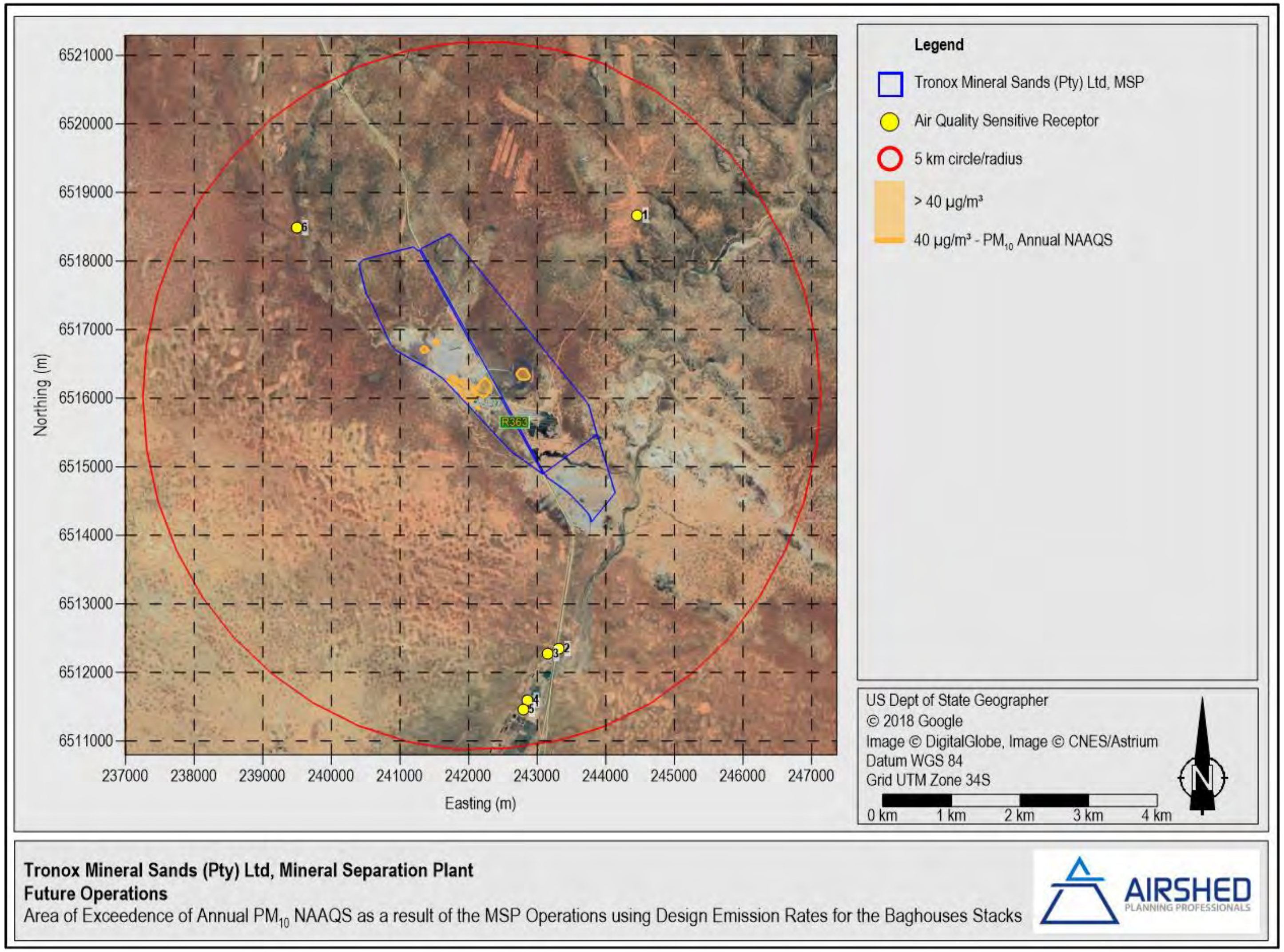

Figure 12: MSP operations with stacks design emissions: simulated exceedance area of the 1-year average PM_{10} NAAQS

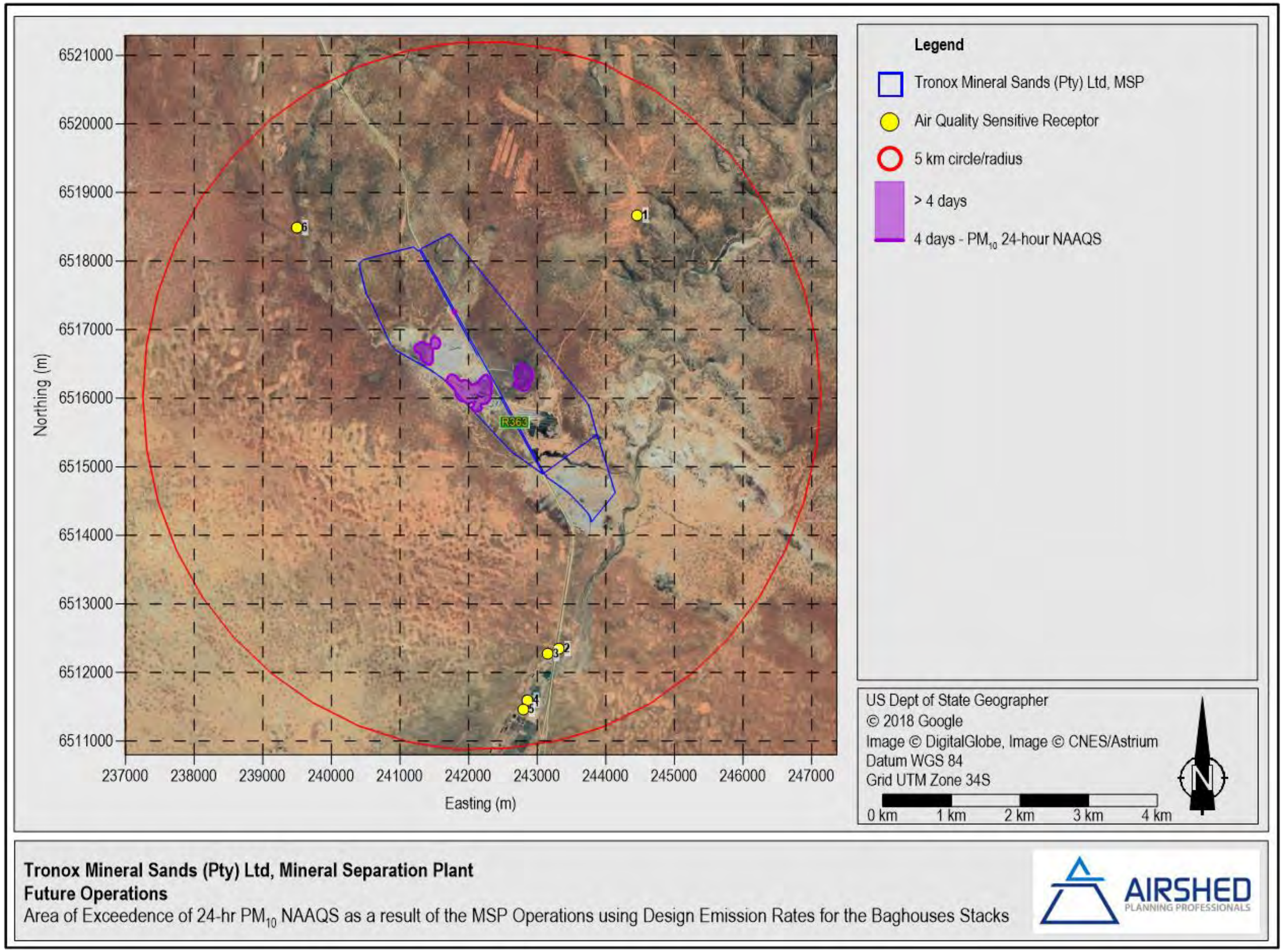

Figure 13: MSP operations with stacks design emissions: exceedance area of the 24-hour average PM_{10} NAAQS

5.1.4.2 MSP Operations – New Plant Minimum Emission Standards

The dispersion simulation results described below are as a result of the MSP operations. These results include all the operations that are taking place at the MSP, these include the point and fugitive sources discussed in Section 4. The fugitive sources' emissions are estimated based on the operational raw material consumption rates and production rates. The baghouses' emissions are based on the subcategory 5.2 MES for new plants. Isopleth plots have only been included for simulated results where the NAAQS are exceeded.

Simulated Ambient $PM_{2.5}$ Concentrations

The simulated annual average $PM_{2.5}$ concentrations as a result of the MSP operations with baghouses emitting at new plant MES (NMES) do not exceed the current NAAQS of 20 µg/m³ off-site or at any residences, schools or clinics (Figure 14). The simulated annual average $PM_{2.5}$ concentrations exceed the future NAAQS of 15 µg/m³ off-site (over the R363) but not at any residences, schools or clinics (Figure 14). The maximum simulated annual average $PM_{2.5}$ concentration at the boundary is 16 µg/m³, north-east of the main processing building (where the dryers are located) adjacent to the R363. The current 24-hour NAAQS (4 days of exceedance of 40 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 15). The simulated frequency of exceedance of the 24-hour $PM_{2.5}$ NAAQ limit of 40 µg/m³ at the boundary is 5 days, south-west of the main processing building (where the dryers are located). The future 24-hour NAAQS (4 days of exceedance of 25 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 15). The simulated frequency of exceedance of the 24-hour $PM_{2.5}$ NAAQ limit of 25 µg/m³ at the boundary is 8 days, south-west of the main processing building (where the dryers are located).

Simulated Ambient PM_{10} Concentrations

The simulated annual average PM_{10} concentrations as a result of the MSP operations with baghouses emitting at NMES do not exceed the NAAQS of 40 µg/m³ off-site or at any residences, schools or clinics (Figure 16). The maximum simulated annual average PM_{10} concentration at the boundary is 32 µg/m³, north-east of the main processing building (where the dryers are located) adjacent to the R363. The 24-hour NAAQS (4 days of exceedance of 75 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 17). The simulated frequency of exceedance of the 24-hour PM_{10} NAAQ limit of 75 µg/m³ at the boundary is 7 days, south-west of the main processing building (where the dryers are located).

Simulated Ambient NO_2 Concentrations

The simulated NO_x concentrations were compared to the NO_2 NAAQS. The simulated annual average NO_x concentrations as a result of the MSP operations with baghouses emitting at NMES exceed the NO_2 NAAQS of 40 µg/m³ off-site (over the R363) but not at any residences, schools or clinics (Figure 18). The maximum simulated annual average NO_x concentration at the boundary is 58 µg/m³, north-east of the main processing building (where the dryers are located) adjacent to the R363. The 1-hour NAAQS (88 hours of exceedance of 200 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 19). The simulated frequency of exceedance of the 1-hour NO_2 NAAQ limit of 200 µg/m³ at the boundary is 263 hours, south-west of the main processing building (where the dryers are located).

