ATMOSPHERIC IMPACT REPORT

PROPOSED SINTER PLANT ADDITION AT TRANSALLOYS (PTY) LTD., EMALAHLENI

SPECIALIST REPORT

VERSION 1

Mamadi & Company | SA

DOCUMENT CONTROL

TITLE	**ATMOSPHERIC IMPACT REPORT – PROPOSED SINTER PLANT ADDITION AT TRANSALLOYS (PTY) LTD., EMALAHLENI**
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AUTHOR

THE FOLLOWING RESOURCE HAVE AUTHORED AND REVIEWED THIS DOCUMENT:

NAME	DESIGNATION
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NEMA REGULATION (2014), APPENDIX 6

NEMA Regulations (2014) - Appendix 6	**Relevant section in report**
Details of the specialist who prepared the report.	Report details (page i) Section 13
The expertise of that person to compile a specialist report including curriculum vitae.	Report details (page i) Section 13
A declaration that the person is independent in a form as may be specified by the competent authority.	Section 12.2
An indication of the scope of, and the purpose for which, the report was prepared.	Executive Summary (page iii and iv)
The date and season of the site investigation and the relevance of the season to the outcome of the assessment.	The Specialist is familiar with the site based on previous work done over the past 6 years, hence, a site visit was not conducted for this task since no additional information would be collected. Section 5.2 – Ambient data representative of all seasons was available.
A description of the methodology adopted in preparing the report or carrying out the specialised process.	Emissions inventory: Section 4 Dispersion simulation and impact assessment: Sections 5.3.2.1, 5.3.2.2, 5.3.2.3 and 5.3.2.4
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure.	Section 1.2 Sections 5.3.1, 5.4.1, 5.5.1
An identification of any areas to be avoided, including buffers.	Not applicable
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 5.4
A description of any assumptions made and any uncertainties or gaps in knowledge.	Emissions inventory: Section 4 Dispersion simulation and impact assessment: Sections 5.3.2.1, 5.3.2.2, 5.3.2.3 and 5.3.2.4
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment.	Sections 5.4, 5.5 and 5.6
Any mitigation measures for inclusion in the EMPr.	Section 7, 7.2.1, 7.2.2, 7.2.3, 7.2.4
Any conditions for inclusion in the environmental authorisation	Section 7
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	Section 7.2.5
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised.	Section 7.2
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan.	Section 7.1 and 7.2
A description of any consultation process that was undertaken during the course of carrying out the study.	Not applicable.
A summary and copies if any comments that were received during any consultation process.	No comments received
Any other information requested by the competent authority.	Not applicable

EXECUTIVE SUMMARY

Mamadi and Company SA (Pty) Ltd (Mamadi) was commissioned by Transalloys (Pty) Ltd (Transalloys) to undertake an Air Quality Assessment for the proposed Sinter Plant addition at Transalloys (the Project). The Air Quality Impact Assessment form part of the Environmental Authorization process required for the Project. This included the following tasks:

- A baseline assessment including:
    - The identification of current sources of emission.
    - The identification of sensitive receptors.
    - The characterisation of atmospheric dispersion potential of the Transalloys site based on updated meteorological data.
    - The characterisation of existing ambient air quality based on available ambient air quality monitoring data.
    - Baseline emissions inventory and dispersion modelling for current Transalloys operations.
- An impact assessment, including:
    - The estimation of emissions from proposed operations.
    - Dispersion modelling to predict incremental ambient air concentrations to assess compliance with South African National Ambient Air Quality Standards (NAAQS) and health risk screening criteria; and
    - Assessing the significance of impacts.
- A management plan, including:
    - Identifying and recommending measures of mitigation and air quality management, including source and ambient air quality monitoring.

Two distinct scenarios were assessed. These can be summarised as follows:

- **Scenario 1** represents incremental emissions due to proposed Sinter Plant operations at Transalloys; and
- **Scenario 2** represents existing Transalloys operations in addition to proposed Sinter Plant operations.

This study is an amendment to the studies conducted for Transalloys in 2019, 2017 and 2014 (Akinshipe & Bird, Atmospheric Impact Report for the Proposed Process Modifications at Transalloys (Pty) Ltd, eMalahleni, 2017; Akinshipe & von Reiche, 2014; Akinshipe & Bird, Atmospheric Impact Report for the Proposed Process Modifications at Transalloys (Pty) Ltd, eMalahleni, 2019). The findings of the above tasks and assessed scenarios are presented here as an Air Impact Report (AIR) in the format prescribed by the Department of Environmental Affairs (DEA). The AIR serves as supporting documentation for Atmospheric Emission Licence (AEL) amendment applications. The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the Project on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential air quality sensitive receptors (AQSRs) in relation to proposed activities as well as existing ambient pollutant levels and dustfall rates.

A comprehensive atmospheric emissions inventory was compiled for the operational phase of the Project. Pollutants quantified included those mostly associated with ferro-alloy production i.e. particulate matter (TSP, PM_{10}, and $PM_{2.5}$). PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Respirable particulate matter, $PM_{2.5}$, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas PM_{10} and $PM_{2.5}$ fractions are considered to determine the potential for human health risks, total suspended particulate matter (TSP) is included to assess nuisance dust effects. All particulate matter (PM) emissions were determined through the application of emission factors published by the United States Environmental Protection Agency (US EPA) and the Australian National Pollutant Inventory (NPI). Gaseous emissions, including sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) were also quantified and utilized in dispersion simulations. In addition, manganese (Mn), a constituent of PM emissions, was also quantified and utilized in dispersion simulations.

The main findings of the assessment are summarised below:

- The receiving environment:

  - Hourly meteorological data for the period January 2017 to December 2019 was simulated and utilised for the study.
  - The Project area is dominated by strong winds from the northwest, north-northwest and north, with strong but less frequent winds from the westerly and easterly sectors. An average wind speed of 3.0 m/s was simulated over the 2017 to 2019 period.
  - Ambient air pollutant levels in the Project area are currently affected by the following sources of atmospheric emissions: mining; industries; vehicle tailpipe emissions; agriculture; domestic fuel combustion; and open areas exposed to wind erosion.

- Impact of the Project:
  - Sources of emission quantified included: materials handling; vehicles entrained PM on paved and unpaved roads; stack; building fugitives; and, crushing and screening.
  - Annual average PM_{10} concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at the plant boundary or off-site. More than the permissible 4 days exceeding the 24-hour limit value of 75 $\mu g/m^3$ is simulated at the Transalloys boundary, but not at Clewer or any other residential area.
  - Similarly, annual average $PM_{2.5}$ concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at the Transalloys boundary or off-site. More than the permissible 4 days exceeding the 24-hour limit value of 40 $\mu g/m^3$ occur at the Transalloys boundary, but not at Clewer or any other residential area.
  - Also, simulated dustfall rates due to Scenario 1 and Scenario 2 emissions indicates rates below the NDCR residential limits at the Transalloys boundary and at any AQSRs.
  - Simulated annual average and maximum hourly NO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the NO_2 NAAQS at the Transalloys boundary, and at all AQSRs.
  - Simulated annual average and maximum hourly SO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the SO_2 NAAQS at the Transalloys boundary, and at all AQSRs.
  - Finally, the annual average Mn concentrations due to Scenario 1 emissions are low and within WHO GV at AQSRs, however Mn concentrations due to Scenario 2 emissions exceed the WHO GV off-site by a considerable margin, affecting AQSRs such as Clewer, and Kwa-Guqa. However, findings of the human health risk assessment based on the simulated manganese concentrations indicates that potential health impact associated with exposure to manganese contributed by the Transalloys facility for both scenarios are not significant, and risk of health effects will be minimal or negligible (van Niekerk & Fourie, 2017).
  - The direct contribution of the proposed Sinter Plant to simulated ground level impacts due to cumulative Transalloys emissions ranged between 3.0% and 7.6%. This indicates that the impact of proposed Sinter Plant will be minimal or negligible.

In conclusion, it is the specialist opinion that the proposed amendment may be authorised provided that the recommended air quality management measures are implemented to ensure the lowest possible impact on nearby AQSRs and the environment. These air quality management practices include mitigation measures aimed at reducing emissions at the following sources:

  - Furnace building fugitives;
  - Crushing and screening;
  - Stack emissions; and,
  - Vehicle entrained dust from paved and unpaved roads.

Dustfall and PM_{10} is already measured on-site and at various locations in Clewer; however, it is proposed that ambient monitoring of other pollutants such as SO_2, NO_2 and $PM_{2.5}$ be conducted until trends become apparent. Also, the Mn content of measured PM_{10} concentrations and dustfall rates should be determined for future reference.

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LIST OF ABBREVIATIONS

AEL	Atmospheric Emission Licence
AIR	Air Impact Report
AQSRs	Air Quality Sensitive Receptors
ASTM	American Standard for Testing and Materials
CAS	Crushing and screening (source identifier)
CO	Carbon monoxide
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
FeMn	Ferromanganese
FeSi	Ferrosilicon
GV	Guideline Value
HCFeMn	High carbon ferromanganese
masl	Meters above sea level
MCFeMn	Medium carbon ferromanganese
MHD	Materials handling (source identifier)
Mn	Manganese
NAAQS	National Ambient Air Quality Standard
NEMAQA	National Environmental Management Air Quality Act
NPI	National Pollutant Inventory (Australia)
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
P	Point source (source identifier)
PM	Particulate matter, also TSP
$PM_{2.5}$	Inhalable particulate matter with a diameter of less than 2.5 µm
PM_{10}	Thoracic particulate matter with a diameter of less than 10 µm
PRD	Paved roads (source identifier)
SAF	Submerged Arc Furnace
SAWS	South African Weather Service
SO_2	Sulphur dioxide
SiMn	Silico-manganese
Transalloys	Transalloys (Pty) Ltd.
TSP	Total suspended particulates, also PM (particulate matter)
URD	Unpaved roads (source identifier)
US EPA	United States Environmental Protection Agency
WHO	World Health Organisation

1 ENTERPRISE DETAILS

1.1 ENTERPRISE DETAILS

The details of Transalloys (Pty) Ltd (Transalloys) operations are summarised in Table 1. The contact details of the responsible person, the emission control officer, are provided in Table 2.

Table 1: Enterprise details

Enterprise Name	Transalloys (Proprietary) Limited
Trading as	Transalloys (Proprietary) Limited
Type of Enterprise	Company
Company Registration Number	2007/004433/07
Registered Address	Portion 34 of the farm Elandsfontein 309 JS
Registered Postal Address	PO Box 856, eMalahleni, 1035
Telephone Number (General)	013 693 8000
Fax Number (General)	013 659 7173
Industry Type/Nature of Trade	Manganese Alloy Production
Land Use Zoning as per Town Planning Scheme	Ferro-Alloy
Land Use Rights if Outside Town Planning Scheme	Industrial

Table 2: Contact details of responsible person

Responsible Person	Mr. Theo Morkel
Telephone Number	013 693 8027
Cell Number	082 336 3665
Fax Number	(013) 336 3665
Email Address	theom@transalloys.co.za
After Hours Contact Details	082 336 3665

1.2 LOCATION AND EXTENT OF THE PLANT

Table 3: Location and extent of the plant

Physical Address of the Plant	Clewer Road, eMalahleni, Mpumalanga
Description of Site (Where no Street Address)	Remaining extent of Portion 34 of the farm Elandsfontein 309 JS District EMalahleni, Mpumalanga
Coordinates of Approximate Centre of Operations	North-south: 25°53'45.24" S East-west: 29°07'1.92" E
Extent	0.88 km^2 (factory and slag disposal) ; 4.48km^2 total
Elevation Above Sea Level	1 548 masl
Province	Mpumalanga
Metropolitan/District Municipality	Nkangala
Local Municipality	eMalahleni
Designated Priority Area	Highveld Priority Area

Transalloys is located ~9 kilometres south-west of eMalahleni in Mpumalanga Province and directly south of the N4 freeway between Pretoria and Mbombela (Nelspruit). Transalloys is located on portions 34 and 35 of the farm Elandsfontein 309JS and portions 20 and 24 of the farm Schoongezicht 308JS.

It is bounded to the south-east by Clewer, a small township south-west of eMalahleni (Figure 1). The site falls within the jurisdiction of the eMalahleni Local Municipality, a constituent of the Nkangala District Municipality. Land use activities in the Transalloys neighbourhood include agriculture, residential, industrial and mining. Other residential areas in proximity include Kwa-Guqa and Lynville (Akinshipe & Bird, 2019).

Figure 1: Plant location in relation to the surrounding community

1.3 ATMOSPHERIC EMISSION LICENCE AND OTHER AUTHORISATIONS

The following authorisations, permits and licences related to air quality management are applicable:

  - Air Pollution Prevention Act (APPA) Registration Certificate: Permit Number - 13/6
- Atmospheric Emission License (AEL):
  - AEL issue – 17/04/AEL/MP312/11/05
  - AEL Amendment issue – NDM/AEL/MP312/11/05 (March 2019 to March 2024).

2 NATURE OF THE PROCESS

2.1 LISTED ACTIVITIES

A summary of listed activities currently undertaken and proposed at Transalloys is provided in Table 4.

Table 4: Listed activities

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
4 – Metallurgical Industry	4.6 – Basic Oxygen Furnace	Basic oxygen furnaces in the steel making industry
4 – Metallurgical Industry	4.9 – Ferro-alloy Production	The production of alloys of iron with manganese using heat
4 – Metallurgical Industry	4.11 – Agglomeration Operations	The production of pellets or briquettes using presses, inclined discs, or rotating drums
4 – Metallurgical Industry	4.5 – Sinter Plants	Sinter Plants for agglomeration of fine ores using a heat process, including sinter cooling, where applicable

2.2 PROCESS DESCRIPTION

2.2.1 SIMN AND/OR FEMN PRODUCTION

This study is an amendment to the studies conducted for Transalloys in 2019, 2017 and 2014 (Akinshipe & Bird, 2017; Akinshipe & von Reiche, 2014; Akinshipe & Bird, 2019).

Manganese ore from the Northern Cape is transported by rail and road (20 000 – 35 000 tons per month), and converted to silicomanganese (SiMn), ferromanganese (FeMn) and/or ferrosilicon (FeSi). Currently, silicomanganese is produced in five submerged arc furnaces (SAFs) no. 1, 3, 5, 6, and 7 using manganese (Mn) ore and quartz as the source of manganese and silicon respectively. Coal and coke are added to serve as reductants.

The molten metal and slag are tapped into a ladle. The molten alloy is heavier than the slag and it remains in the ladle while the slag overflows into a series of cast steel slag pots. Left-over slag in the ladle is decanted off. The alloy is cast into beds, in layers when the material is cooled sufficiently. Front end loaders are used to strip the cast material from the casting beds and placed into stockpiles. The SiMn stockpiles is crushed and screened into sizes according to customer specifications. Slag in the slag pot retains about 1% Mn and is transported to the slag stockpile by dump trucks for processing in the metal Recovery Plant. The SiMn slag from ladle cleanings and ladle excess contains metal. All metal containing slag is treated at the metal recovery plant. Refer to Figure 2 and Figure 3 below.

It should be noted that agglomeration processes do not include any point source emissions. Briquettes dry in the open. It was observed during a site visit that the agglomeration plant is mostly a sealed process with immaterial air emissions.

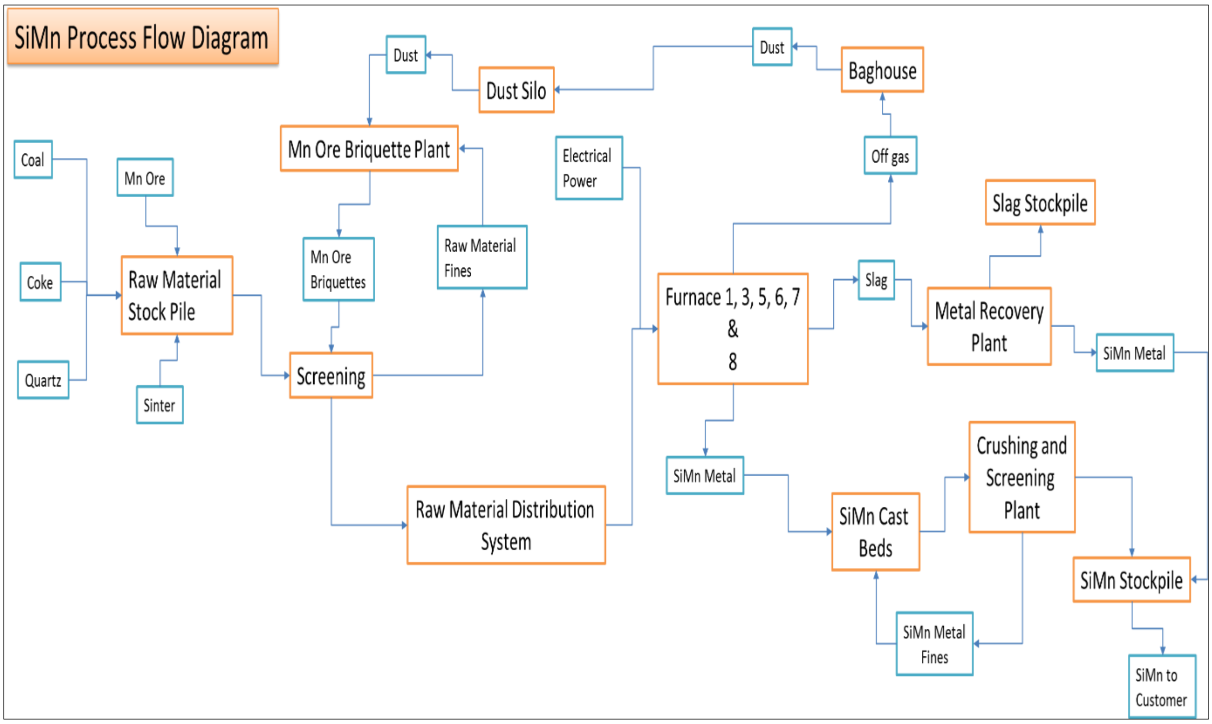


Figure 2: Production of SiMn at Transalloys – Flow Block Diagram

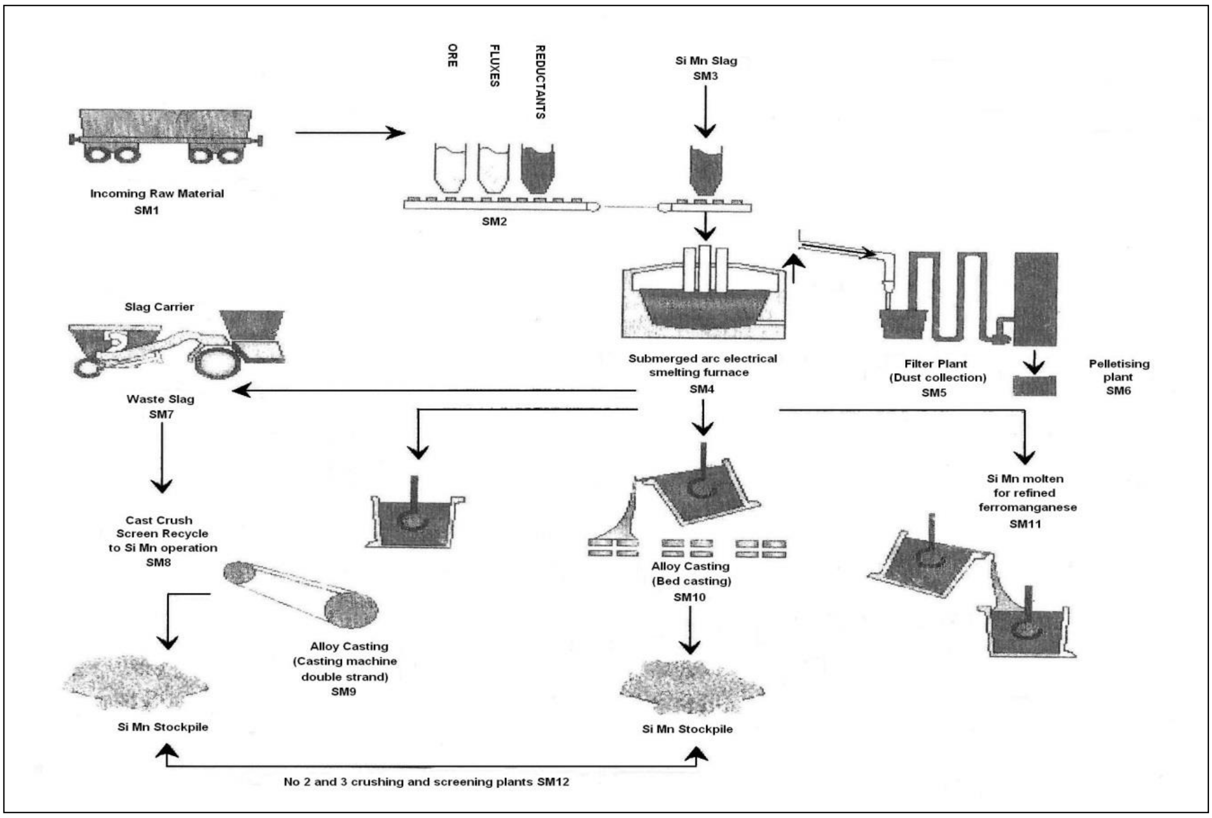


Figure 3: Production of SiMn – Process Flow Diagram

2.2.2 MCFeMn Production and Sinter Plant Addition

Transalloys designed and commissioned a Creusot Loire Uddeholm (CLU) oxygen blown converter (OBC) capable of producing 94 000t (maximum of 188 000) per annum of MCFeMn containing 1.38% carbon in the 2019 – 2020 preiod. The process is argon/oxygen decarburisation (AOD). The CLU OBC is the latest technology and uses steam as the medium for agitation as well as for decarburisation. This reduces the consumption of expensive argon (Ar) and oxygen (O_2). The HCFeMn exiting Furnace 5 and 7 will be used to manufacture the HCFeMn to feed the OBC. The HCFeMn with a carbon content of 6.5% will be tapped from the Furnace 5 and 7 into a ladle, any slag that is carried over with the metal will be raked off and the ladle moved by an overhead crane to the OBC where the alloy will be poured into the preheated 27t capacity OBC. The OBC will be in the titled position during the pouring “charging” of alloy.