Simulated Ambient SO_2 Concentrations

The simulated annual average SO_2 concentrations as a result of the MSP operations with baghouses emitting at NMES exceed the SO_2 NAAQS of 50 µg/m³ off-site but not at any residences, schools or clinics (Figure 18). The maximum simulated annual average SO_2 concentration at the boundary is 114 µg/m³, north-east of the main processing building (where the dryers are located) adjacent to the R363. The 24-hour NAAQS (4 days of exceedance of 125 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 21). The simulated frequency of exceedance of the 24-hour SO_2 NAAQ limit of 125 µg/m³ at the boundary is 11 days, south-west of the main processing building (where the dryers are located). The 1-hour NAAQS (88 hours of exceedance of 350 µg/m³) is exceeded off-site but not at any residences, schools or clinics (Figure 22). The simulated frequency of exceedance of the 1-hour NO_2 NAAQ limit of 200 µg/m³ at the boundary is 305 hours, south-west of the main processing building (where the dryers are located).

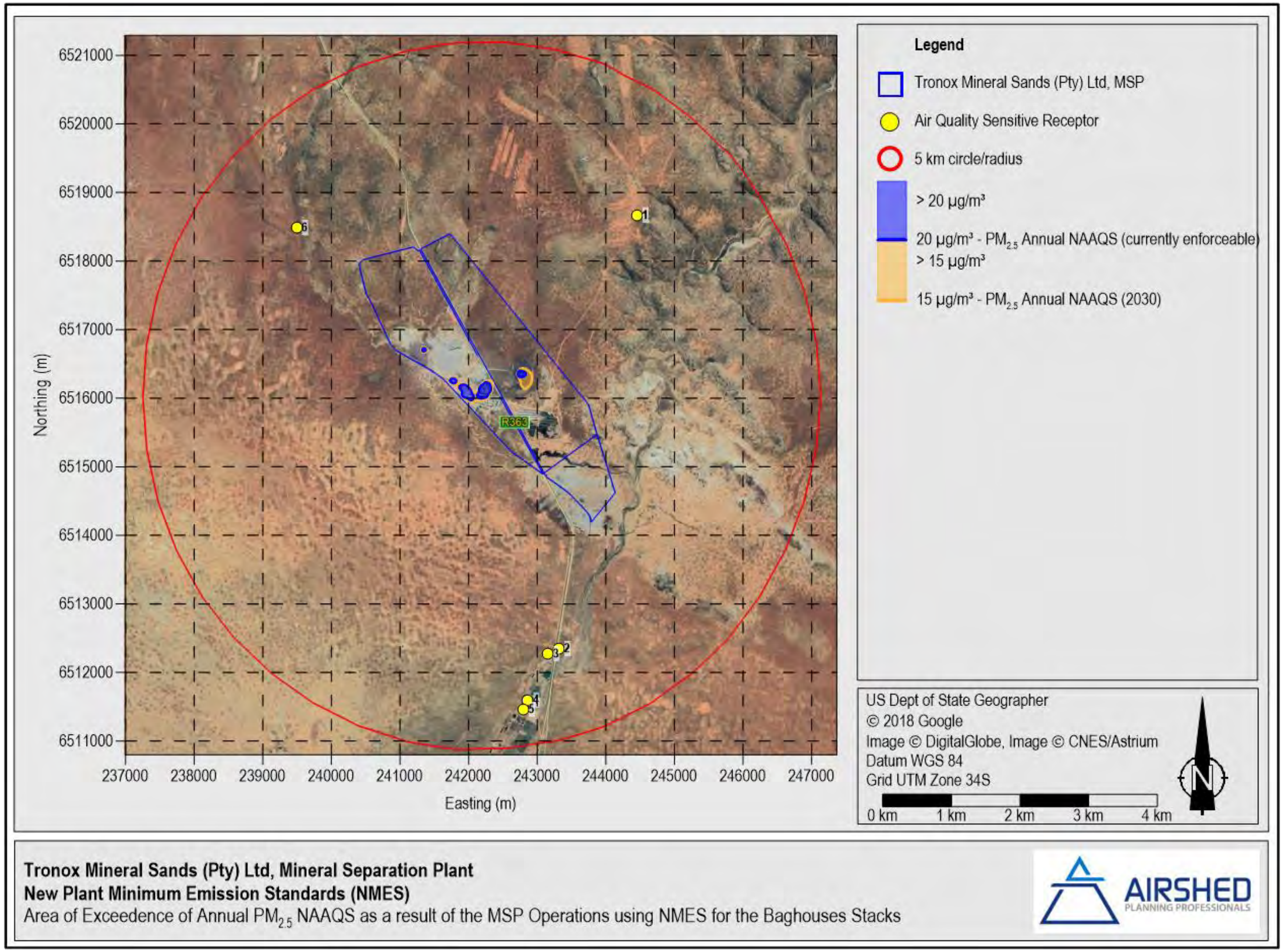

Figure 14: MSP operations with new plant minimum emission standards: simulated exceedance area of the 1-year average $PM_{2.5}$ NAAQS

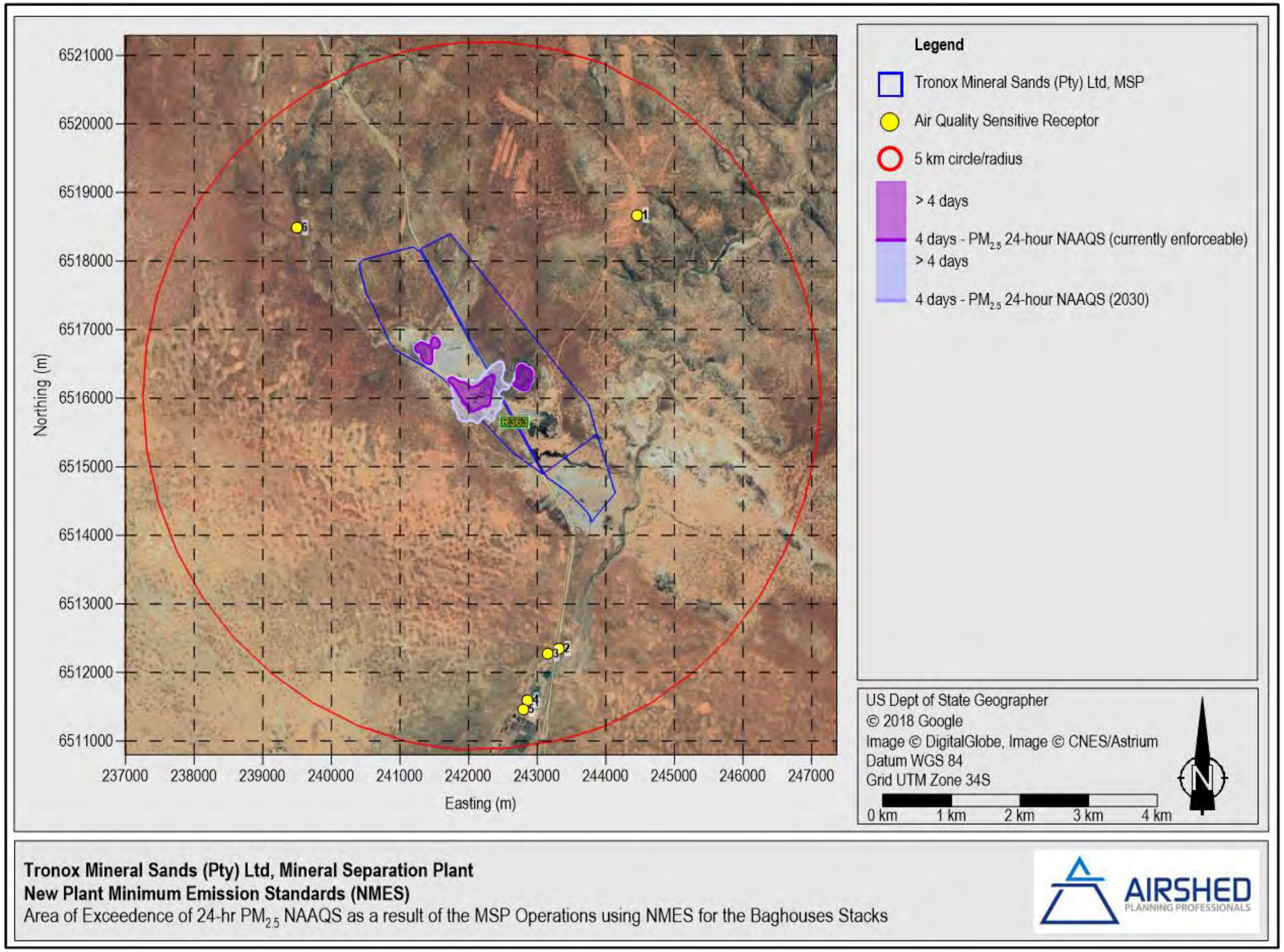

Figure 15: MSP operations with new plant minimum emission standards: simulated exceedance area of the 24-hour average $PM_{2.5}$ NAAQS

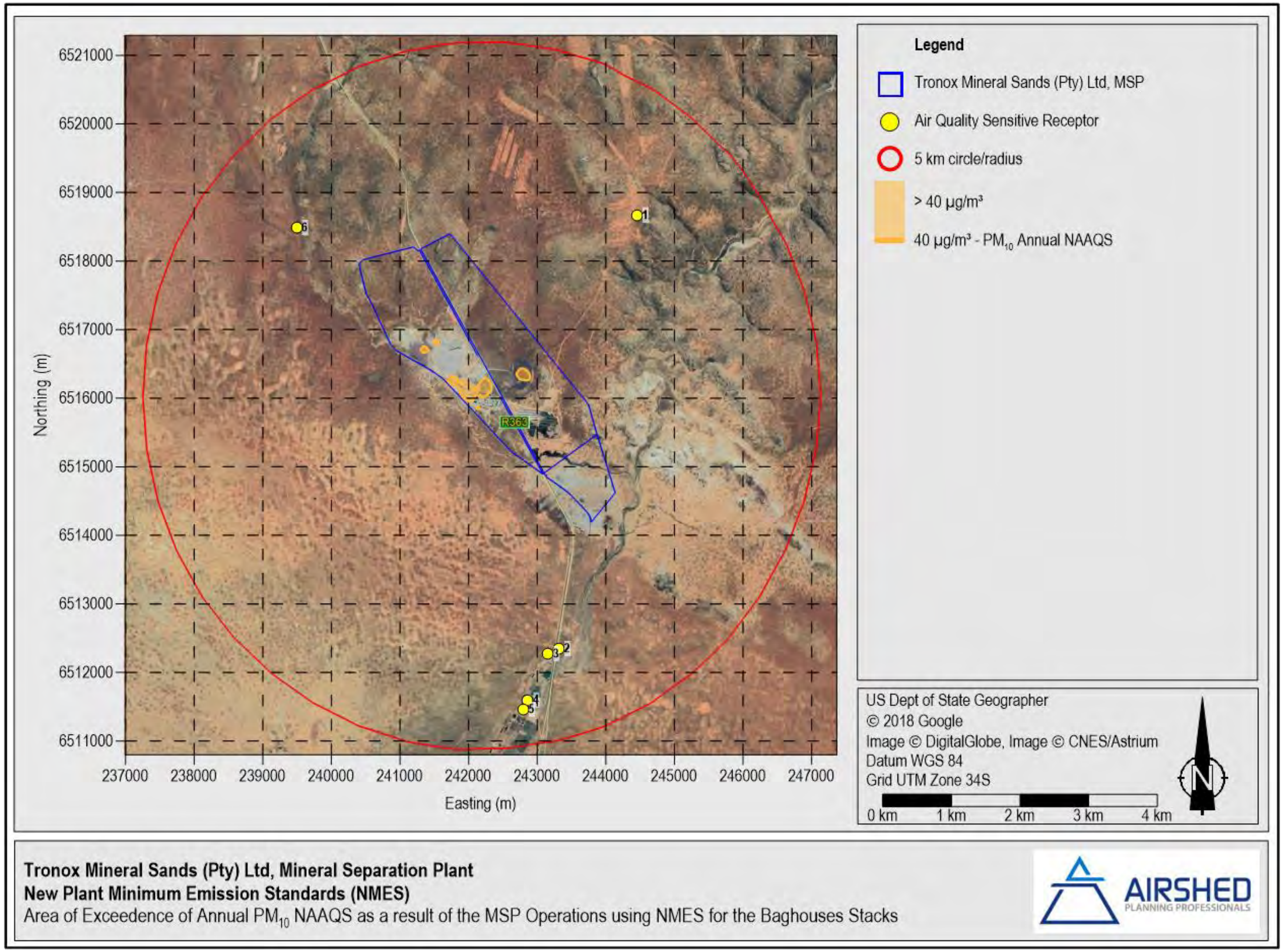

Figure 16: MSP operations with new plant minimum emission standards: simulated exceedance area of the 1-year average PM_{10} NAAQS