The OBC will then move to its upright position and the decarburization process will commence by blowing O_2 via the top lance and later in the process diluted O_2 through shrouded nozzles (tuyeres) from the bottom of the OBC. The steam converts to hydrogen (H) and O_2 in the high temperature conditions, the H carrying out the agitation and the O_2 carrying out the decarburisation. Ar will still be available for agitation if necessary, to facilitate the reduction of the carbon content. The decarburisation process produces the MCFeMn containing 1.38% carbon. During the first ten minutes, lime, dolomite, and manganese metal fines will be added from the designated over-head bins. The blowing will continue and be controlled by a fully automated process control system. During the blowing, addition of necessary alloys, slag formers and coolants will be made from the additive system.

Off-gas emissions formed during decarburisation pass from the OBC and are combusted in a water-cooled hood before being further cooled by trombone coolers. The cooled gas will then pass to a newly constructed baghouse before being released to atmosphere. A “dog-house” enclosure will be constructed around the OBC to collect any additional secondary emissions created when charging or tapping the OBC.

After reduction of the slag, temperature and analysis adjustment the OBC will be tilted and the slag will be partially tapped into a slag ladle. The alloy together with the remaining slag will be tapped into a pre-heated casting ladle. The off-gases generated during the loading and tapping processes will be conveyed to the existing baghouse. The ladle containing the freshly cast MCFeMn will be moved by crane to just above a slag ladle. The MCFeMn will then be tilted slowly so that the small quantities of slag, that may be present, flow into the slag ladle. Once the slag has been removed the ladle will be moved to the casting beds and allowed to cool. Slag from the ladle cast into the casting beds will be taken to the existing licenced slag stockpile (WML: reference number 12/9/11/L261/6).

The metal casting beds will consist of MCFeMn fines in the form of a flat area with surrounding banks. The MCFeMn ladle will be tilted and the alloy poured onto the bed; it forms a layer a few centimetres thick. The next casting will then be poured on top of the previous one as thin layers poured on top of each other are easier to break up and handle through final product dispatch. It is a batch process to produce the 1.38% carbon MCFeMn in the OBC. The design allows for sixteen batches (heats) to be produced typically in a twenty-four-hour period, with an operational average of 7 – 8 heats per day. The batch production process from charging of the alloy from the sub-arc furnace into the OBC to tapping of the refined alloy into a ladle will be approximately 90 minutes. The design is operation for 246 days per annum. In practice, Transalloys expect operation to be as follows:

- 16 maximum heats per day, with an average of 7 – 8 per day;
- Operation for 355 day per annum (97% availability);
- 10 days' shutdown for annual maintenance; and
- Routine maintenance shutdown for a shift (5 heats) every 10 days.

Raw materials such as dolomite, alumina and lime will be stored in the raw material storage area. Transfer bins will be used to transport the material by means of conveyers to day bins. The materials will then, by means of vibrating feeders, be transferred into weigh bins where the actual proportioning of the materials according to the smelt balance occurs. The material will be transported to a proportional bin from which it will be gravitationally fed into the OBC. The existing, decommissioned raw materials and flux addition system that use to feed Furnaces 2 and 4 will be utilised and modifications and refurbishment are proposed to provide a fully functional automatic flux and raw-material addition system for the new converter installation.

A chemically treated closed circuit cooling water system cools the OBC equipment due to high temperatures reached during operation. Gases and fumes, off-gas, from the OBC will pass through a water-cooled converted hood to reduce the off-gas temperature before entering the trombone coolers. The off-gas hood and duct cooling will be achieved by a closed loop water cooling system consisting of circulation pumps and closed circuit, forced draft evaporative coolers. Off-gas emissions are combusted in a water-cooled hood before being further cooled by trombone coolers. Trombone coolers consist of a series of vertical pipes and bends creating a radiant heat transfer area through which the gas temperature can be reduced to a level for safe operation of the baghouse. The role of the OBC Baghouse system is to cool and filter the off gases from the proposed OBC operation. Hot gases 600 ^{o}C pass from the OBC vessel via a water-cooled duct into a steel duct at the top of the furnace building. The ducting then passes in a westerly direction away from the baghouses of the other furnaces, before it passes to the trombone coolers which reduce the temperature to 240 ^{o}C before a fan passes the gases having drawn them from the OBC into the baghouse where they are filtered before releasing to atmosphere (Knights, 2019). The temperature at the roof and plenum will be lower than 240 ^{o}C because there is a dilution effect from ambient air being drawn in through the sheeting and through the grating at hopper level. When doing emissions testing this dilution effect is accounted for in EPA Method 5D. It's not possible to calculate how much dilution will occur. An estimate based on experience on similar applications the temperature at the plenum is expected to be in the range 80 ^{o}C – 130 ^{o}C. Mass and energy balances have been carried out for the 2 temperature extremes of 80 ^{o}C and 130 ^{o}C degrees (Knights, 2019). The gas farm will be a gas storage facility for liquefied petroleum gas (LPG), carbon dioxide (CO_2), Ar and O_2 gases. LPG will be used for the ladle heaters pilot flame, Ar will be used for agitation of the hot alloy in the converter, CO_2 will mainly be used as a standby or emergency alternative to Ar and O_2 is the process gas that will be used at the OBC during decarburisation. A 2.5t, LPG or oil fired, boiler will be used to generate steam. To ensure the steam does not condensate before being injected into the OBC, it will be superheated in an electrical super heater. Heat exchangers will be included to ensure steam does not condensate when mixed with other gases.

The flow diagram and mass balance of the CLU converter unit is shown in Figure 4. The proposed amendment of the flow diagram and mass balance for the dedicated OBC Baghouse (Case 1 and Case 2) are shown in Figure 5.

Additionally, Transalloys proposes to design, build and operate a Sinter Plant capable of producing 100 000 tons per annum. The anticipated materials feed into the plant will be as follows:

- Ore fines – 120 000 tons per annum
- Dust – 15 000 tons per annum
- Coke or Calcined Anthracite fines – 20 000 tons per annum.

The flow diagram and mass balance of the Sinter Plant unit processes are presented in Figure 6 and Figure 7.

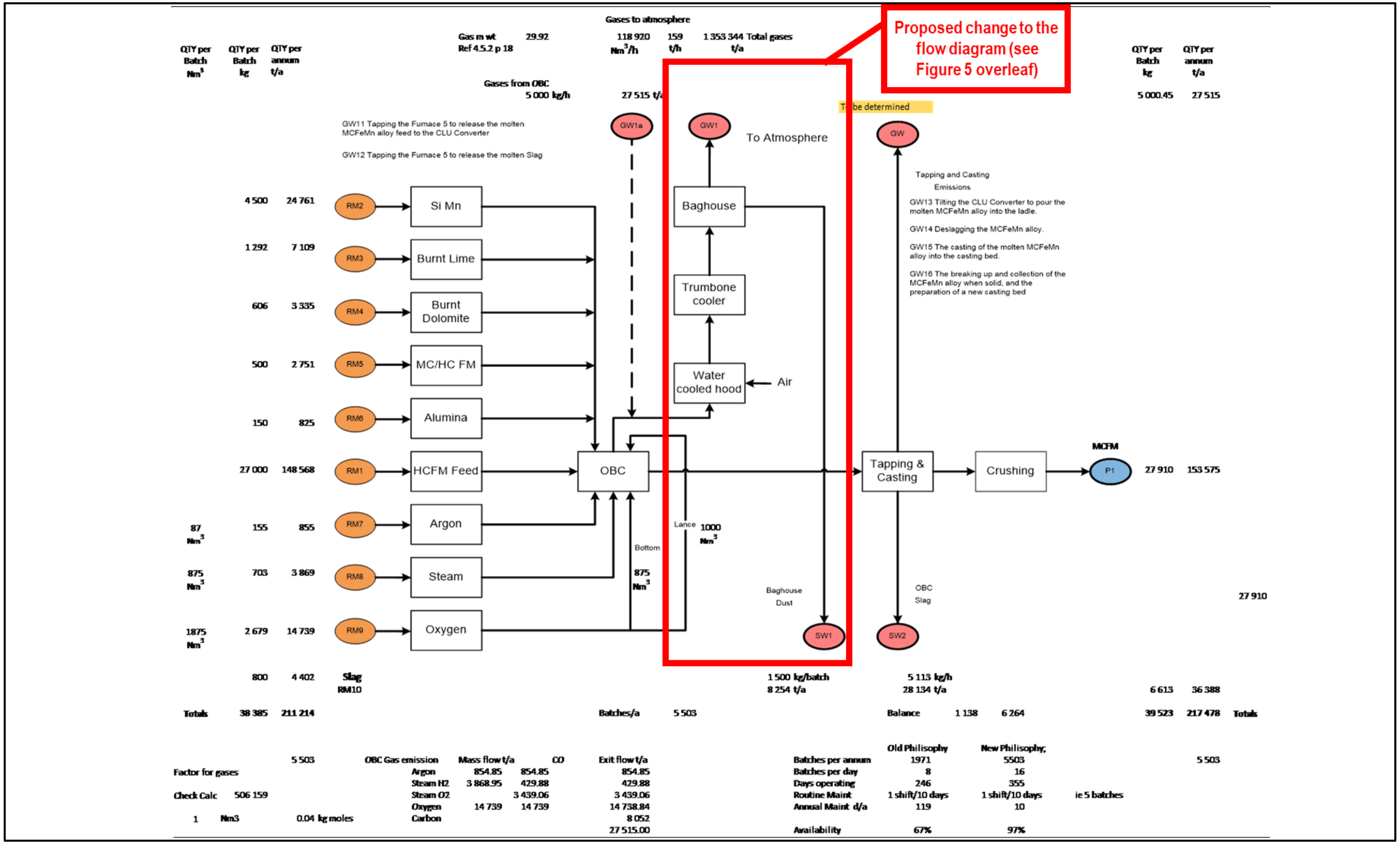
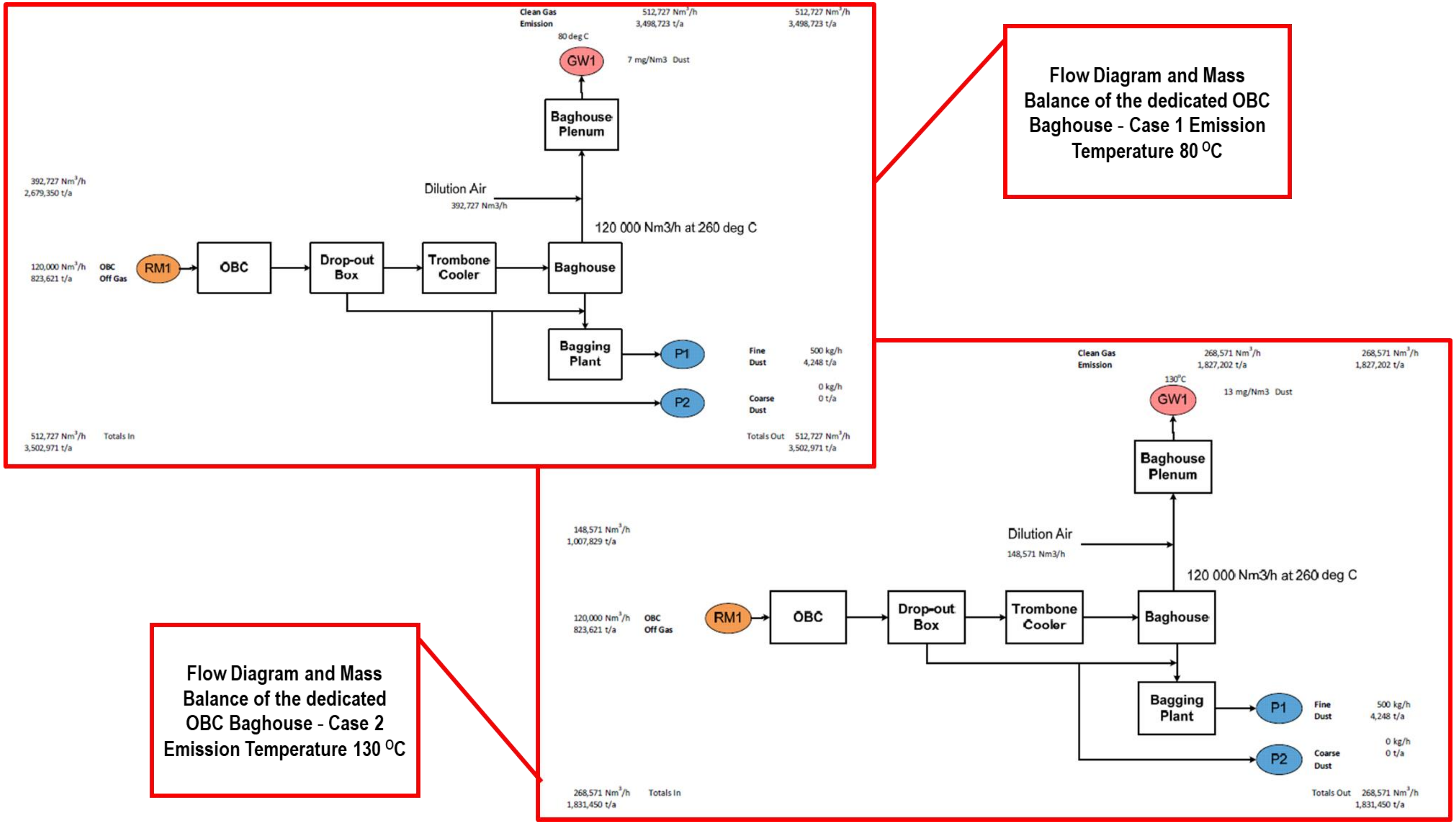


Figure 4: Flow diagram and mass balance for the CLU converter operation (Knights, 2017)



Flow Diagram and Mass Balance of the dedicated OBC Baghouse - Case 1 Emission Temperature 80 ⁰C

Flow Diagram and Mass Balance of the dedicated OBC Baghouse - Case 2 Emission Temperature 130 ⁰C

Figure 5: Flow diagram and mass balance of the dedicated OBC Baghouse - Case 1 and Case 2 (Knights, 2019)

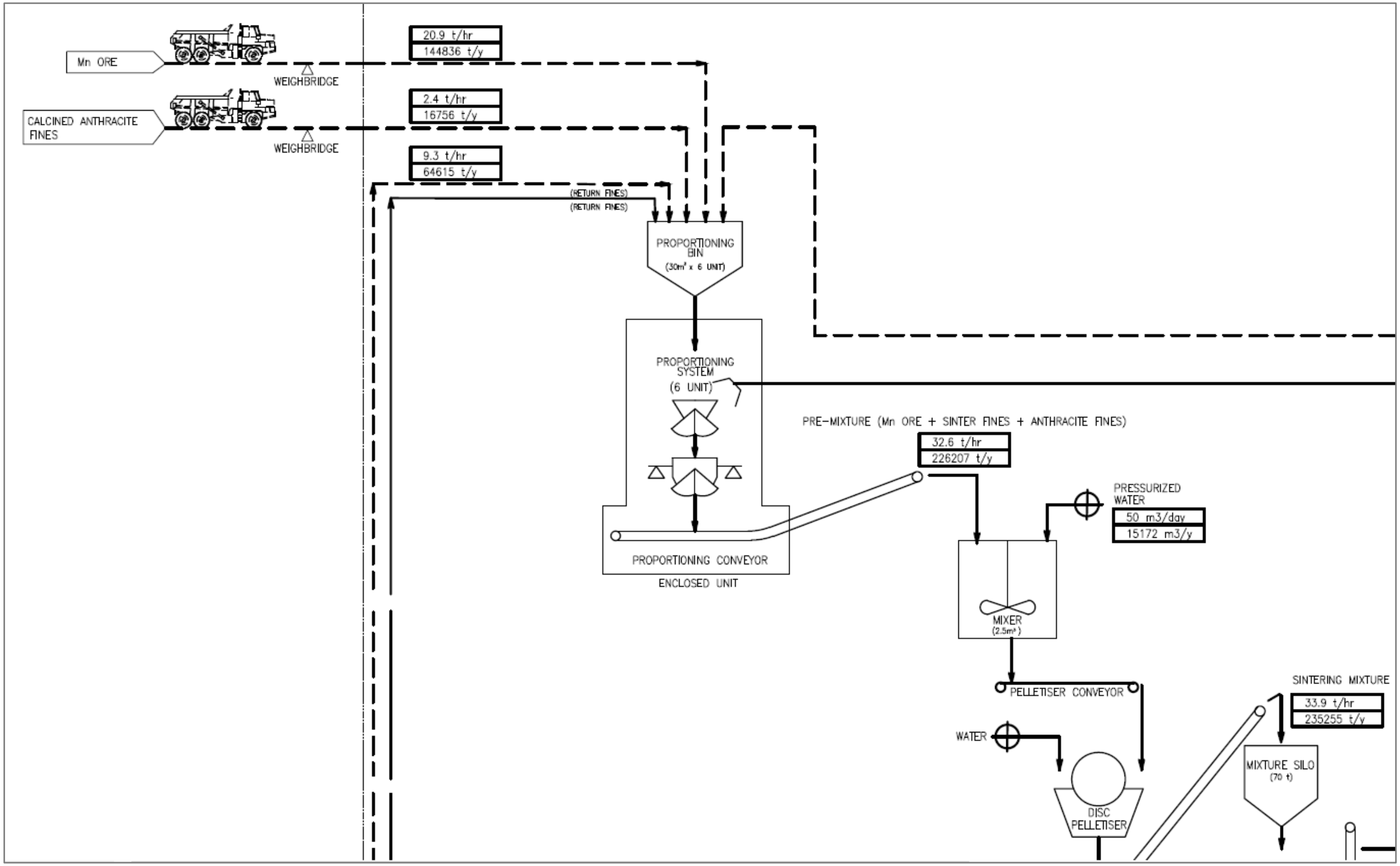


Figure 6: Flow diagram and mass balance of the Sinter Plant (Part 1 of 2)

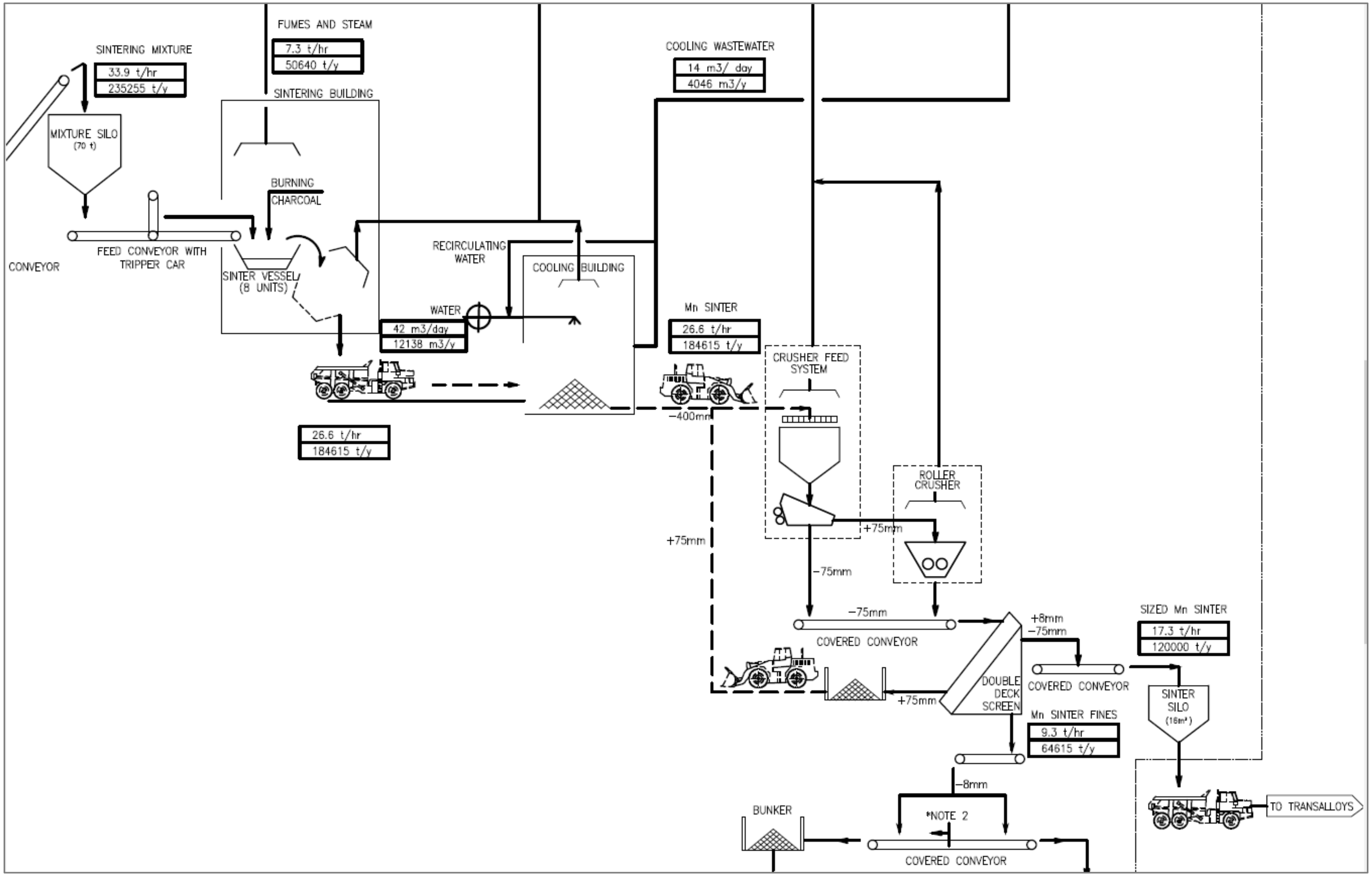


Figure 7: Flow diagram and mass balance of the Sinter Plant (Part 2 of 2)

2.3 UNIT PROCESSES

Unit process considered listed activities under the National Environmental Management Air Quality Act (NEMAQA) are summarised in Table 5. Other unit processes that may result in atmospheric emission which are however not considered listed activities are summarised in Table 6.