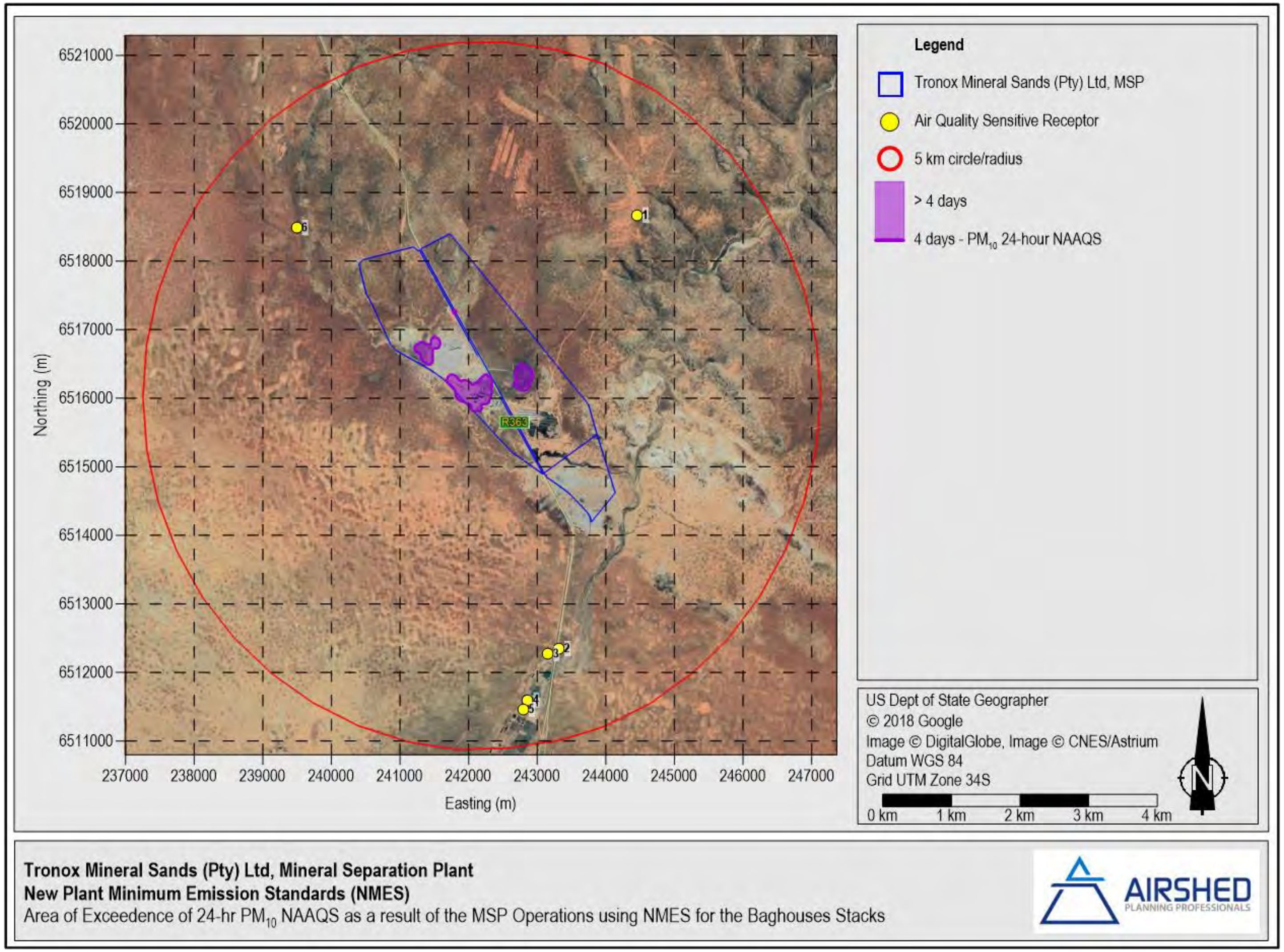

Figure 17: MSP operations with new plant minimum emission standards: exceedance area of the 24-hour average PM_{10} NAAQS

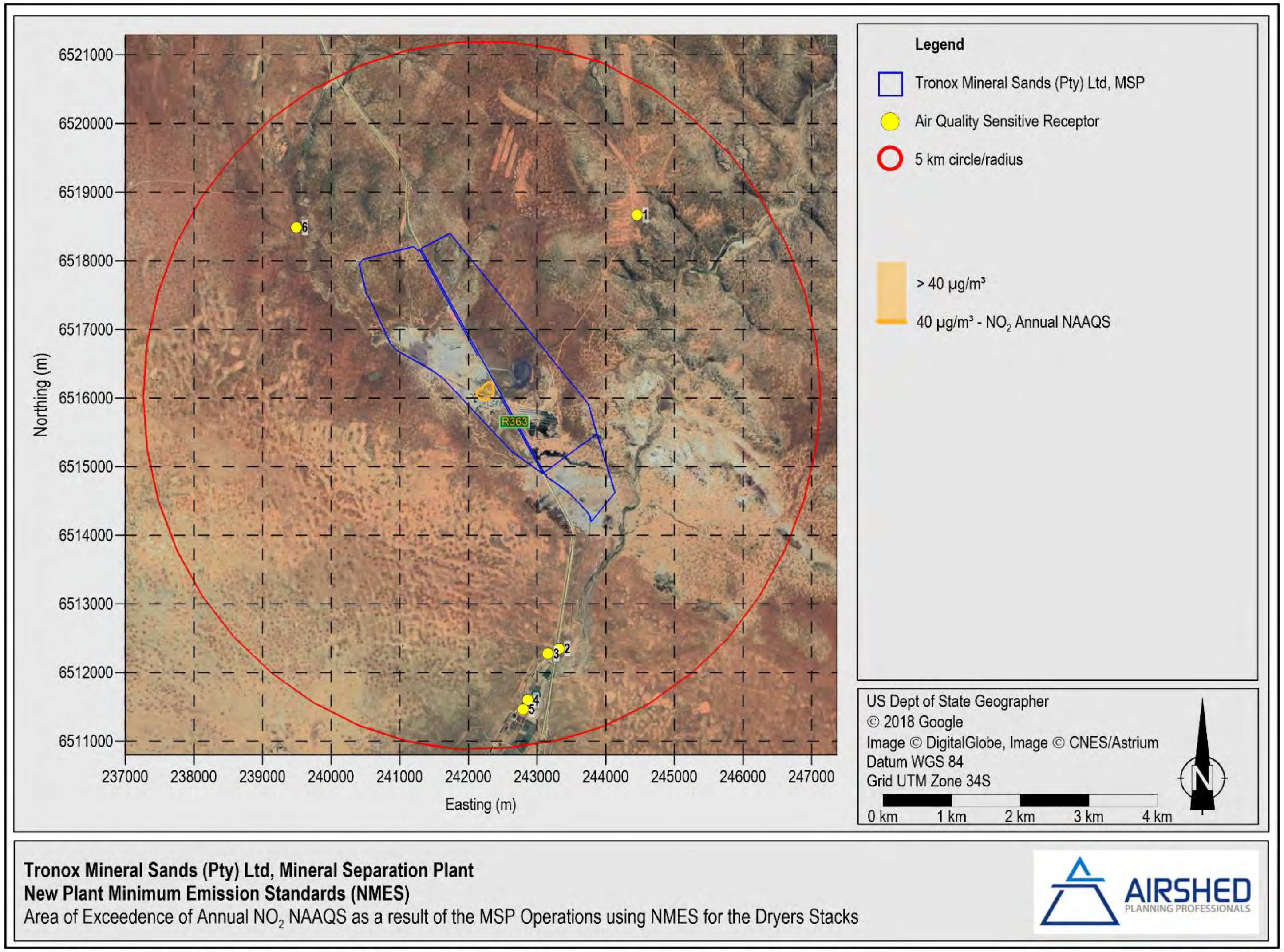

Figure 18: MSP operations with new plant minimum emission standards: simulated exceedance area of the 1-year average NO_2 NAAQS

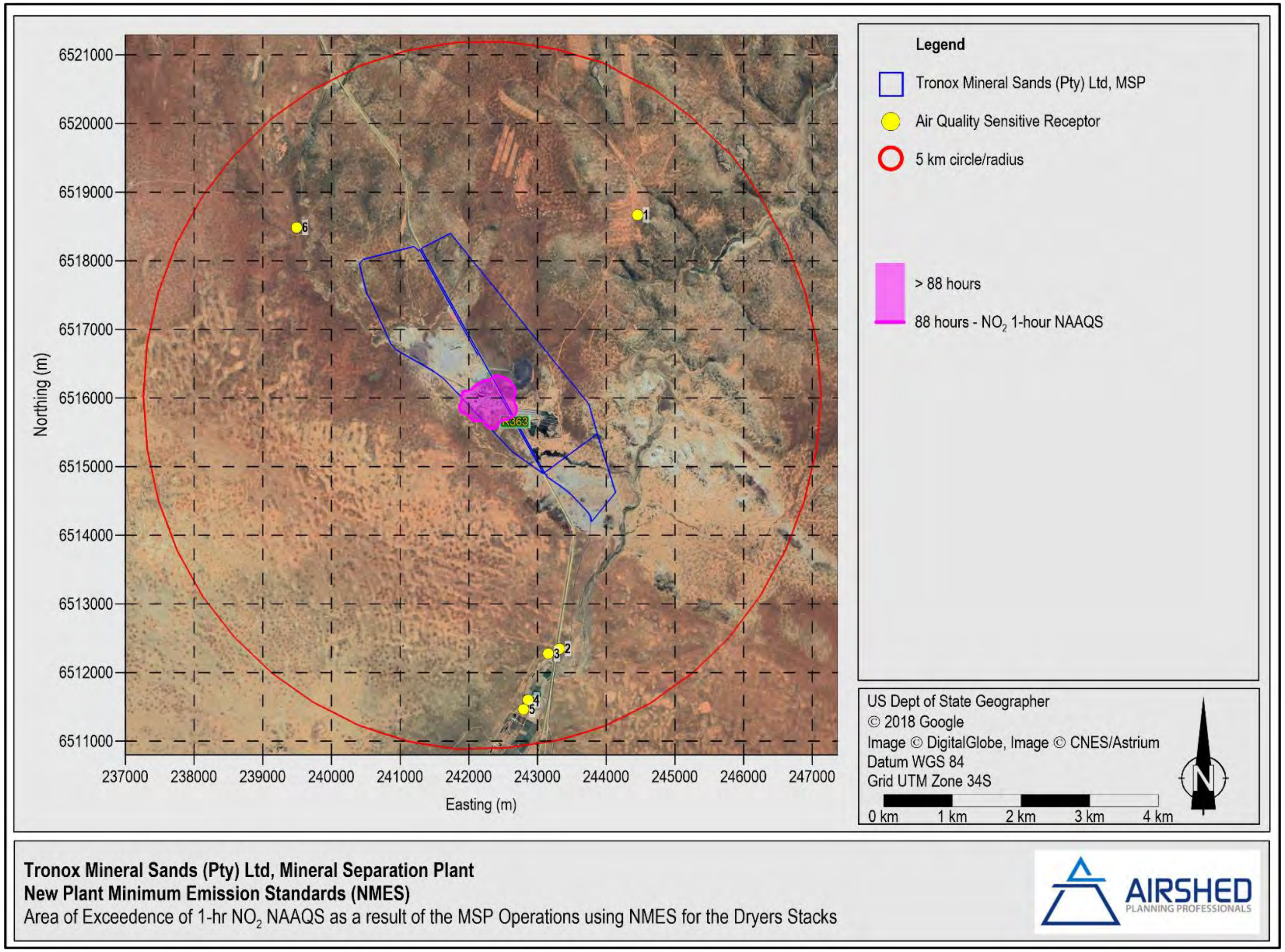

Figure 19: MSP operations with new plant minimum emission standards: exceedance area of the 1-hour average NO_2 NAAQS

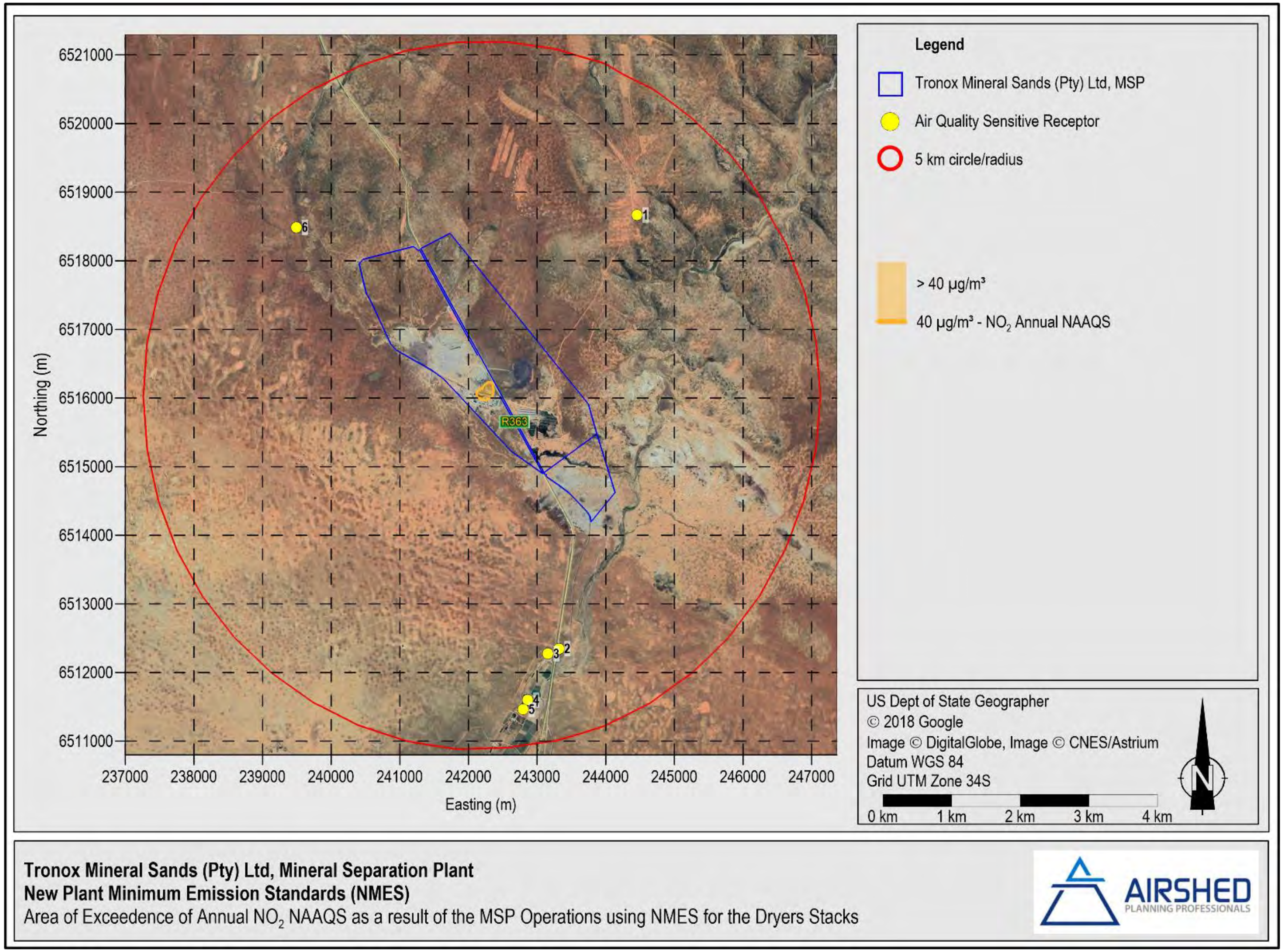

Figure 20: MSP operations with new plant minimum emission standards: simulated exceedance area of the 1-year average SO_2 NAAQS

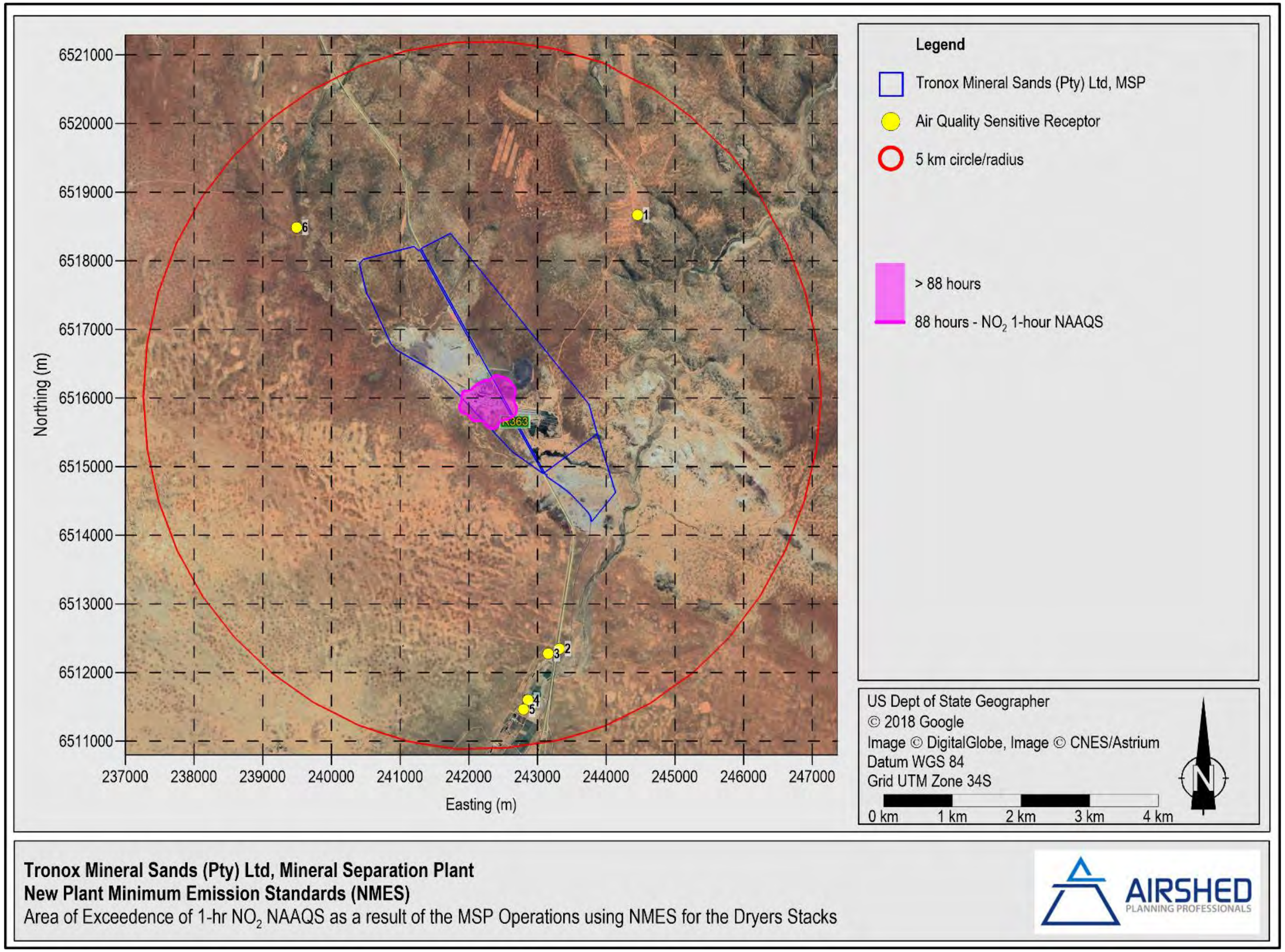

Figure 21: MSP operations with new plant minimum emission standards: exceedance area of the 24-hour average SO_2 NAAQS