Table 5: List of unit processes considered listed activities under NEMAQA

Name of the Unit Process	Unit Process Function	Batch or Continuous Process	Listed Activity Sub-category
F1 SAF (open)	The production of SiMn	Continuous	4.9
F3 SAF (open)	The production of SiMn	Continuous	4.9
F5 SAF (semi-open)	The production of HCFeMn	Continuous	4.9
F6 SAF (semi-open)	The production of SiMn	Continuous	4.9
F7 SAF (semi-open)	The production of SiMn	Continuous	4.9
Agglomeration plant	The production of briquets	Batch	4.11
CLU Converter	The production of MCFeMn	Batch	4.6
PROPOSED Sinter Plant	Sinter Plant for agglomeration	Continuous	4.5

Table 6: List of non-listed activity unit processes

Name of the Unit Process	Unit Process Function	Batch or Continuous Process
Raw material delivery and storage bunkers	Raw material transport handling and storage	Continuous
Crushing and screening plants	Crushing and screening of SiMn / FeMn / MCFeMn product	Batch
Product storage and dispatch	Saleable product storage, handling and dispatch	Continuous
Jigging plant	Crushing of slag	Batch

3 TECHNICAL INFORMATION

Raw material consumption and ferroalloy production rates are tabulated in Table 7 and Table 8 respectively. These rates, as provided by Transalloys personnel, were used in the estimation of atmospheric emissions from Transalloys operations (See Section 4). Pollution abatement technologies employed at Transalloys' listed activities, and technical specifications thereof, are provided in Table 9.

3.1 RAW MATERIALS USED AND PRODUCTION RATES

Table 7: Raw materials for ferroalloy production

Raw Material Type	Process	Maximum Permitted Consumption Rate	Design Consumption Rate	Actual Consumption Rate	Rate Unit
Mn Ore (Lumpy, Chips, Fines)	SAF 1	82 125	82 125	82 125	t/a
	SAF 3	82 125	82 125	82 125	t/a
	SAF 5	182 500	182 500	182 500	t/a
	SAF 6	100 375	100 375	100 375	t/a
	SAF 7	182 500	182 500	182 500	t/a
	PROPOSED Sinter Plant	120 000	120 000	120 000	t/a
	Total	**749 625**	**749 625**	**749 625**	**t/a**
Quartzite, Magnesite, Scrap slag, Mn briquettes	SAF 1	70 096	70 096	70 096	t/a
	SAF 3	70 096	70 096	70 096	t/a
	SAF 5	168 000	168 000	168 000	t/a
	SAF 6	81 229	81 229	81 229	t/a
	SAF 7	133 325	133 325	133 325	t/a
	Total	**522 746**	**522 746**	**522 746**	**t/a**
Reductants (Coal, Coke, Anthracite)	SAF 1	38 635	38 635	38 635	t/a
	SAF 3	38 635	38 635	38 635	t/a
	SAF 5	51 125	51 125	51 125	t/a
	SAF 6	46 665	46 665	46 665	t/a
	SAF 7	85 800	85 800	85 800	t/a
	PROPOSED Sinter Plant	20 000	20 000	20 000	t/a
	Total	**280 860**	**280 860**	**280 860**	**t/a**
Fluxes other additives (Dolomite, Lime, etc.)	SAF 1	14 653	14 653	14 653	t/a
	SAF 3	14 528	14 528	14 528	t/a
	SAF 5	26 042	26 042	26 042	t/a
	SAF 6	13 553	13 553	13 553	t/a
	SAF 7	29 817	29 817	29 817	t/a
	Total	**98 593**	**98 593**	**98 593**	**t/a**
Dust	PROPOSED Sinter Plant	15 000	15 000	15 000	t/a

3.2 PRODUCTION RATES

Table 8: Production Rates

Product Type	Unit Process	Maximum Permitted Consumption Rate	Design Consumption Rate	Actual Consumption Rate	Rate Unit
SiMn / FeMn / MCFeMn / Sinter Plant	SAF 1	42 236	42 236	42 236	t/a
	SAF 3	42 236	42 236	42 236	t/a
	SAF 5	93 857	93 857	93 857	t/a
	SAF 6	51 521	51 521	51 521	t/a
	SAF 7	93 857	93 857	93 857	t/a
	CLU converter unit	148 568	148 568	148 568	t/a
	Sinter	100 000	100 000	100 000	t/a
	Total	**654 275**	**654 275**	**654 275**	**t/a**
Slag	SAF 1	50 683	50 683	50 683	t/a
	SAF 3	50 683	50 683	50 683	t/a
	SAF 5	112 628	112 628	112 628	t/a
	SAF 6	61 825	61 825	61 825	t/a
	SAF 7	112 628	112 628	112 628	t/a
	CLU converter unit	36 388	36 388	36 388	t/a
	Total	**643 235**	**643 235**	**643 235**	**t/a**

3.3 APPLIANCES AND ABATEMENT EQUIPMENT CONTROL TECHNOLOGY

Table 9: Appliances and abatement equipment control technology

Appliance Name	Abatement Technology Name and Model Number	Abatement Technology Manufacturer Date	Abatement Appliance Type	Abatement Technology Commission Date	Date of Significant Modification	Minimum Control Efficiency	Minimum Utilisation
SAF 1	American Air Filter	1964	Bagfilter	1978	Not applicable	98%	100%
SAF 3	American Air Filter	1964	Bagfilter	1978	Not applicable	98%	100%
OBC Baghouse	Resonant Environmental Technologies	2019	Bagfilter	To be commissioned	Not applicable	98%	98%
SAF 5	Elkem	1977	Bagfilter	1977	1999; 2005	98%	100%
SAF 6	Elkem	1977	Bagfilter	1977	1999	98%	100%
SAF 7	Filter Media	1990	Bagfilter	1990	-	98%	100%
SP 1 **(Proposed)**	Chamine do Lavdor de Gases	2021	Wet Scrubber	2021	Not Applicable	95%	100%
SP 2 **(Proposed)**	Chamine - Bag House - Saida	2021	Baghouse	2021	Not Applicable	98%	100%

4 ATMOSPHERIC EMISSIONS

A comprehensive emission inventory for existing and proposed operations was set up to serve as basis for the assessment of the air quality impacts from Transalloys on the receiving environment. Emissions from the proposed expansion were quantified in two distinct scenarios:

- **Scenario 1** represents incremental emissions due to proposed Sinter Plant operations at Transalloys; and
- **Scenario 2** represents existing Transalloys operations in addition to proposed Sinter Plant operations.

Ferroalloy production results in fugitive particulate emissions and gaseous process emissions. Fugitive emissions are discussed in Section 4.2 and they refer to emissions that are spatially distributed over a wide area. They are not confined to a specific discharge point as would be the case for process related emissions (discussed in Section 4.1).

4.1 POINT SOURCE EMISSIONS

Point source emissions were quantified from stack/baghouse emission sampling data (EnviroNgaka CC, 2017a; 2017b; 2017c) and emission factors that relate emission rates to production rates. Since emission rates obtained from the afore-mentioned stack/baghouse emission sampling data are expected to change due to the proposed process modification, reference was made to emission factors for controlled FeMn/SiMn SAFs (in quantifying PM and Mn emissions). These emission factors are provided in the United States Environmental Protection Agency (US EPA) AP 42 documents (US EPA, 1986) and the US EPA document on manganese (US EPA, 1985), describing the types of sources that may emit manganese and emissions factors for manganese and its compounds released into the air from each operation. However, in quantifying SO_2 and NO_2 emissions, reference was made to Minimum Emission Standards set out in Section 21 of NEMAQA (since emission factors are not available for these pollutants (Akinshipe & Bird, 2019).

Current and future PM[1], PM_{10}[2], $PM_{2.5}$[3], Mn, SO_2[4] and NOx (as NO_2)[5] emissions from bagfilter and scrubber stacks were quantified and simulated as point sources. Details are provided in Table 10 and Table 11.

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[1] PM – Particulate matter, synonymous with total suspended particulate matter (TSP) with a reported diameter of less than 30 µm
[2] PM_{10} – Particulate matter with an aerodynamic diameter of less than 10 µm
[3] $PM_{2.5}$ – Particulate matter with an aerodynamic diameter of less than 2.5 µm
[4] SO_2 – Sulfur dioxide
[5] NO_x as NO_2 – Nitrogen oxides are reported as nitrogen dioxide

4.1.1 Point Source Parameters

Table 10: Point source parameters

Point Source Number	Point Source Name	Point Source Coordinates	Height of Release above Ground (m)	Actual Gas Exit Temperature (°C)	Height above Nearby Building (m)	Diameter at Stack Tip or Vent Exit (m)	%O_2	Type of Emission (Continuous /Batch)
P01	Open SAF 1 and 3 Bagfilter	29.1168773 E 25.8966878 S	28.0	71	No Data	3.1	21.0	Continuous
P02	Open SAF 5 and 6 Bagfilter	29.1176662 E 25.8958777 S	29.4	77	No Data	10.3	20.0	Continuous
P03	Semi-open SAF 7 Bagfilter	29.1182236 E 25.8954386 S	26.7	72	No Data	9.9	20.0	Continuous
P06	CLU Converter Unit Bagfilter (Knights, 2019)	29.115173 E 25.894685 S	24.1	80 – 130	18.0	2.33	16.9 – 17.2	Intermittent
SP1	Sinter Plant Bagfilter	29.118377 E 25.899259 S	19	318	No Data	1.5	No Data	Continuous
SP2	Sinter Plant Wet Scrubber	29.118298 E 25.899388 S	19	348	No Data	1.5	No Data	Continuous

4.1.2 Point Source Maximum Emission Rates during Normal Operating Conditions

Table 11: Point source emission rates during normal operating conditions

Point Source Number	Point Source Name	Pollutant Name	Average Emissions			Duration of Emission
			Minimum Emission Standard Existing/New Plant (mg/Nm^3)	Modelled Emission Concentration (mg/Nm^3)	Averaging Period	
P01(a)	Open SAF 1 and 3 Bagfilter	PM	100/30	9.67	60 minutes to 8 hours	Continuous
		NO_x ad NO_2	750/400	750		
		SO_2	500/500	500		
		Mn	Not Applicable	7.19		
P02(a)	Open SAF 5 and 6 Bagfilter	PM	100/30	8.26	60 minutes to 8 hours	Continuous
		NO_x ad NO_2	750/400	750		
		SO_2	500/500	500		

		Mn	Not Applicable	6.15		
P03[(a)]	Semi-open SAF 7 Bagfilter	PM	50	4.76	60 minutes to 8 hours	Continuous
		NO$_x$ ad NO$_2$	700	750		
		SO$_2$	500	500		
		Mn	Not Applicable	0.71		
SP1	Sinter Plant Bagfilter	PM	50	50.0	60 minutes to 8 hours	Continuous
		NO$_x$ as NO$_2$	700	700		
		SO$_2$	500	500		
		Mn	Not Applicable	5.00		
SP2	Sinter Plant Wet scrubber	PM	100/50	50.0	60 minutes to 8 hours	Continuous
		NO$_x$ as NO$_2$	750/400	700		
		SO$_2$	500/500	500		
		Mn	Not Applicable	5.00		
P06[(b)]	CLU converter unit Bagfilter (Knights, 2017)	PM	100/50	48.0	60 minutes to 8 hours	Intermittent
		NO$_x$ ad NO$_2$	750/400	400		
		SO$_2$	500/500	500		
		Mn	Not Applicable	35.7		

Table 12: Point source emission estimation methods

ID	Source Name	Point Source Emission Estimation Methods
P01 P02 P03 P06	Open SAF 1, 3 SP Bagfilter and Wet Scrubber **(proposed)** Open SAF 5 and 6 Bagfilter Semi-open SAF 7 Bagfilter	Point source emissions were quantified from stack/baghouse emission sampling data (EnviroNgaka CC, 2017a; 2017b; 2017c). **PM** emissions were estimated through the application of the US EPA emission factor to produce FeMn in controlled open submerged arc furnaces (US EPA, 1986). **PM$_{10}$** and **PM$_{2.5}$** fractions of 0.96 and 0.65 were also obtained from this document. **Mn** emissions were estimated from emission factors published by the US EPA for manganese production (US EPA, 1985). In the absence of source measurements and emission factors, Subcategory 4.5 Minimum Emission Standards for **NO$_x$ as NO$_2$** (700 mg/Nm^3) and **SO$_2$** (500 mg/Nm^3) were used in the estimation of emissions.

4.1.3 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. 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 below. For current operation, the furnaces and associated pollution mitigation mechanisms will run alongside the furnaces and ore conversion process. During start-up, all pollution reduction plant and equipment, will be started up first and checked to see if running properly in accordance with good operating practice. Only then will the furnace process be started up. The same will apply to the proposed Sinter Plant when fully operational.

4.2 FUGITIVE EMISSIONS (AREA AND LINE SOURCES)

Fugitive emissions arise from the following activities at Transalloys:

- Screening and crushing of product and/or slag – Mn, $PM_{2.5}$, PM_{10} and PM
- Furnace building fugitives from activities such as tapping, casting etc. – $PM_{2.5}$, PM_{10}, TSP and Mn.
- Handling of raw materials, wastes and products – Mn, $PM_{2.5}$, PM_{10} and TSP
- Transport of raw materials, wastes and products:
    - Vehicle entrained dust from paved road surfaces – Mn, $PM_{2.5}$, PM_{10} and TSP
    - Vehicle entrained dust from unpaved road surfaces – Mn, $PM_{2.5}$, PM_{10} and TSP

Source parameters, emissions, emission estimation techniques and mitigation measures for each of these source groups are provided in subsequent sub-sections (Sub-sections 4.2.1 to 4.2.6).

4.2.1 CRUSHING AND SCREENING

Screening activities at Transalloys involve primary and secondary screening of manganese ferroalloys. Secondary screening of product is done when necessary. It was assumed that 20% of ferroalloy product is sent to the secondary screening circuit. Also, a jigging plant is used to crush slag before it is transported to the slag dump. It was assumed that 50% of slag produced is sent to the jigging plant. As per the Department of Environmental Affairs (DEA) requirements, sources of fugitive dust associated with crushing and screening (CAS) are presented as follows:

- Table 13 summarizes source parameters.
- Table 14 provides fugitive particulate emission rates.
- Table 15 lists mitigation and management measured currently employed to reduce fugitive particulate emissions from crushing and screening.
- Methods employed in the estimation of emissions are listed in Table 16.

It should be noted that from an atmospheric dispersion modelling perspective, crushing, and screening operations are modelled as volume, not area, sources. The DEA Atmospheric Impact Report (AIR) format, however, requires the definition of all fugitive sources as area sources.

Table 13: Crushing and screening source parameters

Unique Source Code	Source Name and Description	Latitude of SW Corner	Longitude of SW Corner	Height of Release above Ground Level (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
CAS01	Screening Plant 2	29.116091 E	25.894420 S	4.5	3	3	Not applicable
CAS02	Screening Plant 4	29.117412 E	25.893912 S	4.5	3	3	NA
CAS03	Jigging Plant	29.122324 E	25.891669 S	4.5	3	3	NA
CAS04	Proposed Sinter Crushing Plant	29.118494 E	-25.899129 S	4.5	3	3	NA

Table 14: Crushing and screening emissions

Unique Source Code	Pollutant Name	Scenario 1 (Sinter Plant)		Scenario 2 (Existing and Sinter Plant)		Emission Hours	Type of Emission (Continuous/ Intermittent)	Wind Dependant (Yes/No)
		Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)	Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)			
CAS01	$PM_{2.5}$	–	–	1.35E-01	4.24	24 hours/day	Continuous	No
	PM_{10}	–	–	2.24E-01	7.07			
	PM	–	–	2.99E-01	9.43			
	Mn	–	–	8.97E-02	2.83			
CAS02	$PM_{2.5}$	–	–	7.92E-02	2.50	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.32E-01	4.16			
	PM	–	–	1.32E+00	41.6			
	Mn	–	–	5.28E-02	1.66			
CAS03	$PM_{2.5}$	–	–	3.17E-02	1.00	24 hours/day	Intermittent	No
	PM_{10}	–	–	5.28E-02	1.66			
	PM	–	–	1.32E-01	4.16			
	Mn	–	–	2.11E-02	0.67			
CAS04	$PM_{2.5}$	1.18E-02	0.37	3.17E-02	1.00	24 hours/day	Intermittent	No
	PM_{10}	1.97E-02	0.62	5.28E-02	1.66			
	PM	4.92E-02	1.55	1.32E-01	4.16			
	Mn	7.86E-03	0.25	2.11E-02	0.67			

Table 15: Crushing and screening management and mitigation measures

Unique Source Code	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
CAS01	Bag filter[(a)]	Not applicable	Not applicable	None
CAS02	None	Not applicable	Not applicable	None
CAS03	None	Not applicable	Not applicable	None
CAS04	None	Not applicable	Not applicable	None

Notes:

(a) Assumed control efficiency – 75%

Table 16: Crushing and screening emission estimation information

Unique Source Code	Emission Estimation Technique	Emission Factor (kg per tonne)	Processing Rate (tonnes per hour)[(b)]	
			Scenario 1 (Sinter Plant)	Scenario 2 (existing operation plus Sinter Plant)
CAS01	**PM** and **PM$_{10}$** - NPI emission factor for screening of low moisture ore (NPI, 2011). **PM$_{2.5}$** – no emission factor available. PM$_{2.5}$ fraction assumed to be similar to PM$_{2.5}$/PM$_{10}$ ratio of 0.65 as published for FeMn production (US EPA, 1986). **Mn** – US EPA emission factor for crushing and screening (US EPA, 1985).	PM$_{2.5}$ – 0.036 PM$_{10}$ – 0.06 PM – 0.08 Mn – 0.065	–	74.3
CAS02	**PM** and **PM$_{10}$** - NPI emission factor for screening of low moisture ore (NPI, 2011). **PM$_{2.5}$** – No emission factor available. PM$_{2.5}$ fraction assumed to be similar to PM$_{2.5}$/PM$_{10}$ ratio of 0.65 as published for FeMn production (US EPA, 1986). **Mn** – US EPA emission factor for crushing and screening (US EPA, 1985).	PM$_{2.5}$ – 0.036 PM$_{10}$ – 0.06 PM – 0.08 Mn – 0.065	–	14.9
CAS03	**PM** and **PM$_{10}$** - US EPA metallic minerals processing emission factor for primary crushing of low moisture ore (US EPA, 1982). **PM$_{2.5}$** - No emission factor available. PM$_{2.5}$ fraction assumed to be similar to PM$_{2.5}$/PM$_{10}$ ratio of 0.65 as published for FeMn production (US EPA, 1986). **Mn** – US EPA emission factor for crushing and screening (US EPA, 1985)	PM$_{2.5}$ – 0.012 PM$_{10}$ – 0.02 TSP – 0.2 Mn – 0.065	–	30.9
CAS04	**PM** and **PM$_{10}$** - US EPA metallic minerals processing emission factor for primary crushing of low moisture ore (US EPA, 1982). **PM$_{2.5}$** - No emission factor available. PM$_{2.5}$ fraction assumed to be similar to PM$_{2.5}$/PM$_{10}$ ratio of 0.65 as published for FeMn production (US EPA, 1986). **Mn** – US EPA emission factor for crushing and screening (US EPA, 1985)	PM$_{2.5}$ – 0.012 PM$_{10}$ – 0.02 TSP – 0.2 Mn – 0.065	17.7	17.7

4.2.2 FURNACE BUILDING FUGITIVES

Furnace fugitive particulate emissions occur as result of smelting, tapping, casting and hot metal or slag transfer within furnace buildings. As per the DEA requirements for an AIR, furnace building fugitive emissions are presented as follows:

- Table 17 summarizes source parameters.
- Table 18 provides a summary of estimated fugitive PM2.5, PM10, TSP and Mn emission rates.
- Table 19 lists mitigation and management measured currently employed to reduce furnace building fugitive emissions.