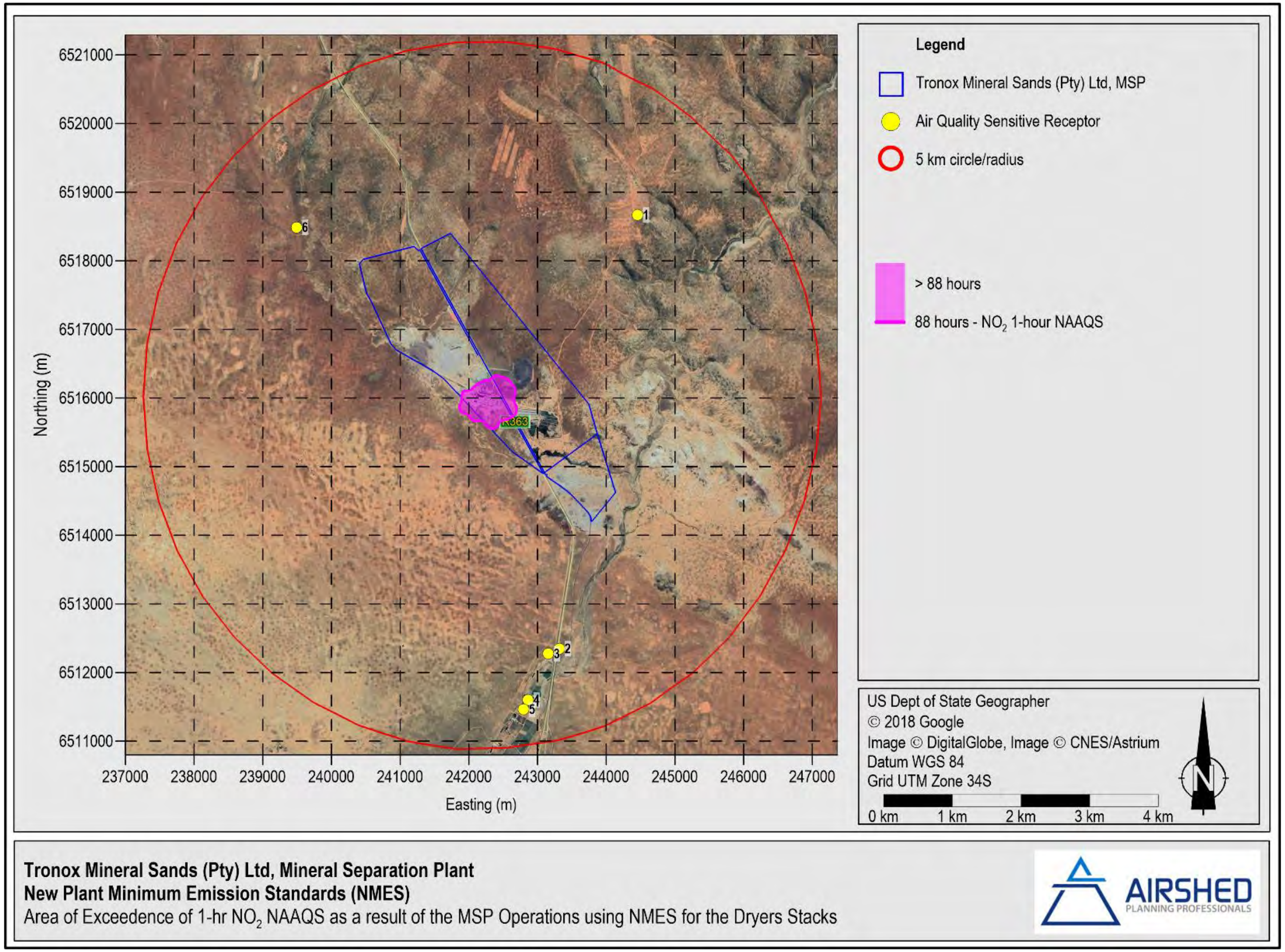

Figure 22: MSP operations with new plant minimum emission standards: exceedance area of the 1-hour average SO_2 NAAQS

5.2 **Analysis of Emissions' Impact on the Environment**

5.2.1 Assessment Criteria for Dustfall

5.2.1.1 National Dust Control Regulations

National Dust Control Regulations (NCDR) were published on the 1st of November 2013 (Government Gazette No. R. 827). Acceptable dustfall rates per the Regulation are summarised in Table 21.

Table 21: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m^2-day over a 30-day average	Permitted frequency of exceedance
Residential areas	D < 600	Two within a year, not sequential months.
Non-residential areas	600 < D < 1 200	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or an equivalent method approved by any internationally recognized body. Dustfall is assessed for nuisance impact and not inhalation health impact.

5.2.1.2 Screening Criteria for Animals and Vegetation

Limited information is available on the impact of dust on vegetation and grazing quality. While there is little direct evidence of the impact of dustfall on vegetation in the South African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in sunflower and cotton plants exposed to dust fall rates greater than 400 $mg/m^2/day$ (Farmer, 1993). In addition, there is anecdotal evidence to indicate that over extended periods, high dustfall levels in grazing lands can soil vegetation and this can impact the teeth of livestock (Farmer, 1993).

5.2.2 Measured Dustfall Rates

Data from January 2017 to December 2018 was available for on-site dustfall rates. The monitoring method changed; therefore the older data cannot be used to compare to NDCR. The locations of the single dust buckets are shown in Figure 23.During 2017, two buckets (DMP05 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months (Figure 24); this would indicate non-compliance with the NDCR. During 2018, three buckets (DMP05, DMP07 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months and one bucket (DMP06) with dustfall rates in excess of the NDCR limit for non-residential areas for two consecutive months (July and August) (Figure 25); this would indicate non-compliance with the NDCR.