- Methods employed in the estimation of emissions are listed in Table 20.

It should be noted that from an atmospheric dispersion modelling perspective, furnace building fugitive emissions are modelled as volume, not area, sources. The DEA AIR format however requires the definition of all fugitive sources as area sources.

Table 17: Furnace building fugitive source parameters

Unique Source Code	Source Name and Description	Latitude of SW Corner	Longitude of SW Corner	Height of Release above Ground Level (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
FBF01	SAF 1 Building	25.8959 S	29.1166 E	20	13.0	27.7	Not applicable (NA)
FBF02	SAF 3 Building	25.8957 S	29.1165 E	20	19.0	27.7	NA
FBF03	SAF 5 Building	25.8953 S	29.117 E	20	13.8	21.3	NA
FBF04	SAF 6 Building	25.8954 S	29.1176 E	20	18.3	21.3	NA
FBF05	SAF 7 Building	25.8948 S	29.1175 E	30	19.3	21.3	NA
FBF06	CLU converter	25.894685 S	29.115173 E	17	24.0	18.6	NA
FBSP01	**Proposed** Sinter Plant	25.899542 S	29.118149 E	10	40.0	56.5	NA

Table 18: Furnace building fugitive emissions

Unique Source Code	Pollutant Name	Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)	Emission Hours	Type of Emission	Wind Dependant (Yes/No)
FBF01	$PM_{2.5}$	0.12	3.92	24 hours/day	Intermittent	No
	PM_{10}	0.18	5.79			
	PM	0.19	6.03			
	Mn	0.05	1.46			
FBF02	$PM_{2.5}$	0.12	3.92	24 hours/day	Intermittent	No
	PM_{10}	0.18	5.79			
	PM	0.19	6.03			
	Mn	0.05	1.46			
FBF03	$PM_{2.5}$	0.28	8.71	24 hours/day	Intermittent	No
	PM_{10}	0.41	12.87			
	PM	0.42	13.40			
	Mn	0.10	3.24			
FUR04	$PM_{2.5}$	0.15	4.78	24 hours/day	Intermittent	No
	PM_{10}	0.22	7.06			
	PM	0.23	7.36			
	Mn	0.06	1.78			
FBF05	$PM_{2.5}$	0.06	1.74	24 hours/day	Intermittent	No
	PM_{10}	0.08	2.57			
	PM	0.08	2.68			
	Mn	0.02	0.65			
FBF06	$PM_{2.5}$	0.04	1.16	24 hours/day	Intermittent	No
	PM_{10}	0.05	1.72			
	PM	0.06	1.79			
	Mn	0.01	0.43			
FBSP01	$PM_{2.5}$	0.01	0.19	24 hours/day	Intermittent	No
	PM_{10}	0.01	0.28			
	PM	0.01	0.30			
	Mn	0.00	0.07			

Table 19: Furnace building fugitive management and mitigation measures

Unique Source Code	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
FBF01, FBF02, FBF03, FBF04, and FBF05	None. Primary fume extraction directly from the furnace is in place but secondary fume extraction to capture tapping, casting and escaped furnace fumes are not currently done.	Not applicable	Not applicable	None
FBSP01	Secondary fume extraction will be in place to capture tapping, casting, and escaped furnace fumes. Fumes will be sent to the dedicated primary scrubber plants.	Included in design	Visual inspection of fumes escaping secondary extraction.	None

Table 20: Furnace building fugitive emission estimation information

Unique Source Code	Emission Estimation Technique	Emission Factor (kg per tonne)	Production (tonnes/hour)
FBF01 FBF02	**PM** emissions were estimated from the US EPA ferroalloys production emission factor for uncontrolled open FeMn SAFs. The US EPA states that fugitive emissions amount to 3.4% of uncontrolled primary emissions. This document also specifies **PM_{10}** and **$PM_{2.5}$** emissions to be 96% and 65% of PM emissions (US EPA, 1986). **Mn** emissions were estimated from the Mn/PM ratio of 0.242 reported by the US EPA (1985). This ratio was applied to the PM emission factor described above.	PM – 0.48 PM_{10} – 0.46 $PM_{2.5}$ – 0.31 Mn – 0.12	FBF01 – 2.41 FBF02 – 2.41
FBF03 FBF04 FBF05 and FBF06	**PM** emissions were estimated from the US EPA ferroalloys production emission factor for uncontrolled semi-open FeMn SAFs. The US EPA states that fugitive emissions amount to 3.4% of uncontrolled primary emissions. This document also specifies **PM_{10}** and **$PM_{2.5}$** emissions to be 96% and 65% of PM emissions (US EPA, 1986). **Mn** emissions were estimated from the Mn/PM ratio of 0.242 reported by the US EPA (1985). This ratio was applied to the PM emission factor described above.	PM – 0.10 PM_{10} – 0.09 $PM_{2.5}$ – 0.06 Mn – 0.06	FBF03 – 10.71 FBF04 – 5.88 FBF05 – 10.71 FBF06 – 21.43
FBSP01	**PM** emissions were estimated from the US EPA ferroalloys production emission factor for sealed FeMn SAFs. The US EPA states that fugitive emissions amount to 3.4% of uncontrolled primary emissions. This document also specifies **PM_{10}** and **$PM_{2.5}$** emissions to be 96% and 65% of PM emissions (US EPA, 1986). **Mn** emissions were estimated from the Mn/PM ratio of 0.242 reported by the US EPA (1985). This ratio was applied to the PM emission factor described above.	PM – 0.20 PM_{10} – 0.20 $PM_{2.5}$ – 0.13 Mn – 0.05	17.7

4.2.3 MATERIALS HANDLING

Handling activities at Transalloys include delivery, loading and off-loading of raw materials, slag and products at various locations around the plant. As per the DEA requirements for an AIR, materials handling emissions are presented as follows:

- Table 21 summarizes source parameters.
- Table 22 provides fugitive particulate emission rates.
- Table 23 lists mitigation and management measured currently employed to reduce fugitive particulate emissions.
- Methods employed in the estimation of materials handling emissions are listed in Table 24.

It should be noted that from an atmospheric dispersion modelling perspective, crushing, and screening operations are modelled as volume, not area, sources. The DEA AIR format however requires the definition of all fugitive sources as area sources.

Table 21: Materials handling source parameters

Unique Source Code	Source Name	Latitude of SW Corner	Longitude of SW Corner	Height of Release above Ground Level (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
MHD01	Raw material (excl. ore) delivery by truck (1 handling step).	25.8961752 S	29.1156315 E	2	2	2	Not applicable (NA)
MHD02	Ore delivery by rail (1 handling step).	25.8969785 S	29.1160509 E	2	2	2	NA
MHD03	Raw material (excl. ore) handling at stockpile (2 handling steps).	25.8956952 S	29.1159846 E	20	2	2	NA
MHD04	Ore handling at stockpile (2 handling steps).	25.8952638 S	29.1166597 E	20	2	2	NA
MHD05	Raw material (excl. ore) handling at SAF buildings (2 handling steps).	25.8955847 S	29.1161669 E	20	2	2	NA
MHD06	Ore handling at SAF buildings (2 handling steps).	25.895134 S	29.11682 E	20	2	2	NA
MHD07	FeMn casting and loading trucks (2 handling steps).	25.8947881 S	29.1163369 E	2	2	2	NA
MHD08	FeMn handling at screening plant (2 handling steps).	25.8944384 S	29.1161139 E	2	2	2	NA
MHD09	FeMn handling at product storage area (2 handling steps).	25.8938201 S	29.1161571 E	2	2	2	NA
MHD10	Slag handling at slag dump (2 handling steps)	25.8905261 S	29.119503 E	2	2	2	NA
MHD11	HCFeMn handling at CLU converter (2 handling steps)	25.895134 S	29.116820 E	2	2	2	NA
MHD12	Raw material (reductants, fluxes etc) handling at CLU converter (2 steps)	25.895134 S	29.116820 E	2	2	2	NA
MHD13	Sinter plant tipping/materials handing	25.898934 S	29.118571 E	2	2	2	NA

Table 22: Materials handling emissions

Unique Source Code	Pollutant Name	Scenario 1		Scenario 2		Emission Hours	Type of Emission (Continuous/ Intermittent)
		Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)	Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)		
MHD01	$PM_{2.5}$	–	–	9.75E-04	0.03	24 hours/day	Intermittent
	PM_{10}	–	–	6.44E-03	0.20		
	PM	–	–	1.36E-02	0.43		
	Mn	–	–	–	–		
MHD02	$PM_{2.5}$	–	–	9.83E-04	0.03	24 hours/day	Intermittent
	PM_{10}	–	–	6.49E-03	0.20		
	PM	–	–	1.37E-02	0.43		
	Mn	–	–	2.60E-03	0.08		
MHD03	$PM_{2.5}$	–	–	1.95E-03	0.06	24 hours/day	Intermittent
	PM_{10}	–	–	1.29E-02	0.41		
	PM	–	–	2.72E-02	0.86		
	Mn	–	–	-	-		
MHD04	$PM_{2.5}$	–	–	1.97E-03	0.06	24 hours/day	Intermittent
	PM_{10}	–	–	1.30E-02	0.41		
	PM	–	–	2.75E-02	0.87		
	Mn	–	–	5.20E-03	0.16		
MHD05	$PM_{2.5}$	–	–	3.90E-03	0.12	24 hours/day	Intermittent
	PM_{10}	–	–	2.58E-02	0.81		
	PM	–	–	5.45E-02	1.72		
	Mn	–	–	–	–		
MHD06	$PM_{2.5}$	–	–	3.93E-03	0.12	24 hours/day	Intermittent
	PM_{10}	–	–	2.60E-02	0.82		
	PM	–	–	5.49E-02	1.73		
	Mn	–	–	1.04E-02	0.33		
MHD07	$PM_{2.5}$	–	–	1.90E-03	0.06	24 hours/day	Intermittent
	PM_{10}	–	–	1.26E-02	0.40		
	PM	–	–	2.65E-02	0.84		
	Mn	–	–	5.02E-03	0.16		

MHD08	$PM_{2.5}$	–	–	4.07E-04	0.01	24 hours/day	Intermittent
	PM_{10}	–	–	2.69E-03	0.08		
	PM	–	–	5.69E-03	0.18		
	Mn	–	–	1.08E-03	0.03		
MHD09	$PM_{2.5}$	–	–	2.72E-03	0.09	24 hours/day	Intermittent
	PM_{10}	–	–	1.79E-02	0.57		
	PM	–	–	3.79E-02	1.20		
	Mn	–	–	7.17E-03	0.23		
MHD10	$PM_{2.5}$	–	–	1.13E-03	0.04	24 hours/day	Intermittent
	PM_{10}	–	–	7.46E-03	0.24		
	PM	–	–	1.58E-02	0.50		
	Mn	–	–	–	–		
MHD11	$PM_{2.5}$	–	–	9.26E-04	0.03	24 hours/day	Intermittent
	PM_{10}	–	–	6.12E-03	0.19		
	PM	–	–	1.29E-02	0.41		
	Mn	–	–	-	-		
MHD12	$PM_{2.5}$	–	–	7.61E-04	0.02	24 hours/day	Intermittent
	PM_{10}	–	–	5.03E-03	0.16		
	PM	–	–	1.06E-02	0.34		
	Mn	–	–	2.01E-03	0.06		
MHD13	$PM_{2.5}$	3.23E-03	0.10	3.23E-03	0.10	24 hours/day	Intermittent
	PM_{10}	2.13E-02	0.67	2.13E-02	0.67		
	PM	4.51E-02	1.42	4.51E-02	1.42		
	Mn	8.54E-03	0.27	8.54E-03	0.27		

Table 23: Materials handling management and mitigation measures

Unique Source Code	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
MHD01, MHD02, MHD03 and MHD04	Dust suppression with water. Assumed control efficiency – 50%.	Implemented	Visual Inspection	None
MHD05, MHD06, MHD07, MHD08, MHD09, MHD10, MHD11 and MHD12		Not applicable	Not applicable	None

Table 24: Materials handling emission estimation information

Unique Source Code	Emission Estimation Methodology and Emission Factor Equation	Material Moisture Content[(a)]	Scenario 1 Handling Rate (t/h)	Scenario 2 Handling Rate (t/h)
MHD01	US EPA emission factor equation for materials handling (US EPA, 2006). $E = k \cdot 0.0016 \cdot \left(\frac{U}{2.3}\right)^{1.3} \cdot \left(\frac{M}{2}\right)^{-1.4}$ **E** is the calculated emission factor in kg/t. **k** is the default particle size multiplier ($k_{PM2.5}$ – 0.053; k_{PM10} – 0.35 ; k_{TSP} – 0.74) **U** is the average hourly wind speed in m/s. An average wind speed of 2.8 m/s was calculated from wind field data recorded on-site. **M** is material moisture content. Material specific moisture contents were measured during the 2008 air quality study.	3%	78.2	106.8
MHD02		3%	62.5	107.7
MHD03		3%	78.2	106.8
MHD04		3%	62.5	107.7
MHD05		3%	52.8	106.8
MHD06		3%	41.7	107.7
MHD07		3%	37.5	52.0
MHD08		3%	16.1	22.3
MHD09		3%	53.6	74.3
MHD10		3%	13.3	30.9
MHD11		3%	25.4	25.4
MHD12		3%	20.8	20.8

Notes:

(a) Material specific moisture content was assumed to be 3% based on industry average.
(b) Calculated from raw material consumption, slag generation and SiMn production rates (see Table 7 and Table 8).

4.2.4 VEHICLE ENTRAINED DUST FROM UNPAVED ROADS

Notable vehicle movements on the Transalloys site that result in the entrainment of dust include product (SiMn/FeMn), slag and raw material transport. As per the DEA requirements for an AIR, vehicle entrained fugitive emissions are presented as follows:

- Table 25 summarizes source parameters.
- Table 26 provides fugitive particulate emission rates.
- Table 27 lists mitigation and management measured currently employed to reduce fugitive particulate emissions.
- Methods employed in the estimation of vehicle entrained fugitive emissions are listed in Table 28.

Table 25: Vehicle entrainment source parameters – Unpaved roads

Unique Source Code	Source Name	Longitude of SW Corner	Latitude of SW Corner	Height of Release above Ground Level (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from True North (°)
URD A01	Roads to slag dump, used by Haul trucks	25.8919756 S	29.1149154 E	0.5	80.6	6	-56.1
URD A02		25.8916197 S	29.11468 E	0.5	206	6	-62.2
URD A03		25.8913687 S	29.1157756 E	0.5	184	6	-22.2
URD A04		25.893104 S	29.1178848 E	0.5	107	6	-103.1
URD A05		25.8923966 S	29.1184391 E	0.5	56.8	6	-170.1
URD A06		25.8920394 S	29.1197598 E	0.5	49.9	6	-47.0
URD A07		25.8915096 S	29.120124 E	0.5	46.0	6	-120
URD A08		25.8908491 S	29.1198674 E	0.5	113	6	-13.3
URD A09		25.8907411 S	29.1192857 E	0.5	286	6	43.2
URD A10		25.8946961 S	29.1170377 E	0.5	96.1	6	-53.7
URD A11		25.8940862 S	29.1174757 E	0.5	138	6	-15.7
URD A12		25.8924269 S	29.1184043 E	0.5	69.1	6	-57.2
URD A13		25.8917768 S	29.1200908 E	0.5	77.6	6	-108
URD A14		25.890837 S	29.1198314 E	0.5	59.5	6	-167
URD A15		25.8907574 S	29.1192721 E	0.5	36.7	6	-39.3
URD B01	Raw material transport roads	25.8962019 S	29.119915 E	0.5	49.9	6	176
URD B02		25.8974809 S	29.1175591 E	0.5	76.3	6	-161
URD B03		25.8972663 S	29.1168362 E	0.5	95.7	6	-132
URD C01	Product transport roads	25.8933523 S	29.1163286 E	0.5	128	6	-22.2
URD C02		25.892898 S	29.1175021 E	0.5	48.3	6	42.0
URD C03		25.8923873 S	29.1161823 E	0.5	133	6	57.2
URD C04		25.8933825 S	29.1169181 E	0.5	65.4	6	97.4

Table 26: Vehicle entrainment emissions on unpaved roads

Unique Source Code	Pollutant Name	Scenario 1		Scenario 2		Emission Hours	Type of Emission (Continuous/ Intermittent)	Wind Dependant (Yes/No)
		Maximum Release	Average Annual	Maximum Release	Average Annual			
URD A01	PM$_{2.5}$	–	–	1.11E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	1.11E-03	0.04			
	PM	–	–	5.15E-03	0.16			
	Mn	–	–	9.43E-04	0.03			
URD A02	PM$_{2.5}$	–	–	2.85E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	2.85E-03	0.09			
	PM	–	–	1.32E-02	0.42			
	Mn	–	–	2.41E-03	0.08			
URD A03	PM$_{2.5}$	–	–	2.54E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	2.54E-03	0.08			
	PM	–	–	1.17E-02	0.37			
	Mn	–	–	2.15E-03	0.07			
URD A04	PM$_{2.5}$	–	–	1.48E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	1.48E-03	0.05			
	PM	–	–	6.86E-03	0.22			
	Mn	–	–	1.26E-03	0.04			
URD A05	PM$_{2.5}$	–	–	7.85E-05	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	7.85E-04	0.02			
	PM	–	–	3.63E-03	0.11			
	Mn	–	–	6.64E-04	0.02			
URD A06	PM$_{2.5}$	–	–	6.90E-05	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	6.90E-04	0.02			
	PM	–	–	3.19E-03	0.10			
	Mn	–	–	5.84E-04	0.02			
URD A07	PM$_{2.5}$	–	–	2.50E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	2.50E-03	0.08			
	PM	–	–	1.16E-02	0.36			
	Mn	–	–	2.12E-03	0.07			
URD A08	PM$_{2.5}$	–	–	1.92E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	1.92E-03	0.06			
	PM	–	–	8.87E-03	0.28			
	Mn	–	–	1.62E-03	0.05			

URD A09	$PM_{2.5}$	–	–	1.18E-04	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.18E-03	0.04			
	PM	–	–	5.47E-03	0.17			
	Mn	–	–	1.00E-03	0.03			
URD A10	$PM_{2.5}$	–	–	1.11E-04	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.11E-03	0.04			
	PM	–	–	5.15E-03	0.16			
	Mn	–	–	9.43E-04	0.03			
URD A11	$PM_{2.5}$	–	–	2.85E-04	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	2.85E-03	0.09			
	PM	–	–	1.32E-02	0.42			
	Mn	–	–	2.41E-03	0.08			
URD A12	$PM_{2.5}$	–	–	2.54E-04	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	2.54E-03	0.08			
	PM	–	–	1.17E-02	0.37			
	Mn	–	–	2.15E-03	0.07			
URD A13	$PM_{2.5}$	–	–	1.48E-04	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.48E-03	0.05			
	PM	–	–	6.86E-03	0.22			
	Mn	–	–	1.26E-03	0.04			
URD A14	$PM_{2.5}$	–	–	7.85E-05	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	7.85E-04	0.02			
	PM	–	–	3.63E-03	0.11			
	Mn	–	–	6.64E-04	0.02			
URD A15	$PM_{2.5}$	–	–	6.90E-05	0.01	24 hours/day	Intermittent	No
	PM_{10}	–	–	6.90E-04	0.02			
	PM	–	–	3.19E-03	0.10			
	Mn	–	–	5.84E-04	0.02			
URD B01	$PM_{2.5}$	4.07E-04	0.01	5.56E-04	0.02	24 hours/day	Intermittent	No
	PM_{10}	4.07E-03	0.13	5.56E-03	0.18			
	PM	1.88E-02	0.59	2.57E-02	0.81			
	Mn	3.44E-03	0.11	4.70E-03	0.15			
URD B02	$PM_{2.5}$	6.22E-04	0.02	8.50E-04	0.03	24 hours/day	Intermittent	No
	PM_{10}	6.22E-03	0.20	8.50E-03	0.27			
	PM	2.87E-02	0.91	3.93E-02	1.24			

	Mn	5.26E-03	0.17	7.18E-03	0.23			
URD B03	PM$_{2.5}$	7.81E-04	0.02	8.50E-04	0.03	24 hours/day	Intermittent	No
	PM$_{10}$	7.81E-03	0.25	8.50E-03	0.34			
	PM	3.61E-02	1.14	3.93E-02	1.55			
	Mn	6.60E-03	0.21	7.18E-03	0.28			
URD C01	PM$_{2.5}$	7.15E-04	0.02	9.92E-04	0.03	24 hours/day	Intermittent	No
	PM$_{10}$	7.15E-03	0.23	9.92E-03	0.31			
	PM	3.30E-02	1.04	4.59E-02	1.45			
	Mn	6.05E-03	0.19	8.39E-03	0.26			
URD C02	PM$_{2.5}$	2.70E-04	0.01	3.74E-04	0.01	24 hours/day	Intermittent	No
	PM$_{10}$	2.70E-03	0.09	3.74E-03	0.12			
	PM	1.25E-02	0.39	1.73E-02	0.55			
	Mn	2.28E-03	0.07	3.17E-03	0.10			
URD C03	PM$_{2.5}$	–	–	1.03E-03	0.03	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	1.03E-02	0.32			
	PM	–	–	4.75E-02	1.50			
	Mn	–	–	8.70E-03	0.27			
URD C04	PM$_{2.5}$	–	–	5.08E-04	0.02	24 hours/day	Intermittent	No
	PM$_{10}$	–	–	5.08E-03	0.16			
	PM	–	–	2.35E-02	0.74			
	Mn	–	–	4.29E-03	0.14			

Table 27: Vehicle entrainment management and mitigation measures

Unique Source Code	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
All unpaved roads on site	Water sprays and Dustek with assumed 50% control efficiency	Implemented	Visual inspection	None

Table 28: Vehicle entrainment emission estimation information

Unique Source Code	Emission Estimation Technique and Emission Factor Equation	Average Vehicle Weight (tonnes)[a]	Vehicle km Travelled per Hour (VKT/hr.)[b]	
			Scenario 1	Scenario 2
All **Slag** Transport Roads URD A01 to URD A15	US EPA Emission Factor Equation for Unpaved Roads (US EPA, 2006). $E = k \cdot \left(\frac{s}{12}\right)^{a} \cdot \left(\frac{W}{3}\right)^{b} \cdot 281.9$ **E** is the calculated emission factor in grams per vehicle kilometres travelled (g/VKT). **k** is the default particle size multiplier ($k_{PM2.5}$ – 0.15; k_{PM10} – 1.5 ; k_{PM} – 4.9) **a** is and empirical constant ($a_{PM2.5}$ – 0.9; a_{PM10} – 0.9 ; a_{PM} – 0.7) **b** is and empirical constant of 0.45 **s** is the silt content of road surface material i.e. the fraction of material smaller than 75 µm. Sampling indicated a slit content of 2.1%. **W** is the average weight of vehicles travelling the road.	45	0.45	1.88
All **Raw Material** Transport Roads: URD B01 to URD B03		45	0.87	1.18
All **Product** Transport Roads: URD C01 to URD C04		45	0.47	1.86

Notes:

(a) Average vehicle weights were calculated from data provided by Transalloys.
(b) Calculated from material transport rates (see Table 7 and Table 8), truck capacities and estimated road lengths.

4.2.5 VEHICLE ENTRAINED DUST FROM PAVED ROADS

Notable vehicle movements on the Transalloys site that result in the entrainment of dust from paved roads include the product (SiMn/FeMn) and raw material transport. As per the DEA requirements for an AIR, vehicle entrained fugitive emissions are presented as follows:

- Table 29 summarizes source parameters.
- Table 30 provides fugitive particulate emission rates.
- Table 31 lists mitigation and management measured currently employed to reduce fugitive particulate emissions.
- Methods employed in the estimation of vehicle entrained fugitive emissions are listed in Table 32.

Table 29: Vehicle entrained emission source parameters – Paved roads

Unique Source Code	Source Name	Latitude of SW Corner	Longitude of SW Corner	Height of Release above Ground Level (m)	Length of Area (m)	Width of Area (m)	Angle of Rotation from North (°)
PRD01	Raw Material Transport via Delivery Road	25.896303 S	29.1185546 E	0.5	47.1	6.00	99.3
PRD02		25.896723 S	29.1184860 E	0.5	125	6.00	139
PRD03	Product transport via product Road	25.893184 S	29.1178653 E	0.5	97.1	6.00	111
PRD04		25.894007 S	29.1175308 E	0.5	108	6.00	66.0
PRD05		25.894891 S	29.1179853 E	0.5	113	6.00	-43.7

Table 30: Vehicle entrained emissions from paved roads

Unique Source Code	Pollutant Name	Scenario 1		Scenario 2		Emission Hours	Type of Emission (Continuous/ Intermittent)	Wind Dependant (Yes/No)
		Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)	Maximum Release Rate (g/s)	Average Annual Release Rate (t/a)			
PRD01	$PM_{2.5}$	–	–	2.26E-03	0.07	24 hours/day	Intermittent	No
	PM_{10}	–	–	9.35E-03	0.29			
	PM	–	–	4.87E-02	1.54			
	Mn	–	–	6.92E-03	0.22			
PRD02	$PM_{2.5}$	–	–	6.02E-03	0.19	24 hours/day	Intermittent	No
	PM_{10}	–	–	2.49E-02	0.79			
	PM	–	–	1.30E-01	4.09			
	Mn	–	–	1.84E-02	0.58			
PRD03	$PM_{2.5}$	–	–	3.20E-03	0.10	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.32E-02	0.42			
	PM	–	–	6.89E-02	2.17			
	Mn	–	–	9.78E-03	0.31			
PRD04	$PM_{2.5}$	–	–	3.56E-03	0.11	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.47E-02	0.46			
	PM	–	–	7.66E-02	2.42			
	Mn	–	–	1.09E-02	0.34			
PRD05	$PM_{2.5}$	–	–	3.72E-03	0.12	24 hours/day	Intermittent	No
	PM_{10}	–	–	1.54E-02	0.49			
	PM	–	–	8.01E-02	2.53			
	Mn	–	–	1.14E-02	0.36			

Table 31: Vehicle entrained emissions management and mitigation measures

Unique Source Code	Description of Specific Measures	Timeframe for Implementation of Specific Measures	Method of Monitoring Measure Effectiveness	Contingency Measure
All paved and unpaved roads on site	Water sprays and Dustek with assumed 75% control efficiency	Implemented	Visual Inspection	None

Table 32: Vehicle entrained emissions estimation information

Unique Source Code	Emission Factor Equation	Vehicle km Travelled per Hour (VKT/hr.)[(b)]	
		Scenario 1	Scenario 2
Raw Material Transport Roads (PRD01 to PRD02)	US EPA Emission Factor Equation for Paved Roads (US EPA, 2011). $EF = k \cdot (S_l)^{0.91} \cdot (W)^{1.02}$ **EF** is the calculated emission factor in grams per vehicle kilometres travelled (g/VKT). **k** is the default particle size multiplier ($k_{PM2.5}$ – 0.15; k_{PM10} – 0.62 ; k_{PM} – 3.23) **S_L** is the silt loading of road surface material i.e. the mass of material smaller than 75 µm. On-site measurements indicates a silt loading of 15.57 g/m^2. **W** is the average weight of vehicles travelling the road of 45 tonnes [(a)].	0.67	0.76
Product Transport Road (PRD03 to PRD05)		0.85	1.34

Notes:

(a) Average vehicle weights were calculated from data provided by Transalloys.

(b) Calculated from material transport rates (see Table 7 and Table 8), truck capacities and estimated road lengths.

4.2.6 WINDBLOWN DUST

Under strong wind conditions, exposed fine materials in certain areas of the plant may be entrained and result in dust emissions. Windblown dust emissions generally only occur when the exposed material is dry and consists of fine particles and when the wind speed increases above 5 m/s. From site inspections and consultation with Transalloys personnel, windblown dust emissions are not significant at the Transalloys site. A wet slag recovery mechanism is used on site and the product and raw material stockpiles are adequately enclosed.

4.3 EMERGENCY INCIDENTS

The scope of work did not include the assessment of emergency incidents. The scope of this study did not include the quantification of emissions during emergency incidents. Potential upset conditions such as failure of air quality and dust mitigation equipment will result in immediate shut-down of the process and the partially converted product will be cast as off-grade. It is anticipated that a short-term increase (above normal operating conditions) in emission rates will be experienced before complete shut-down of the process is achieved.

4.4 SUMMARY OF EMISSIONS

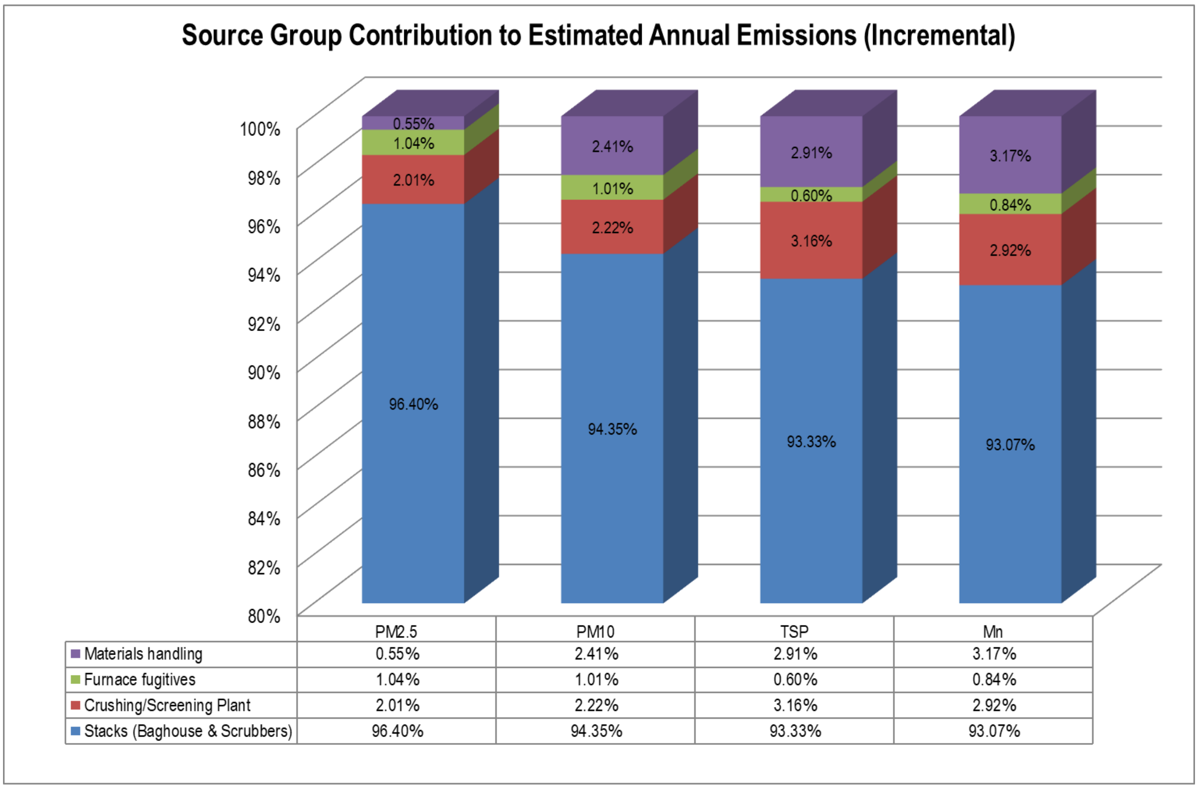
Table 33 and Table 34 provide the summary of source group emissions for Scenario 1 and Scenario 2 respectively. Figure 8 and Figure 9 also depict the contribution of each source groups' emissions to both scenarios.

4.4.1 Scenario 1 – Proposed Operation of the Sinter Plant (Incremental Emissions)

Stack/baghouse emissions were quantified as contributing most significantly to $PM_{2.5}$, PM_{10}, PM and Mn emissions generated due to proposed Sinter Plant, with stack/baghouse emissions accounting for 93% to 96% of particulate emissions. Crushing and screening account for 2% to 3% of particulate emissions.

Table 33: Scenario 1 – Source group contributions to estimated annual emissions

Source Group	Scenario 1 (t/a)					
	$PM_{2.5}$	**PM_{10}**	**PM**	**Mn**	**NO_x as NO_2**	**SO_2**
Materials handling	0.10	0.67	1.42	0.27	–	–
Stacks (Baghouse & Scrubbers)	17.8	26.3	45.7	7.90	640	457
Crushing and Screening Plant	0.37	0.62	1.55	0.25	–	–
Furnace fugitives	0.19	0.28	0.30	0.07	–	–
Total	**18.5**	**27.9**	**49.0**	**8.49**	**640**	**457**



	PM2.5	PM10	TSP	Mn
■ Materials handling	0.55%	2.41%	2.91%	3.17%
■ Furnace fugitives	1.04%	1.01%	0.60%	0.84%
■ Crushing/Screening Plant	2.01%	2.22%	3.16%	2.92%
■ Stacks (Baghouse & Scrubbers)	96.40%	94.35%	93.33%	93.07%

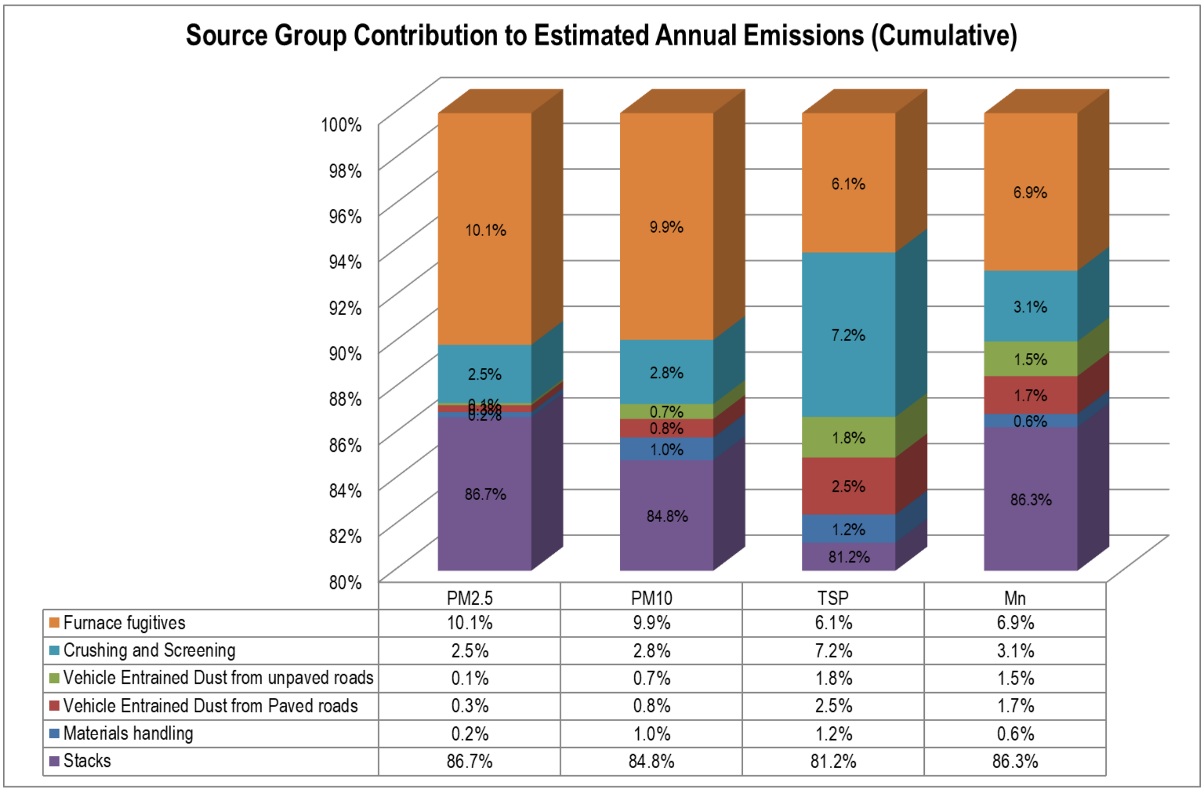
Figure 8: Scenario 1 - Source group contributions to estimated annual average emissions

4.4.2 SCENARIO 2 – EXISTING OPERATIONS IN ADDITION TO PROPOSED SINTER PLANT

Stack/baghouse and furnace fugitive emissions were quantified as contributing most significantly to current $PM_{2.5}$, PM_{10}, PM and Mn emissions generated due to cumulative Transalloys operations, with stack/baghouse emissions accounting for 81% to 87% of particulate emissions and furnace building fugitives 6% to 10%. Crushing and screening account for 3% to 7% of particulate emissions.

Table 34: Scenario 2 – Source group contributions to estimated annual emissions

Source Group	Scenario 2 (t/a)					
	$PM_{2.5}$	PM_{10}	PM	Mn	NO_x as NO_2	SO_2
Materials handling	0.45	3.00	6.35	0.64	–	–
Vehicle Entrained Dust from Paved roads	0.59	2.46	12.8	1.82	–	–
Vehicle Entrained Dust from unpaved roads	0.20	1.98	9.13	1.67	–	–
Stacks (Baghouse & Scrubbers)	174.2	257	417	94.9	2167	702
Crushing and Screening	5.1	8.5	36.9	3.4	–	–
Furnace fugitives	20.3	30.0	31.3	7.6	–	–
Total	**143**	**223**	**346**	**110**	**11034**	**8205**



	PM2.5	PM10	TSP	Mn
🟧 Furnace fugitives	10.1%	9.9%	6.1%	6.9%
🟦 Crushing and Screening	2.5%	2.8%	7.2%	3.1%
🟩 Vehicle Entrained Dust from unpaved roads	0.1%	0.7%	1.8%	1.5%
🟥 Vehicle Entrained Dust from Paved roads	0.3%	0.8%	2.5%	1.7%
🟦 Materials handling	0.2%	1.0%	1.2%	0.6%
🟪 Stacks	86.7%	84.8%	81.2%	86.3%

Figure 9: Scenario 2 - Source group contributions to estimated annual average emissions

5 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

The assessment of the impact of Transalloys' operations on the environment is discussed in this Section. 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 Transalloys (Section 5.2); and
- The methodology followed in determining ambient pollutant concentrations and dustfall rates (Section 5.3).

The impacts on human health due to $PM_{2.5}$, PM_{10}, Mn, NO_2 and SO_2 emissions from Transalloys' operations are discussed in Section 5.4. The impact of dustfall on the environment, due to PM emissions, is discussed in Section 5.5.

5.1 IMPACT ASSESSMENT CRITERIA

Prior to assessing the impact of operations at Transalloys on human health, reference needs to be made to the environmental regulations governing the impact of such operations i.e. ambient air quality standards and guidelines. Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. Ambient air quality standards and guideline values indicate safe daily exposure levels for most of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods. This section summarises national legislation pertaining to air quality for criteria pollutants relevant to the current study. A discussion on inhalation health risk associated with Mn (not considered a criteria pollutant) is also provided.

5.1.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

Criteria pollutants are considered those pollutants mostly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. South African National Ambient Air Quality Standards (NAAQS) for PM_{10}, NO_2 and SO_2 were published on the 13th of March 2009. On the 24th of December 2009 standards for $PM_{2.5}$ were also published. These standards are listed in Table 35.