Figure 23: Single dust bucket locations

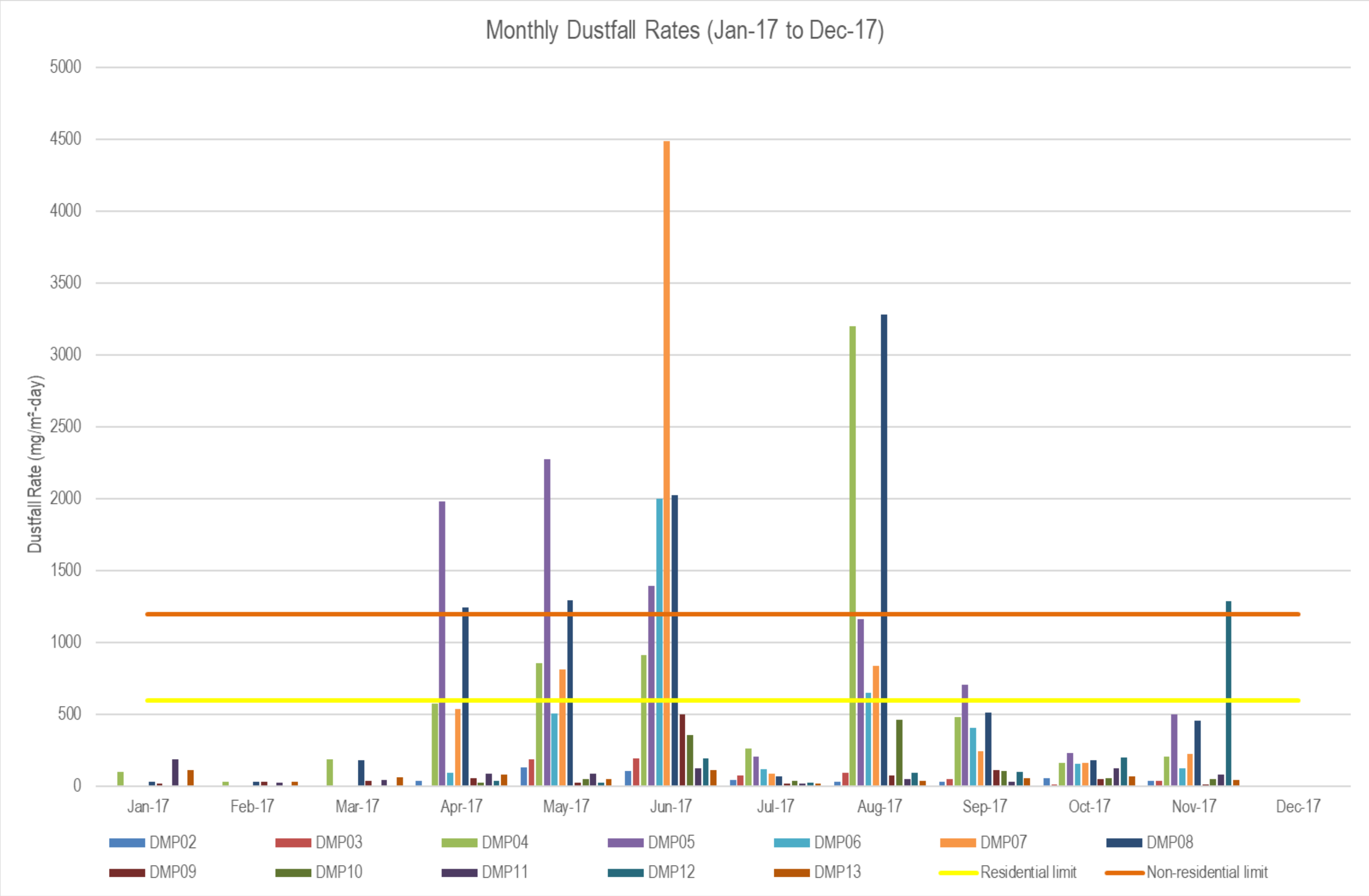

Figure 24: Dustfall rates for January 2017 to December 2017

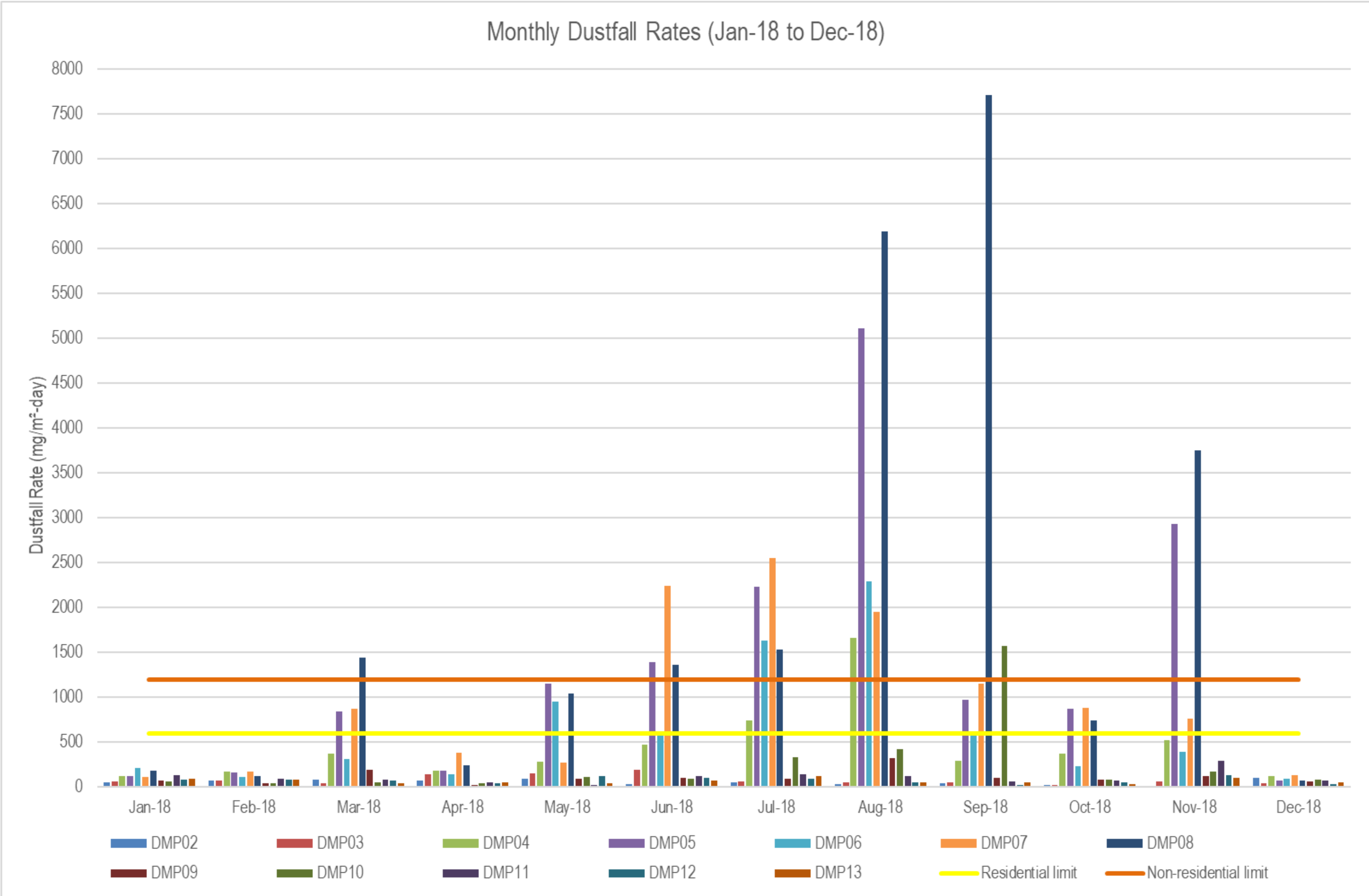

Figure 25: Dustfall rates for January 2018 to December 2018

5.2.3 Screening of Simulated Dustfall Rates for Potential Environmental Impacts (Normal Operating Conditions)

Section 5.2.3.1 are the simulated result for the facility operating at the expected normal operating conditions. Section 5.2.3.2 are the simulated result for the facility operating at the new plant MES. The design PM emissions from the stacks are expected to be slightly lower than the new plant MES.

5.2.3.1 MSP Operations with NG Fuelled Dryers– Estimated Emissions

The dispersion simulation results described below are as a result of the MSP operations with NG fuelled dryers. These results include all of the operations that will be taking place at the MSP should NG be approved as a fuel source. These include all the point and fugitive sources discussed in Section 4. The dryers' emissions are based on the design emission provided by Tronox NS. In July 2017 there was a day in which the meteorological data had wind speed above 12.8 m/s for multiple hours. This resulted in a larger impact area based on the 1st highest monthly TSP deposition rates than for 2015 and 2016. Simulated off-site dustfall rates are not in exceedance of 400 mg/m²-day at any agricultural or vegetated areas (Figure 26 to Figure 28). Simulated off-site dustfall rates are in exceedance of the NDCR limit for residential areas but not at any residences, schools, hospitals or clinics (Figure 26 to Figure 28). Simulated on-site dustfall rates are in exceedance of the NDCR limit for non-residential areas (Figure 26 to Figure 28).

5.2.3.2 MSP Operations – New Plant Minimum Emission Standards

The dispersion simulation results described below are as a result of the MSP operations. These results include all of the operations that are taking place at the MSP. These include all the point and fugitive sources discussed in Section 4. The dryers' emissions are based on the subcategory 5.2 MES for new plants. In July 2017 there was a day in which the meteorological data had wind speed above 12.8 m/s for multiple hours. This resulted in a larger impact area based on the 1st highest monthly TSP deposition rates than for 2015 and 2016. Simulated off-site dustfall rates are not in exceedance of 400 mg/m²-day at any agricultural or vegetated areas (Figure 29 to Figure 31). Simulated off-site dustfall rates are in exceedance of the NDCR limit for residential areas but not at any residences, schools, hospitals or clinics (Figure 29 to Figure 31). Simulated on-site dustfall rates are in exceedance of the NDCR limit for non-residential areas (Figure 29 to Figure 31).

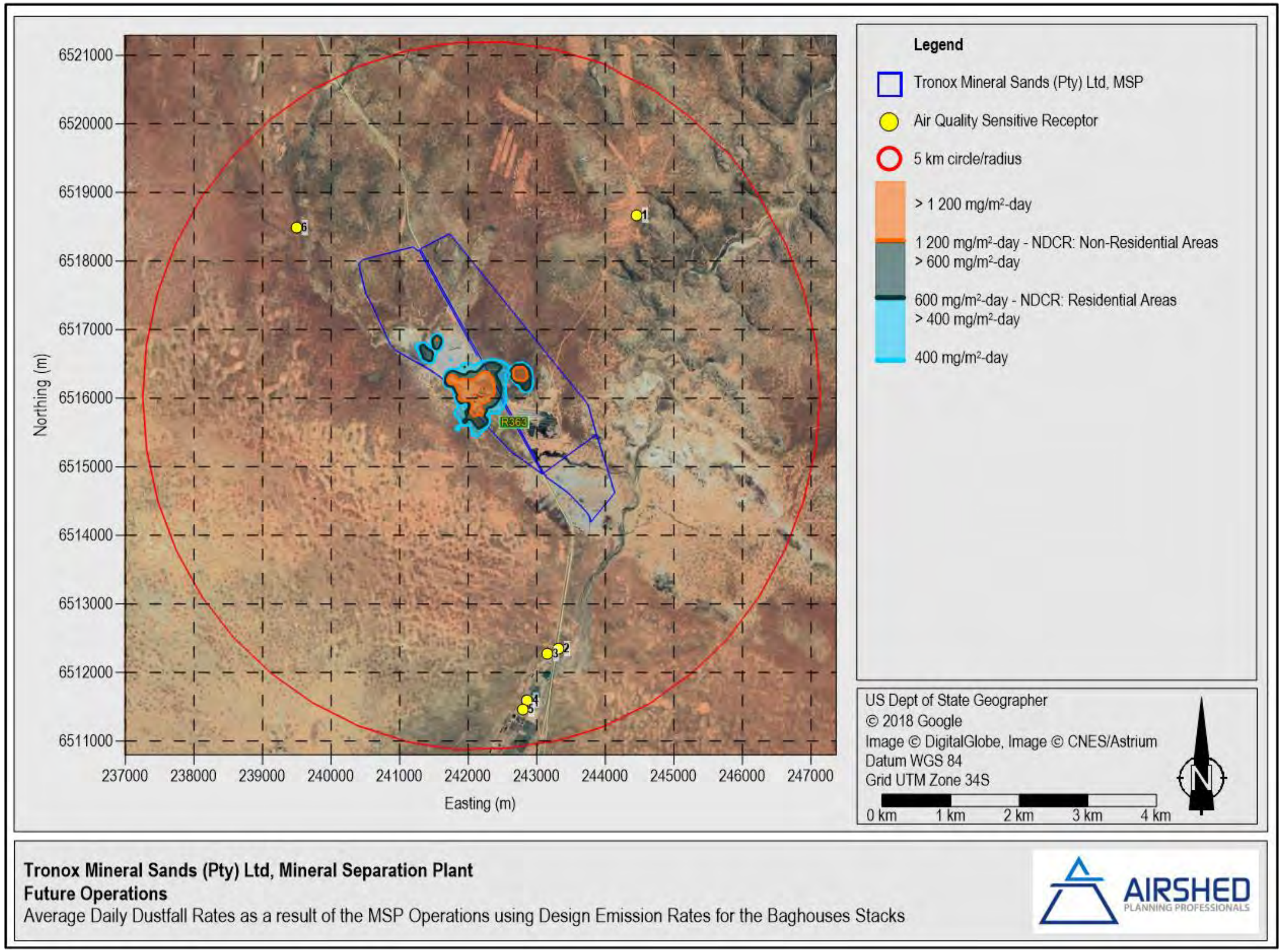

Figure 26: MSP operations with stacks design emissions: simulated dustfall rates for 2015 metrological data

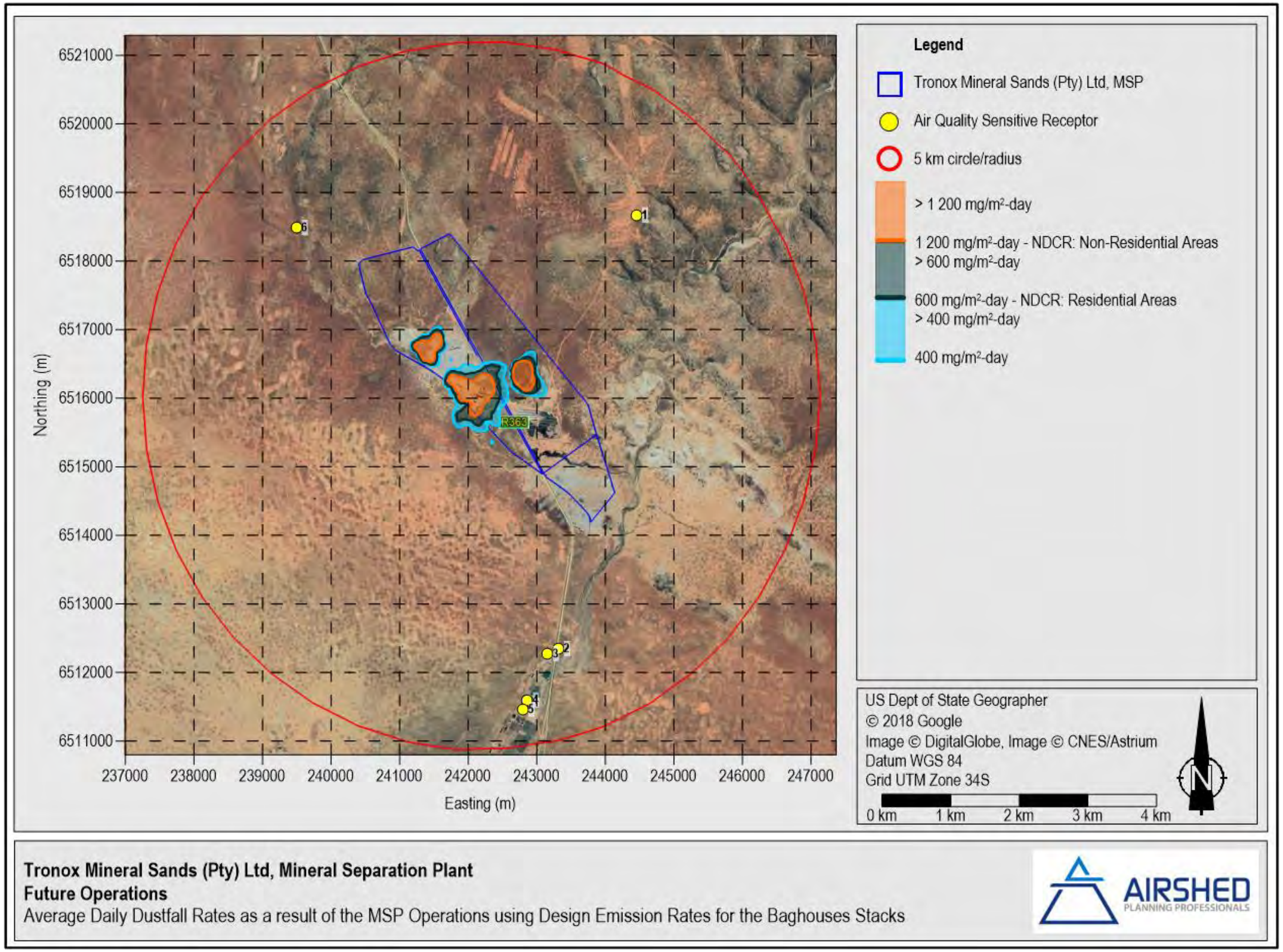

Figure 27: MSP operations with stacks design emissions: simulated dustfall rates for 2016 meteorological data