Table 35: National Ambient Air Quality Standards for criteria pollutants

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
$PM_{2.5}$	24 hour	65	–	4	Immediate – 31 Dec 2015
	24 hour	40	–	4	1 Jan 2016 – 31 Dec 2029
	24 hour	25	–	4	1 Jan 2030
	1 year	25	–	0	Immediate – 31 Dec 2015
	1 year	20	–	0	1 Jan 2016 – 31 Dec 2029
	1 year	15	–	0	1 Jan 2030
PM_{10}	24 hour	120	–	4	Immediate – 31 Dec 2014
	24 hour	75	–	4	1 Jan 2015
	1 year	50	–	0	Immediate – 31 Dec 2014
	1 year	40	–	0	1 Jan 2015
NO_2	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
SO_2	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hour	125	48	4	Immediate
	1 year	50	19	0	Immediate

5.1.2 INHALATION HEALTH CRITERIA FOR MN

The health impact of Mn (not considered a criteria pollutant) is screened against the annual guideline published by the World Health Organisation (WHO). The WHO annual average Guideline Value (GV) for Mn is 0.15 µg/m³.

5.1.3 NATIONAL DUST CONTROL REGULATIONS

The National Dust Control Regulations (NDCR) was published on the 1st of November 2013. The purpose of the regulation is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. Acceptable dustfall rates according to the regulation are summarised in Table 36.

Table 36: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m²-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 equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

5.2 ATMOSPHERIC DISPERSION POTENTIAL

The study of the meteorological conditions of an area helps predict the dispersion potential of pollutants in the atmosphere (Cooper & Alley, 2002). Pollutants released into the atmosphere are transported, diffused, and eventually removed from the atmosphere by physical and meteorological mechanisms. These mechanisms are due to thermal and mechanical turbulence within the boundary layer of the earth. Meteorological principles and a knowledge of both macro- and micro-scale circulation patterns are major factors in effective air pollution dispersion and control (Tiwary & Colls, 2010) (Cooper & Alley, 2002) (Peavy, Rowe, & Tchobanoglous, 1985).

The Transalloys site falls within the Highveld Climatic Zone. The meteorological characteristics present at a specific site, impact on the rate of emissions from fugitive sources, govern the dispersion, chemical transformation, and the eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer, whereas the horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field.

Four basic elements of the atmosphere – wind, moisture, pressure and energy content – influence the weather conditions of the atmosphere, causing variations in diurnal and nocturnal, as well as seasonal observations (Tiwary & Colls, 2010) (Peavy, Rowe, & Tchobanoglous, 1985). The study of these elements, in the form of recorded hourly average weather data, helps to understand the mechanisms of pollutant dispersion within the region (Tiwary & Colls, 2010) (Cooper & Alley, 2002).

Site specific meteorological data was simulated for a period from January 2017 to December 2019 using the Air Pollution Model (TAPM). The location for the simulated meteorological monitoring data is located approximately 250m north-east of the Enterprise (25.9000°S, 29.1200°E) at an elevation of approximately 1548 mamsl, with the wind monitored at a height of 10m and the other parameters at 2m above ground level. This specific data set was assessed and discussed below.

5.2.1 SURFACE WIND FIELD

A wind rose provides graphic representation of prevailing winds by indicating the proportion or percentage of time the wind blows from various directions and at various speeds. Wind speed and wind direction determines how quickly pollutants are dispersed from their sources (Tiwary & Colls, 2010) (Lutgens, Tarbuck, & Tasa, 2013).

The periodic wind rose are presented in Figure 10; with an average wind speed of 3.0 m/s. The periodic wind field (24 hours) was dominated by winds from the northwest, north-northwest and north, with strong but less frequent winds from the westerly and easterly sectors. Day-time wind roses showed similar wind fields with the periodic winds, while night-time wind field showed strong winds from the northerly, easterly, and north-northeast.

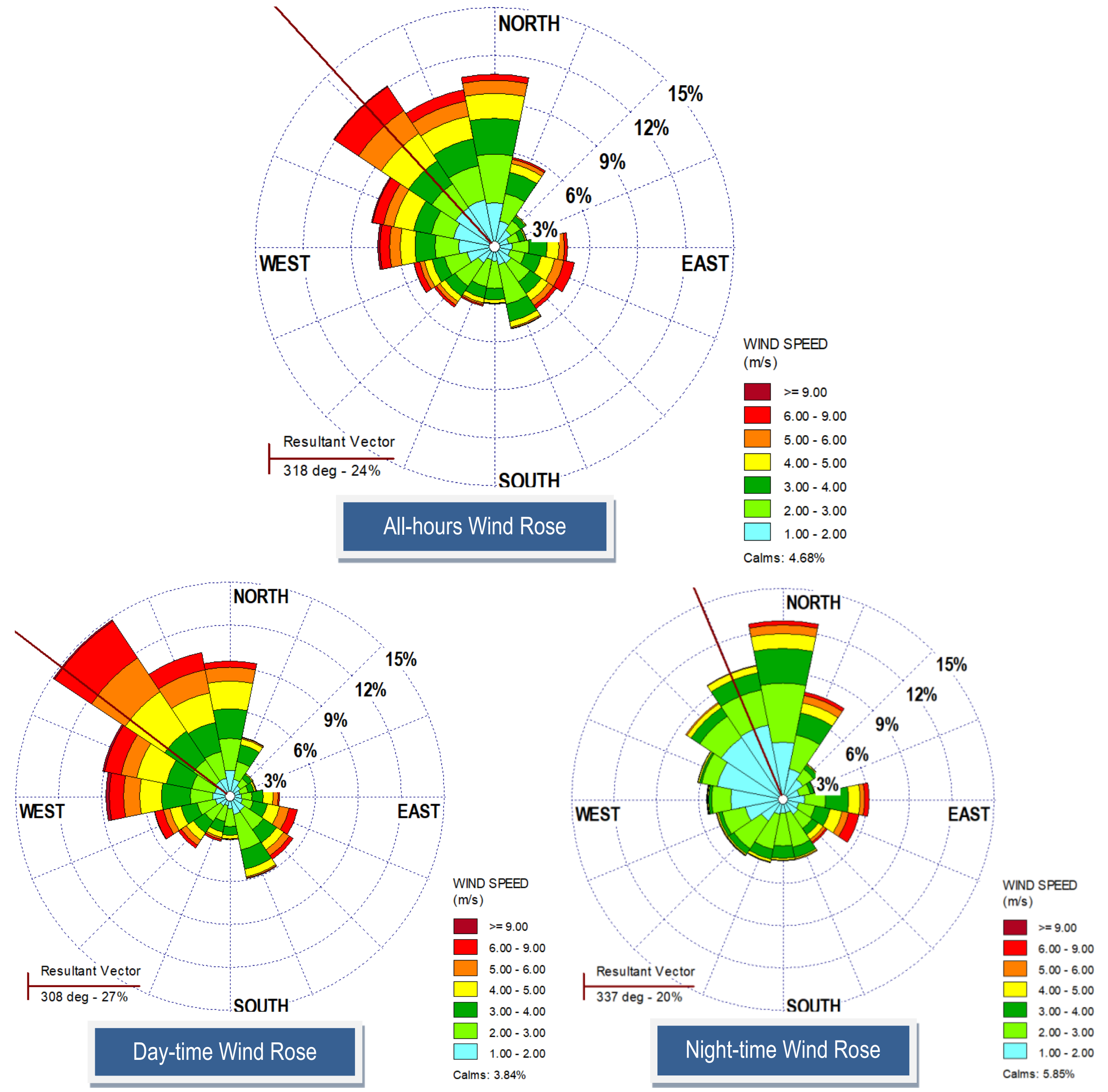


Figure 10: All-hours, day- and night-time wind roses (TAPM data, January 2017 to December 2019)

5.2.2 TEMPERATURE

Temperature is one of the essential elements of weather and climate. It is significant in determining seasonal and diurnal variation in surface heating, which is essential for determining surface circulation patterns. Ambient temperature also influences the impact of plume buoyancy, determining the extent to which emissions are projected and dispersed from their sources (Tiwary & Colls, 2010) (Cooper & Alley, 2002) (Lutgens, Tarbuck, & Tasa, 2013).

The diurnal monthly temperature profile is presented in Figure 11; while the monthly minimum, average and maximum temperatures are presented in Table 37. During the day, temperatures increase to reach maximum at around 13:00 to 14:00 during summer months, while ambient air temperature decreases to reach a minimum at around 05:00 during winter. Minimum and maximum monthly temperatures were recorded as -2.3 ^{o}C and 33.4 ^{o}C respectively.

Table 37: Minimum, average, and maximum monthly temperatures (TAPM data, January 2017 to December 2019)

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Minimum	6.5	9.6	6.8	5.7	1.4	0.5	-2.3	-1.1	0.5	4.1	2.6	8.6
Average	20.0	19.3	18.8	16.2	13.2	10.8	10.8	13.1	16.9	18.2	19.7	20.7
Maximum	32.1	28.6	29.2	26.5	23.0	20.4	22.2	22.4	28.7	31.3	31.8	33.4

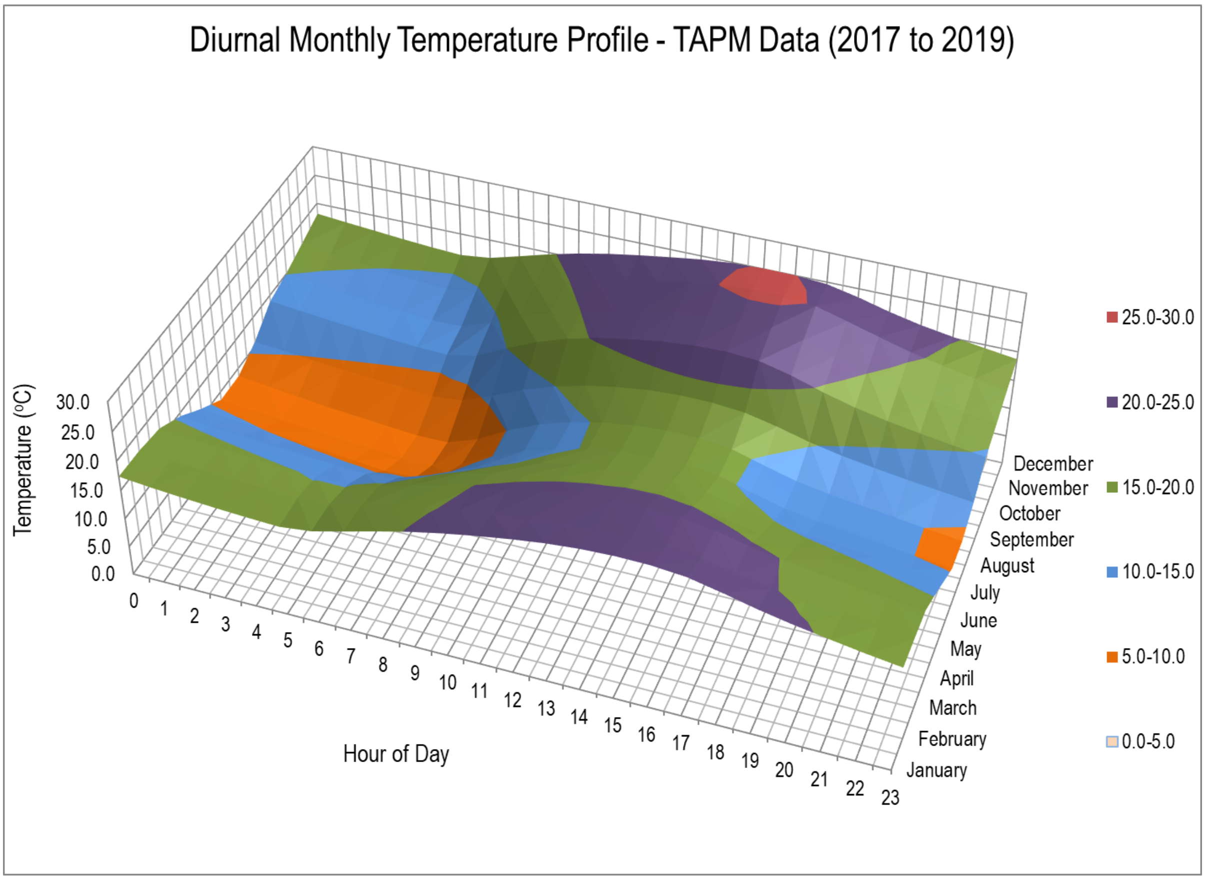


Figure 11: Diurnal monthly temperature profile at (TAPM data, January 2017 to December 2019)

5.2.3 ATMOSPHERIC STABILITY

Atmospheric stability is an indicator of the extent of the vertical motion or air parcels defined by turbulence. The most used atmospheric stability classification is the Pasquill-Gifford (P-G) stability classes with seven classification Table 38.

Table 38: Stability class descriptions

Stability class	Description
A	Extremely unstable conditions
B	Moderately unstable conditions
C	Slightly unstable conditions
D	Neutral conditions
E	Slightly stable conditions
F	Moderately stable conditions
G	Extremely stable conditions

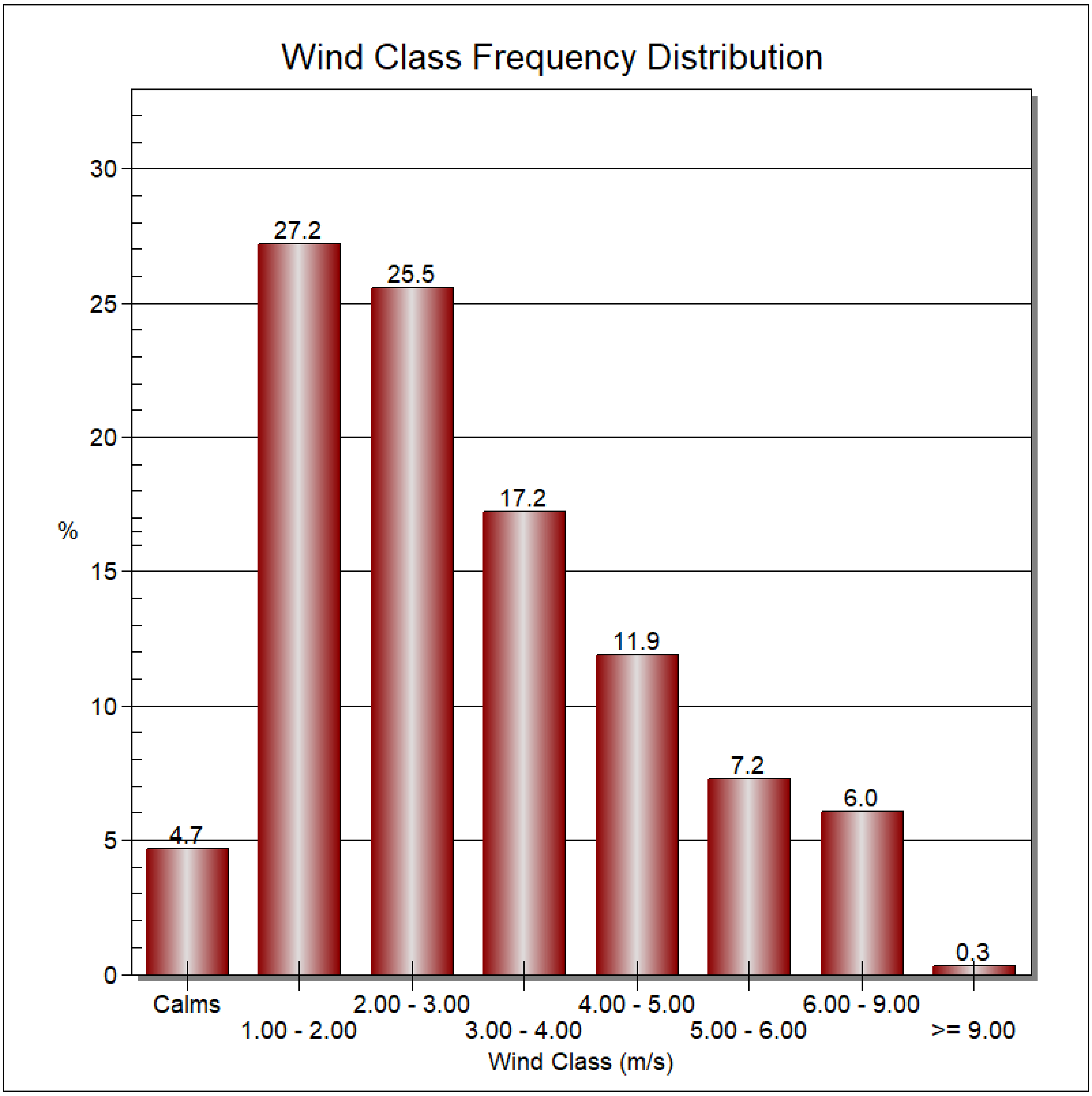


Figure 12: Wind Frequency Classes (January 2017 – December 2019)

5.3 IMPACT ASSESSMENT METHODOLOGY

The impact of Transalloys' operations on the atmospheric environment was determined through sampling and simulation of dustfall rates and ambient pollutant concentrations. Measured dustfall rates and pollutant concentrations account for all sources of atmospheric emission in the greater study area and even some trans-boundary sources, reference was therefore also made to simulated dustfall rates and pollutant concentrations. Simulated air quality impacts represent only those associated with Transalloys' operations. Methodologies followed in the sampling and simulation of dustfall rates and ambient pollutant concentrations are discussed in this section.

5.3.1 MEASURED AMBIENT AIR QUALITY

Transalloys measures PM_{10} concentrations and dustfall rates. In this assessment, reference is made to dustfall data measured from October 2015 to October 2020; and PM_{10} data measured intermittently between January 2012 and December 2015 and between August 2018 and January 2019 (all obtained from Transalloys). The locations of the monitoring stations are shown in Figure 13. PM_{10} sampling is done at Transalloys Weighbridge and at Clewer Primary School. Dustfall is measured at the other seven locations in Figure 13. Trace metals are not currently sampled at Transalloys (Akinshipe & Bird, 2019).

Figure 13: Dustfall sampling and PM_{10} continuous monitoring locations (Akinshipe & Bird, 2019)

5.3.2 ATMOSPHERIC DISPERSION MODELLING METHODOLOGY

Dispersion models simulate ambient concentrations of a pollutant as a function of source configurations, emission metrics and meteorological mechanisms based on physical, chemical, and fluid dynamical processes in the atmosphere. The model utilizes atmospheric, physical and chemical processes within a plume to compute concentrations at desired locations (Tiwary & Colls, 2010). The South African Regulations Regarding Air Dispersion Modelling (Government Gazette No 37804 published 11 July 2014) was referenced in selecting the appropriate model and outlining the modelling methodology utilized in the study (DEA, 2014).

5.3.2.1 DISPERSION MODEL SELECTION

The level of assessment required in an impact study is essential in determining the dispersion model to be employed. The South African Regulations Regarding Air Dispersion Modelling, as well as similar regulations from Canada and Australia, provide adequate description for levels of assessments, technical summaries of the commonly used models, as well as prescription models for each levels of assessment (New South Wales Environment Protection Authority, 2005; Manitoba Conservation, 2006; Ontario Ministry of the Environment and Climate Change, 2016; DEA, 2014).

The three levels of assessment commonly identified are:

- Level 1 – Assessment for worst-case air quality impacts using simpler screening models that requires minimal source and meteorological input (DEFF recommends SCREEN3 or AERSCREEN for this level of assessment) (DEA, 2014).
- Level 2 – Assessment of air quality impacts where impacts are most significant within a few kilometres downwind (less than 50km). This is often required when seeking approval or license from authorities, such as license application or amendment processes etc. (DEFF recommends AERMOD for this level of assessment) (DEA, 2014).

- Level 3 – This assessment requires more sophisticated dispersion models and corresponding source, geophysical and meteorological input data, as well as model operator expertise (DEFF recommends SCIPUFF or CALPUFF for this level of assessment) (DEA, 2014).

AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight-line trajectory limitation. AERMET is a meteorological pre-processor for AERMOD. AERMET outputs surface meteorological observations and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. The output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills (Akinshipe & Bird, 2019).

A disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Input data types required for the AERMOD model include source data, meteorological data (pre-processed by the AERMET model), terrain data and information on the nature of the receptor grid (Akinshipe & Bird, 2019).

5.3.2.2 METEOROLOGICAL REQUIREMENTS

For the dispersion modelling purposes, hourly surface data from SAWS eMalahleni station for the period January 2016 to December 2018 was used. Upper air meteorological data was extrapolated by AERMET.

5.3.2.3 SOURCE DATA REQUIREMENTS

The AERMOD model is capable of modelling point, jet, area, line and volume sources. Sources at Transalloys were modelled as follows:

- Crushing and screening – modelled as volume sources;
- Materials handling – modelled as volume sources;
- Stacks (bagfilter vents and scrubber stacks) – modelled as point sources;
- Furnace building fugitive emissions – modelled as volume sources; and,
- Unpaved and paved roads – modelled as area sources.

5.3.2.4 MODELLING DOMAIN

The dispersion of pollutants expected to arise from current operations was modelled for an area covering 12 km (east-west) by 12 km (north-south). The area was divided into a grid matrix with a resolution of 100 m, with Transalloys operations located centrally. The nearest community areas were included as air quality sensitive receptors (AQSR). AERMOD calculates ground level (1.5 m above ground level) concentrations and dustfall rates at each grid and discrete receptor point.

5.3.2.5 PRESENTATION OF RESULTS

Dispersion modelling was undertaken to determine highest hourly, highest daily and annual average ground level concentrations and dustfall rates for each of the pollutants considered in the study. Averaging periods were selected to facilitate the comparison of simulated pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Ground level concentration isopleths plots presented in this section depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified. Plots reflecting hourly (daily) and averaging periods contain only the 99.99th (99.73th) percentile of simulated ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken. It is therefore possible that even though a high hourly (or daily) average concentration is simulated to occur at certain locations, that this may only be true for one hour (or day) during the year. Results are also provided in tabular form as discrete values simulated at specific sensitive receptors locations.

Ambient air quality criteria apply to areas where the Occupational Health and Safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the public has access. Section 5.4 deals with impacts on human health. Dustfall is assessed for nuisance impact on the environment (Section 5.5) and not inhalation health impact.

5.4 ANALYSIS OF EMISSIONS' IMPACT ON HUMAN HEALTH ($PM_{2.5}$, PM_{10}, NO_2, SO_2 AND MN)

Pollutants released by Transalloys operations, likely to result in human health impacts include $PM_{2.5}$, PM_{10}, NO_2, SO_2 and Mn. Of these pollutants, Transalloys conducts ambient monitoring for PM_{10} only. Measured PM_{10} concentrations are discussed in Section 5.4.1. Simulated concentrations of $PM_{2.5}$, PM_{10}, NO_2, SO_2 and Mn are discussed in Section 5.4.2.

5.4.1 MEASURED AMBIENT PM_{10} CONCENTRATIONS

In the interpretation of this section, the reader should note that measured air pollutant concentrations reflect levels due to several sources of atmospheric emission in the Ferrobank and Highveld area and not concentrations only related to Transalloys operations (Akinshipe & Bird, 2019).

A summary of measured ambient PM_{10} concentrations is provided in Table 39. Results from 2013 and 2015 obtained from the Transalloys Weighbridge (Location A) and the Clewer Primary School (Location B) monitoring stations indicate elevated PM_{10} concentrations in exceedance of the 24-hour NAAQS (4 days exceeding 75 µg/m^3). Calculated period average PM_{10} concentrations of 37 µg/m^3 (Weighbridge) and 39.0 µg/m^3 (Clewer Primary School) did not exceed the annual average NAAQS of 40 µg/m^3, but only marginally (Akinshipe & Bird, 2019).

Recent results (August 2018 to January 2019) obtained from Locations A and B did not exceed the daily or the annual NAAQS with a calculated periodic average of 18 µg/m^3 (Location A) and 25 µg/m^3 (Location B).

Table 39: Summary of measured ambient PM_{10} concentrations (Akinshipe & Bird, 2019)

Parameter	Transalloys Monitoring (Near Weighbridge / Truck Stop)	Transalloys Monitoring (Clewer Primary school) [a]
Reporting Period	**January 2015 to December 2015**	**30 March 2012 to 8 January 2013**
Data Availability During Reporting Period	53%	68%
Period Average PM_{10} Concentration	37 µg/m^3	39 µg/m^3
Maximum 24-hour Average PM_{10} Concentration	120 µg/m^3	1710 µg/m^3
No. of days exceeding 75 µg/m^3	20 days (10%)	36 days (22%)
Reporting Period	**August 2018 to January 2019**	**August 2018 to January 2019**
Data Availability During Reporting Period	67%	46%
Period Average PM_{10} Concentration	18 µg/m^3	25 µg/m^3
Maximum 24-hour Average PM_{10} Concentration	59 µg/m^3	57 µg/m^3
No. of days exceeding 75 µg/m^3	0 days (0%)	0 days (0%)

NOTE: [a] Monitoring data at Clewer Primary School for the January to December 2015 period is not available due to prolonged repair and maintenance of the sampling unit.

5.4.2 SIMULATED AMBIENT AIR POLLUTANT CONCENTRATIONS

Simulated ambient air pollutant concentrations are discussed in this Section. The reader is reminded that simulated concentrations only reflect those associated with atmospheric emissions from Transalloys' operations as quantified in Section 4 for the following scenarios:

- **Scenario 1** represents incremental emissions due to proposed Sinter Plant operations at Transalloys; and
- **Scenario 2** represents existing Transalloys operations in addition to proposed Sinter Plant operations.

5.4.2.1 SIMULATED PM_{10} CONCENTRATIONS

The simulated annual average concentrations for scenarios 1 and 2 are presented in Figure 15 and Figure 15 respectively; while the areas over which 24-hour NAAQS are exceeded for scenario 2 are presented in Figure 16. Figure 17 provides source group contributions to the simulated annual average PM_{10} concentrations.

Annual average PM_{10} concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at the plant boundary or off-site. More than the permissible 4 days exceedance of the 24-hour limit value of 75 µg/m^3 is simulated at the Transalloys boundary, but not at Clewer or any other AQSRs.

Furnace building fugitives contribute most notably (44%) to simulated off-site PM_{10} concentrations. Crushing and screening, vehicle entrained dust from unpaved roads together with stacks emissions contribute more to ground level concentrations than materials handling, and vehicle entrained dust from paved roads.

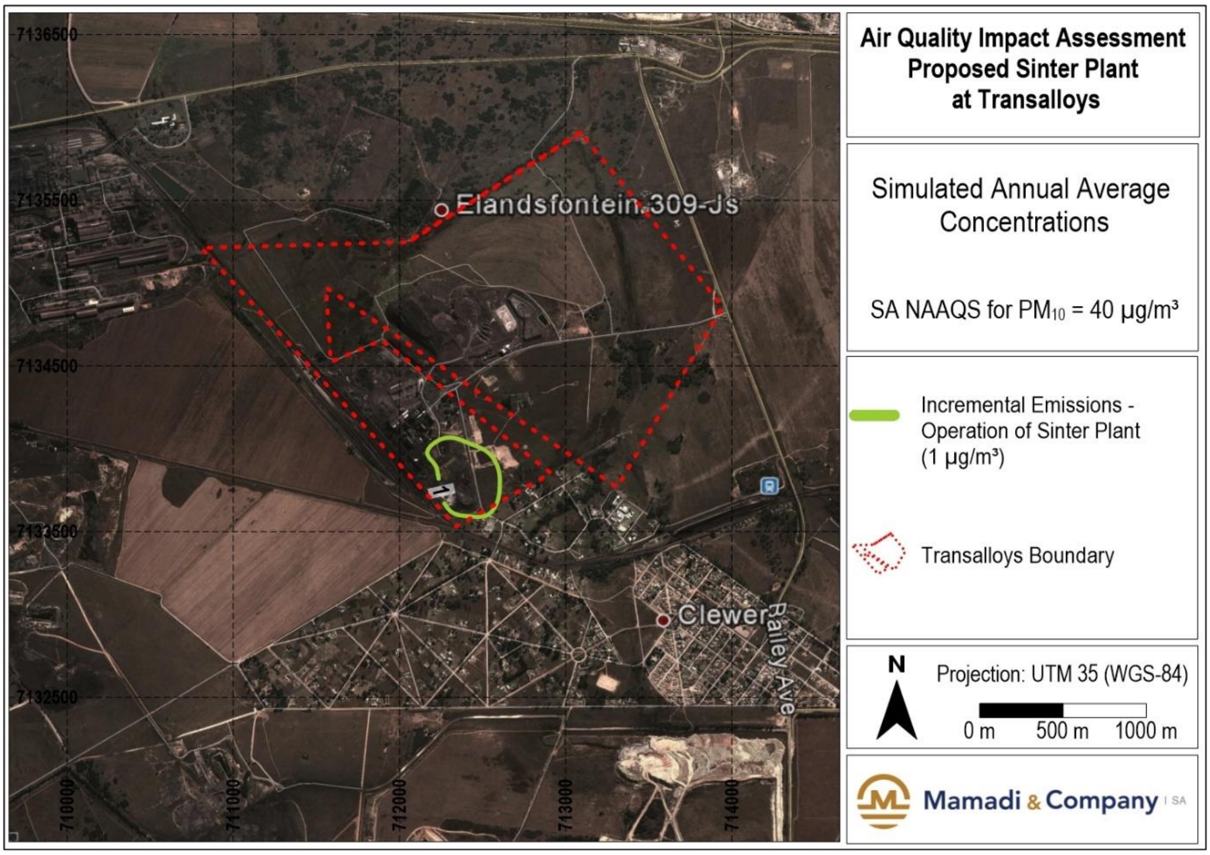


Figure 14: Simulated annual average PM_{10} concentrations due to Scenario 1 (incremental emissions – Isopleth is lower than limit)

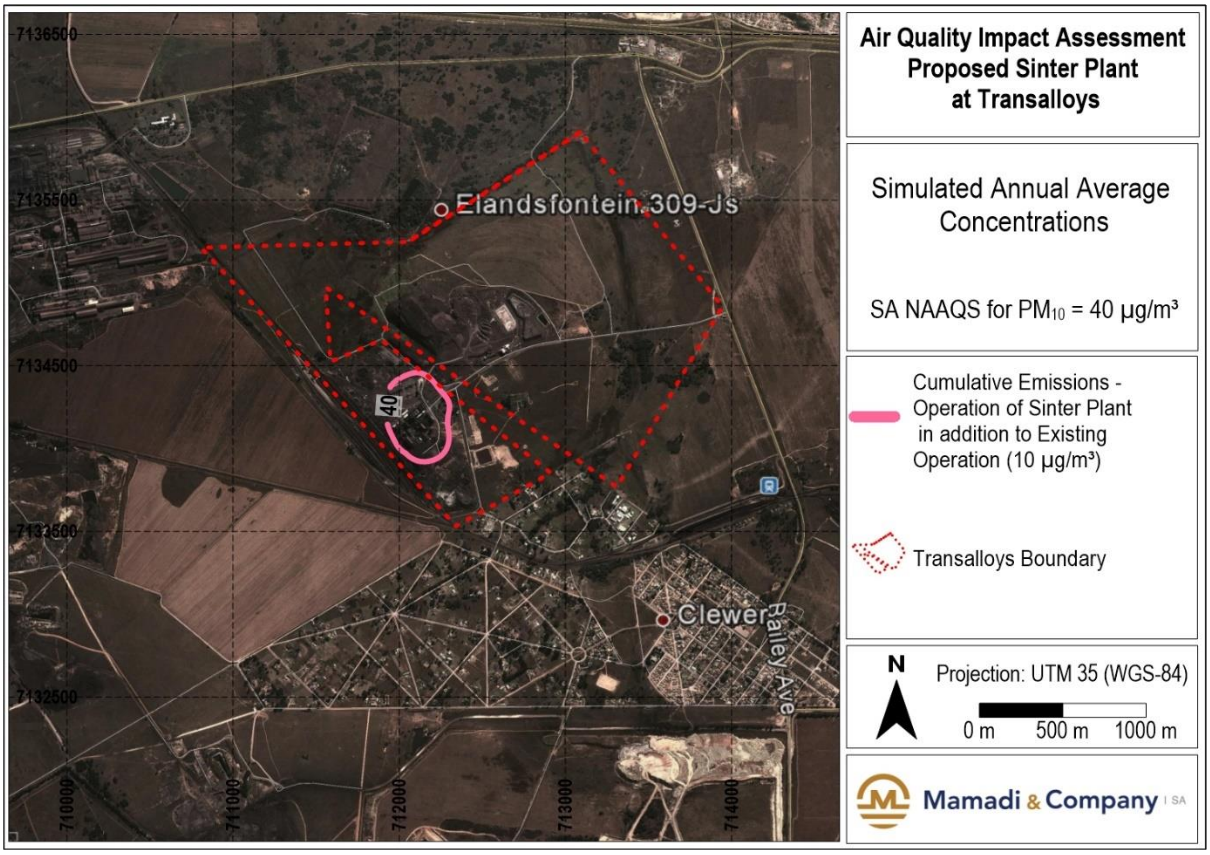


Figure 15: Simulated annual average PM$_{10}$ concentrations due to Scenario 2 (cumulative emissions)

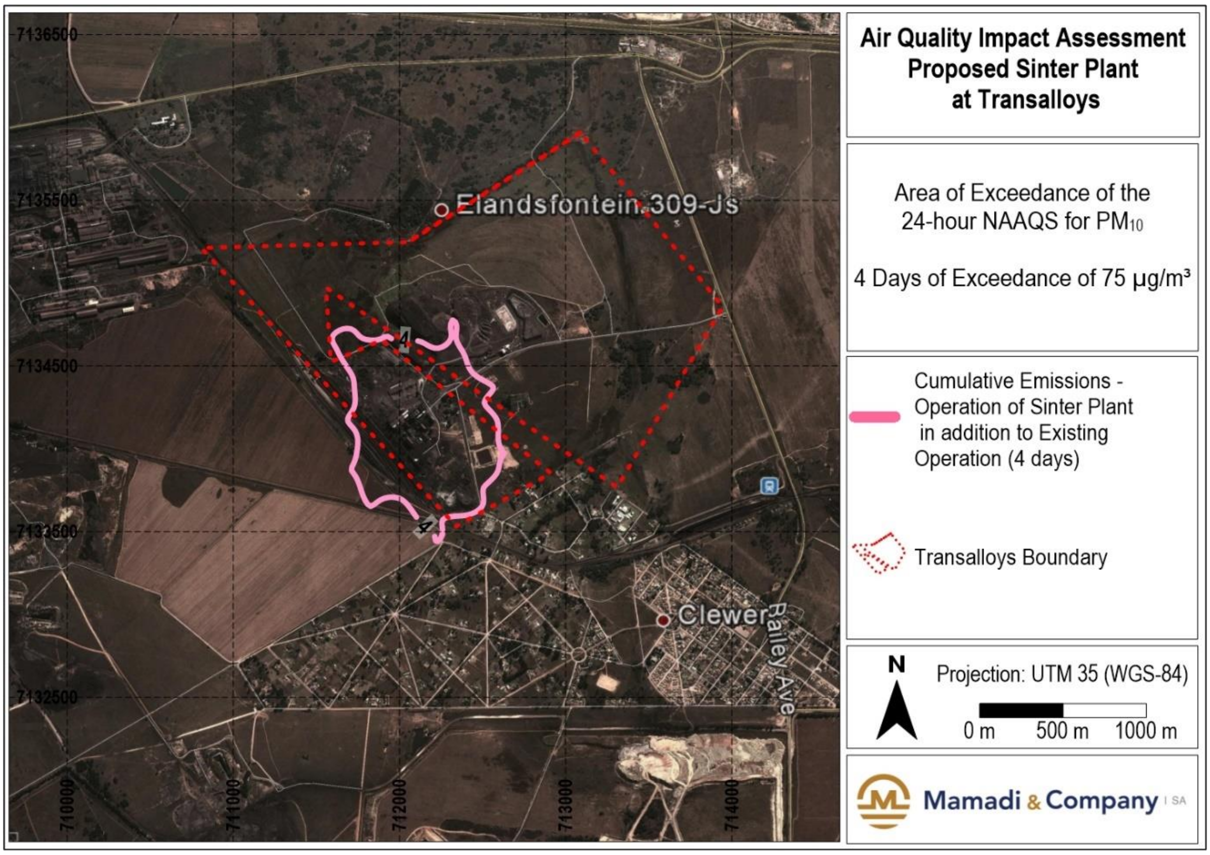


Figure 16: Area of exceedance of the 24-hour NAAQS for PM$_{10}$ (cumulative emissions)

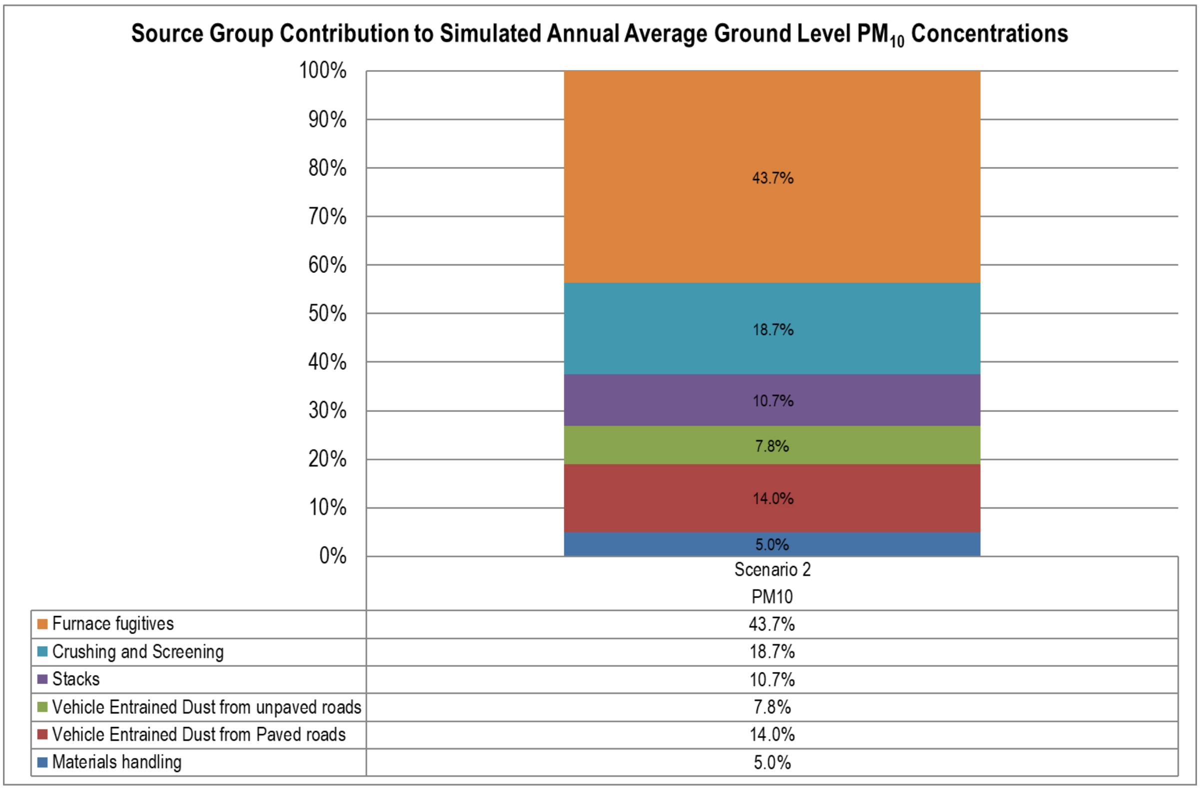


Figure 17: Source group contributions to simulated annual average PM_{10} concentrations

5.4.2.2 SIMULATED $PM_{2.5}$ CONCENTRATIONS

The areas over which annual and 24-hour NAAQS are exceeded for the different scenarios are presented in Figure 18 and Figure 20 respectively. Figure 21 provides source group contributions to the simulated annual average $PM_{2.5}$ concentrations.

Annual average $PM_{2.5}$ concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at Transalloys boundary or off-site. More than the permissible 4 days exceedance of the 24-hour limit value of 40 µg/m^3 is simulated at the Transalloys boundary, but not at Clewer or any AQSRs.

Furnace building fugitives contribute most notably (56%) to simulated off-site $PM_{2.5}$ concentrations. Crushing and screening as well as stack emissions contribute more to ground level concentrations than materials handling, vehicle entrained dust from paved roads and unpaved roads over both scenarios.