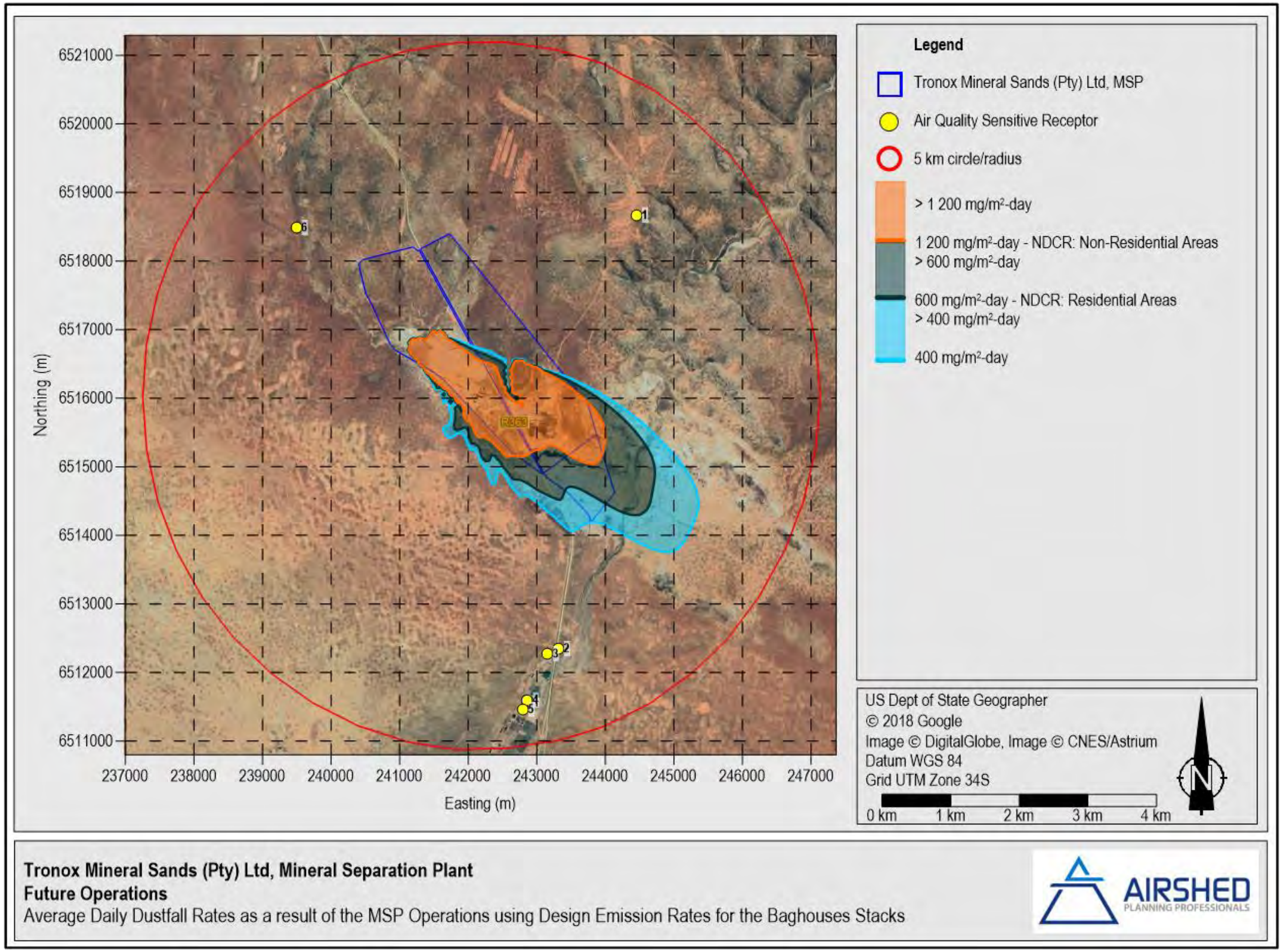

Figure 28: MSP operations with stacks design emissions: simulated dustfall rates for 2017 meteorological data

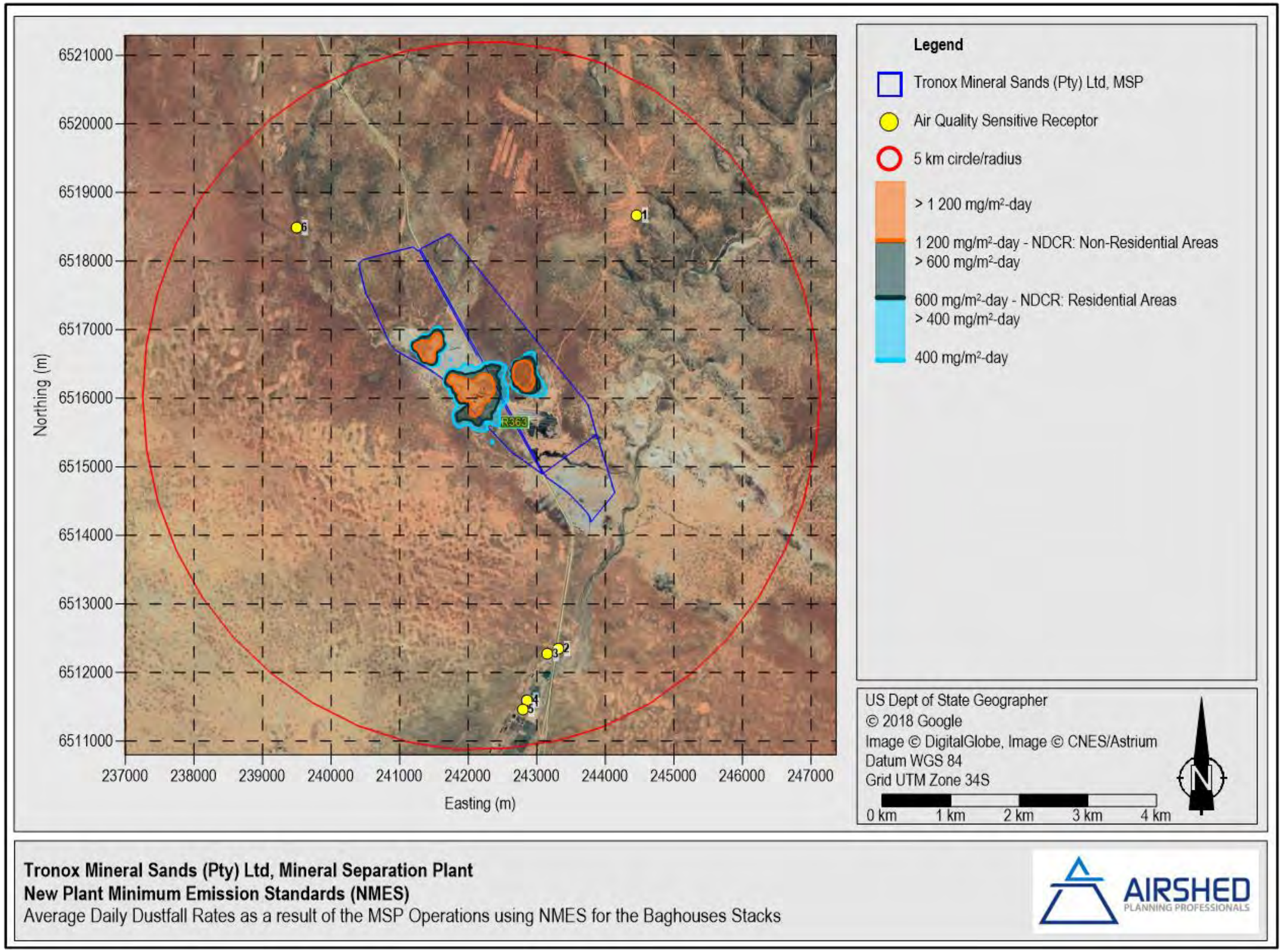

Figure 29: MSP operations with new plant minimum emission standards: simulated dustfall rates for 2015 meteorological data

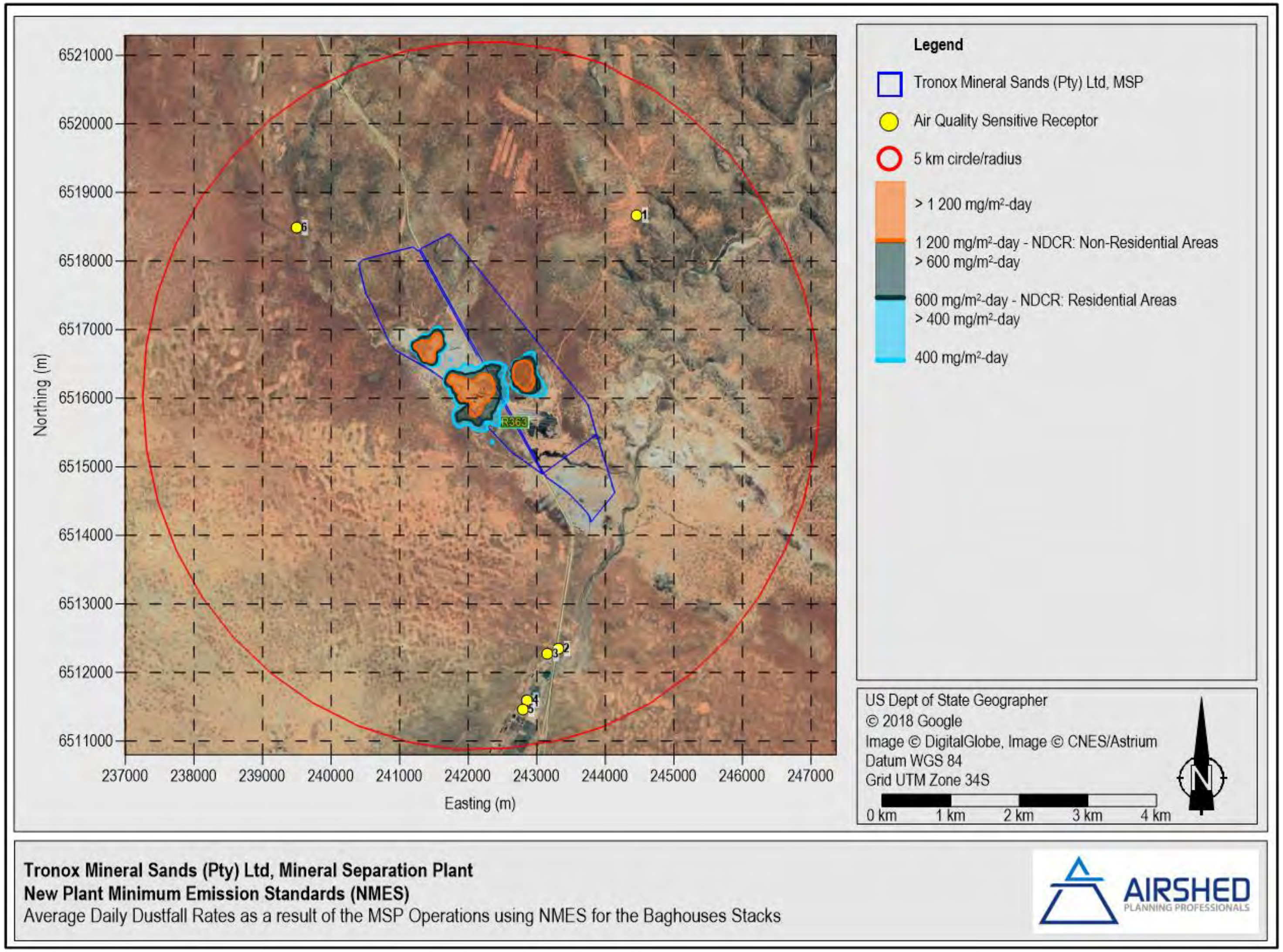

Figure 30: MSP operations with new plant minimum emission standards: simulated dustfall rates for 2016 meteorological data

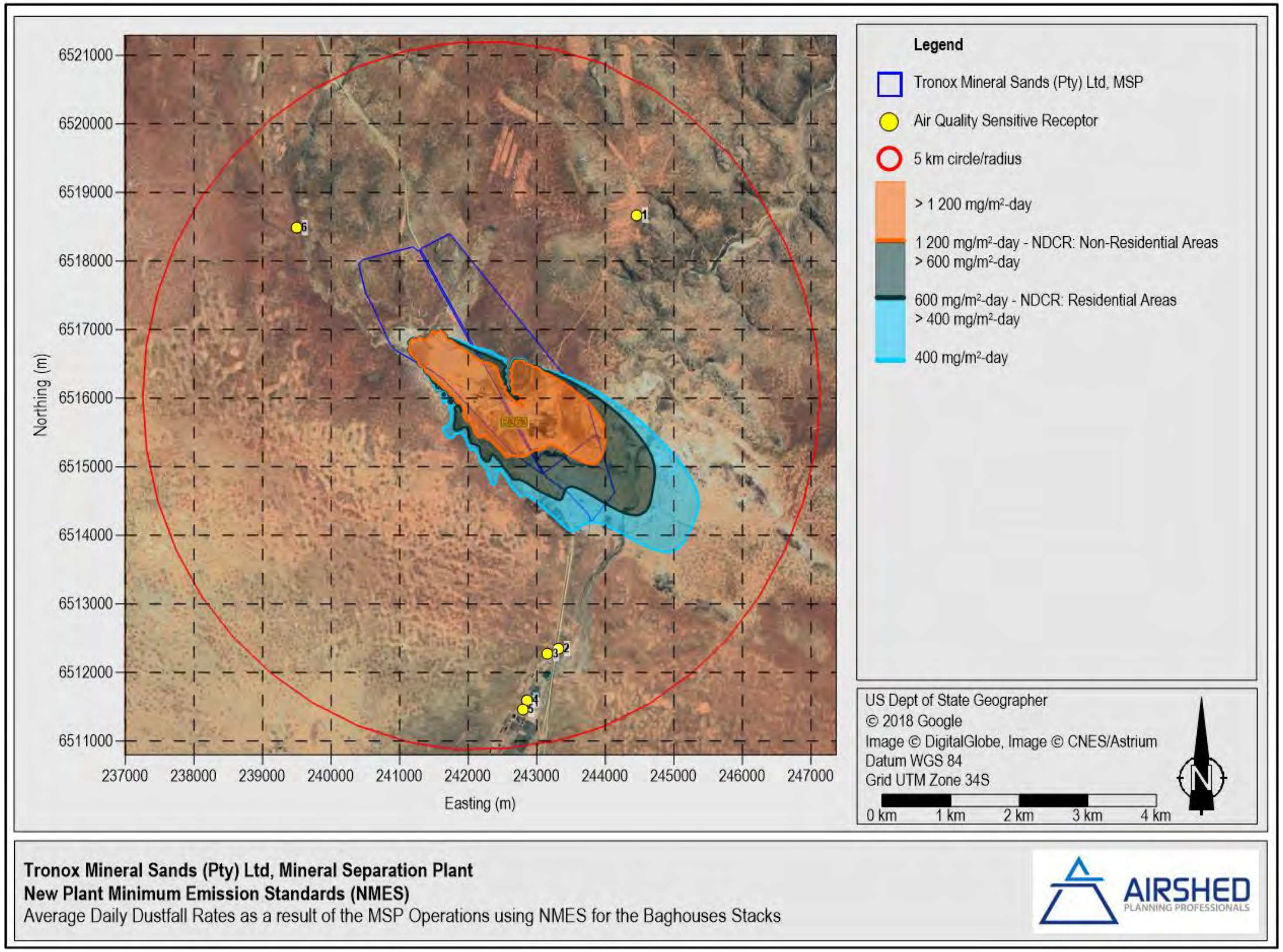

Figure 31: MSP operations with new plant minimum emission standards: simulated dustfall rates for 2017 meteorological data

6 COMPLAINTS

Tronox NS MSP has an active complaint register where complaints from surrounding land users can be registered. No complaints have been received in the past two years.

7 CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

7.1 Mitigation measures

It is planned that the mitigation measures indicated in Table 9 and Table 10 will be implemented or continued.

7.2 Monitoring

Under Section 21 of the NEM:AQA it is compulsory to measure PM, NO_x expressed as NO_2 and SO_2 emissions from the dryers stacks. It further requires the holder of an AEL to submit an emission report in the format specified by the National Air Quality Officer or Licensing Authority on an annual basis. Tronox will undertake monitoring as set out in Table 22.

Table 22: Stack emissions testing

Point Source ID	Pollutants to measure	Emission sampling/monitoring method	Sampling frequency	Motivation
SV000 SV00	PM	As per methods and sampling analysis prescribed in Annex A of Section 21 of NEM:AQA.	Annual	Determine compliance with MES.
	NO_x expressed as NO_2	As per methods and sampling analysis prescribed in Annex A of Section 21 of NEM:AQA.	Annual	Determine compliance with MES.
	SO_2	As per methods and sampling analysis prescribed in Annex A of Section 21 of NEM:AQA.	Annual	Determine compliance with MES.

8 Compliance and Enforcement Actions

The AEL application was submitted and a PAEL was issued by DEA for the MSP. The PAEL expired; an initial application for the renewal of the PAEL has been submitted. Enforcement action has been implemented by the DEA as a result of operating with an expired PAEL.

9 Additional Information

The following additional information not mentioned in the report above is of relevance to this AIR and AEL application:

1. Letter regarding the applicability of the National Environmental Management Act 107 of 1998 Environmental Impact Assessment Regulations, 2014, to the facility - Annexure H.

10 Formal Declarations

10.1 Declaration of Accuracy of Information

Annexure A contains a declaration of accuracy of information by the applicant.

10.2 Declaration of Independence of Practitioner

Annexure B contains a declaration of independence by the practitioner preparing the AIR.

11 Main Findings

The main findings of the baseline assessment are that:

- The wind field was dominated by winds from the south-west followed by winds from the south-south-west. During the day, winds occurred more frequently from the south-westerly and south-south-westerly. Night-time airflow had winds from the north-westerly and south-westerly sectors occurring at approximately the same frequency followed by winds from the west-north-westerly and west-south-westerly directions. In general, the wind speeds at night were lower than those occurring during the day.
- The main sources contributing to current background pollutant concentrations and dustfall rates likely include vehicle entrained dust from local roads, agricultural activities, windblown dust from exposed areas, biomass burning, household fuel burning and vehicle exhaust emissions.
- The MSP is located in a fairly remote area in the West Coast District Municipality of the Western Cape Province. The surrounding land use is agricultural activities consisting of mostly livestock (sheep) with some lands used for dryland wheat production. Agricultural activities to the south include vineyards and lands for vegetables (tomatoes, cabbage, etc.). Making the surrounding expanse a sparsely populated rural area. The closest residences to the MSP are few farm houses located within 5 km to the south and north-east of the section 21 listed activities. The Koekenaap School is located 7.4 km to the south of the listed activities.

- On-site dustfall rates was available from January 2017 to December 2018. During 2017, two buckets (DMP05 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months; this would indicate non-compliance with the NDCR. During 2018, three buckets (DMP05, DMP07 and DMP08) recorded dustfall rates in excess of the NDCR limit for non-residential areas for three or more months and one bucket (DMP06) with dustfall rates in excess of the NDCR limit for non-residential areas for two consecutive months (July and August); this would indicate non-compliance with the NDCR.

The main findings of the impact assessment are as follows:

- PM emissions from Tronox NS regulated stack does not currently comply with the existing plant or new plant national minimum emissions standards (MES). Tronox NS is constructing baghouses for the dryers to enable the facility to comply with the new plant MES.
- NO_x and SO_2 emissions from Tronox Mineral Sands regulated stack does comply with the existing plant and new plant national minimum emissions standards (MES).
- Total suspended particulates (TSP), PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO emissions were quantified and modelled.
- The simulated results of the MSP operations with the dryers fuelled by NG were as follows:
    - Simulated $PM_{2.5}$ and PM_{10} as a result of the Tronox Mineral Sands operations with the dryers emitting the measured emissions exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).
    - Simulated NO_2, SO_2 and CO as a result of the Tronox Mineral Sands operations with the dryers emitting the measured emissions did not exceed the NAAQS.
    - Simulated $PM_{2.5}$, PM_{10}, NO_2, SO_2 as a result of the Tronox Mineral Sands operations with the dryers emitting the existing plant minimum emission standards exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).
    - Simulated $PM_{2.5}$, PM_{10}, NO_2, SO_2 as a result of the Tronox Mineral Sands operations with the dryers emitting the new plant minimum emission standards exceed the NAAQS off-site but not at any of the air quality sensitive receptors (AQSRs).
    - Simulated nuisance dustfall rates as a result of the Tronox Mineral Sands operations were found to be above the NDCR limit for residential areas off-site but not at any AQSRs and the NDCR limit for non-residential areas on-site.
- The dryers are currently fuelled by paraffin, the impacts for the current operations are shown in Annexure G. It is expected that emissions (PM, NOx and SO2) will reduce using NG as a fuel source for the dryers. The concentrations as a result of the dryers operations using NG as a fuel source were determined to lower than current operations (using paraffin as a fuel source).

To ensure the lowest possible impact on AQSRs and the environment it is recommended that Tronox NS ensure that the mitigation and monitoring of sources of emission are undertaken as described in the technical sections of the report.