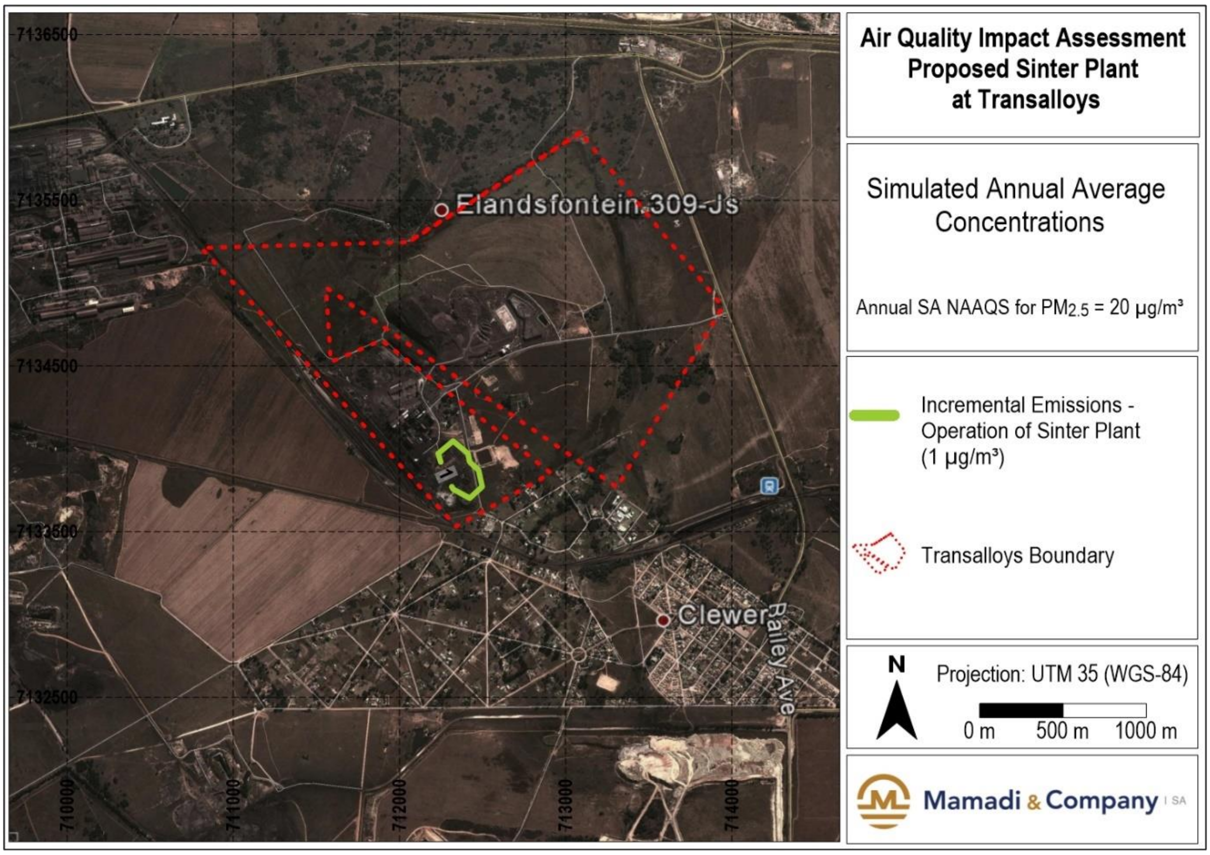


Figure 18: Simulated annual average $PM_{2.5}$ concentrations due to Scenario 1 (incremental emissions – Isopleth is lower than limit)

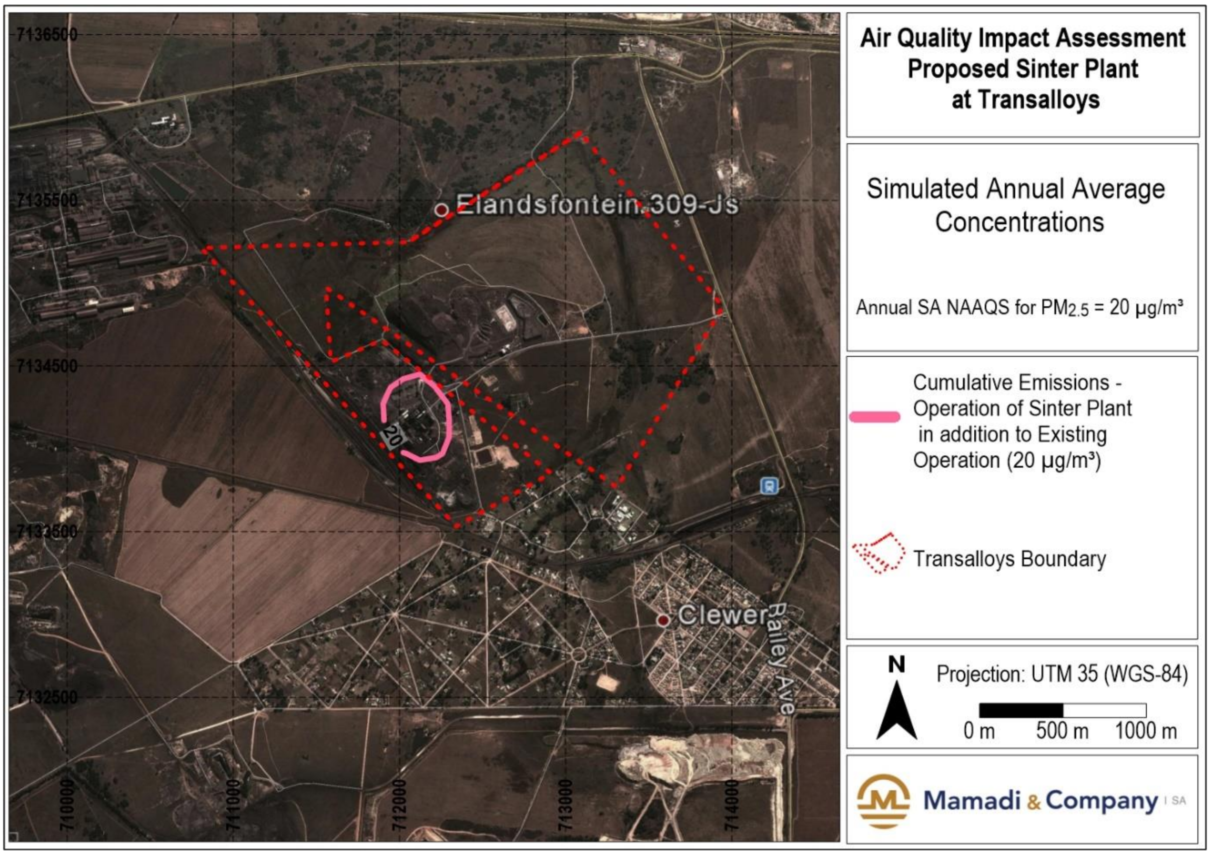


Figure 19: Simulated annual average $PM_{2.5}$ concentrations due to Scenario 2 (cumulative emissions)

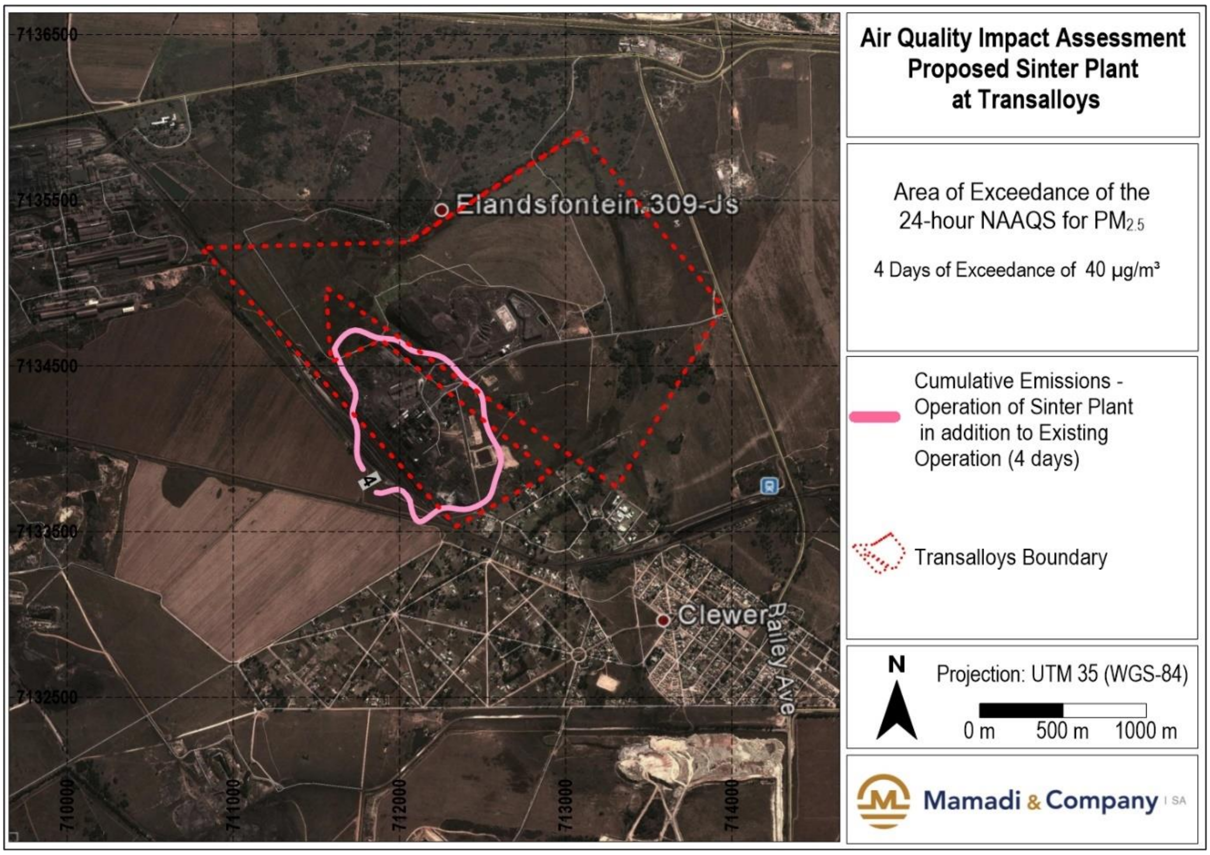
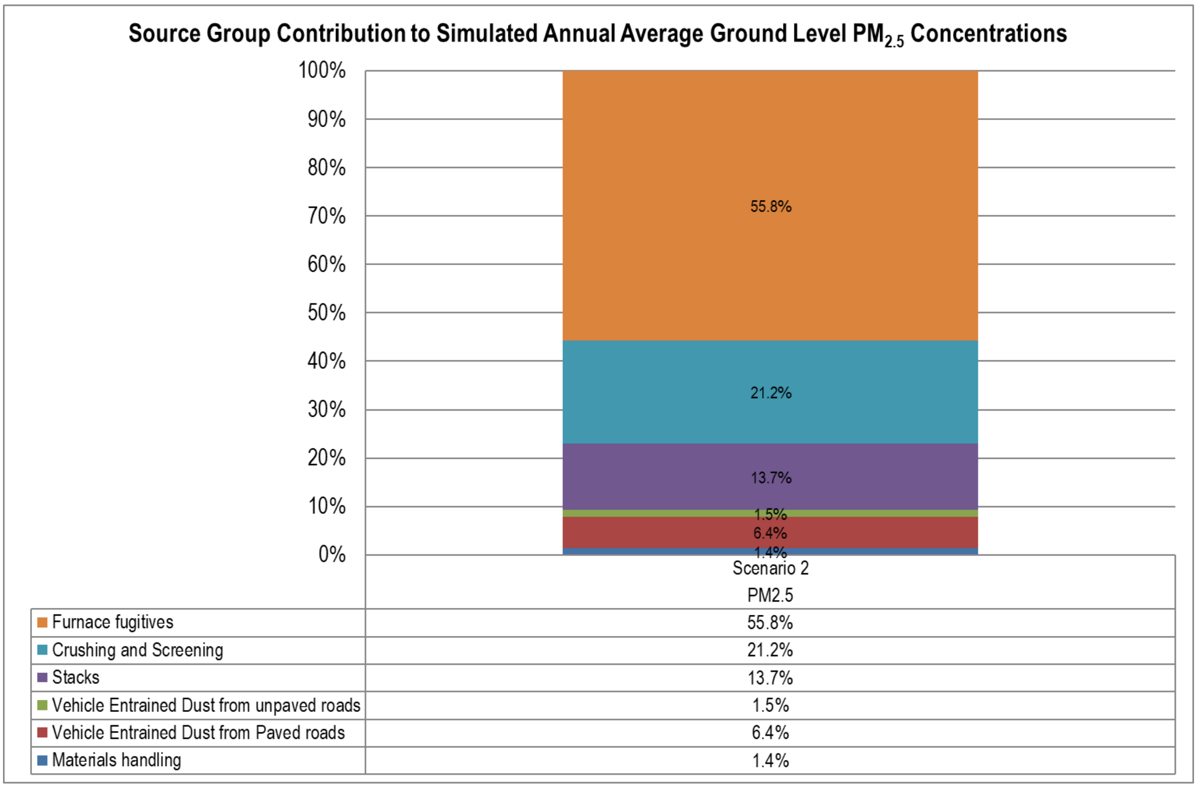


Figure 20: Area of exceedance of the 24-hour NAAQS for $PM_{2.5}$ (cumulative emissions)



	Scenario 2 PM2.5
🟧 Furnace fugitives	55.8%
🟦 Crushing and Screening	21.2%
🟪 Stacks	13.7%
🟩 Vehicle Entrained Dust from unpaved roads	1.5%
🟥 Vehicle Entrained Dust from Paved roads	6.4%
🟦 Materials handling	1.4%

Figure 21: Source group contributions to simulated annual average $PM_{2.5}$ concentrations

5.4.2.3 SIMULATED NO_2 CONCENTRATIONS

Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into the much more poisonous nitrogen dioxide (NO_2) which is regulated by NAAQS. NO_2 impacts where calculated by AERMOD using the ozone limiting method assuming a background ozone concentration of 25 ppb (Zunckel, et al., 2004) and a default stack NO_2/NO_x emission ratio of 0.1. The simulated annual average NO_2 concentrations due to Scenarios 1 and 2 are presented in Figure 22 and Figure 23 respectively.

The simulated annual average and maximum hourly NO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the NO_2 NAAQS at the Transalloys boundary, and at all AQSRs.

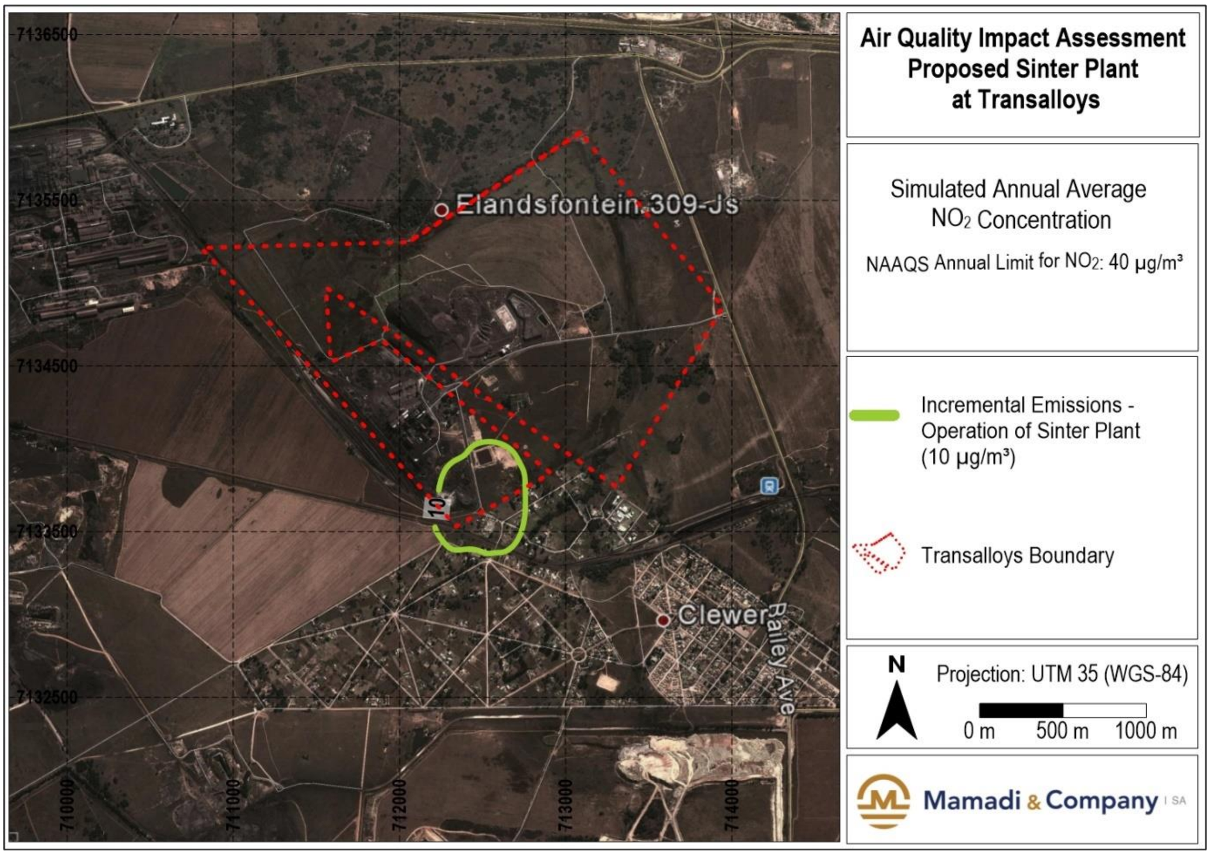


Figure 22: Simulated annual average NO_2 concentrations due to Scenario 1 (incremental emissions – Isopleth is lower than limit)

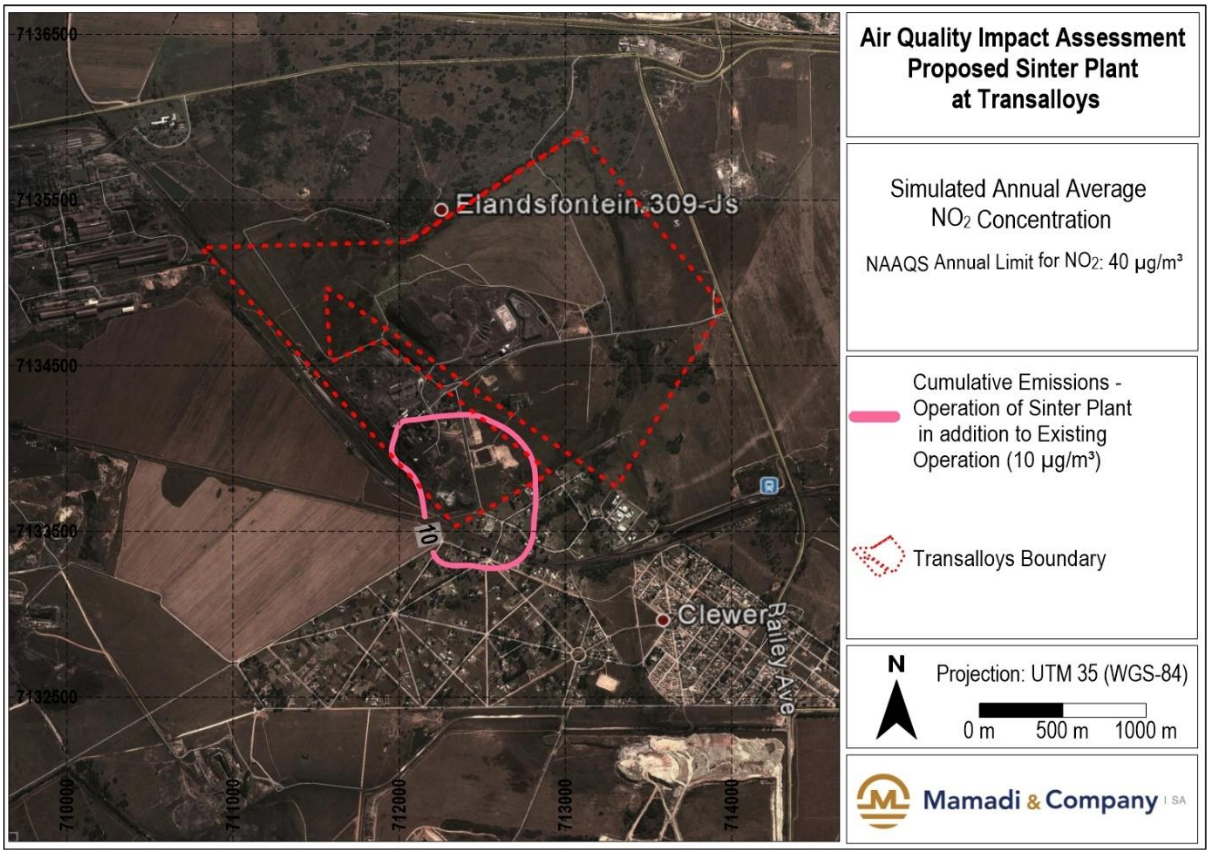


Figure 23: Simulated annual average NO_2 concentrations due to Scenario 2 (cumulative emissions – Isopleth is lower than limit)

5.4.2.4 SIMULATED SO_2 CONCENTRATIONS

The simulated annual average and maximum hourly SO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the SO_2 NAAQS at the Transalloys boundary, and at all AQSRs. The simulated annual average SO_2 concentrations due to Scenarios 1 and 2 are presented in Figure 24 and Figure 25.

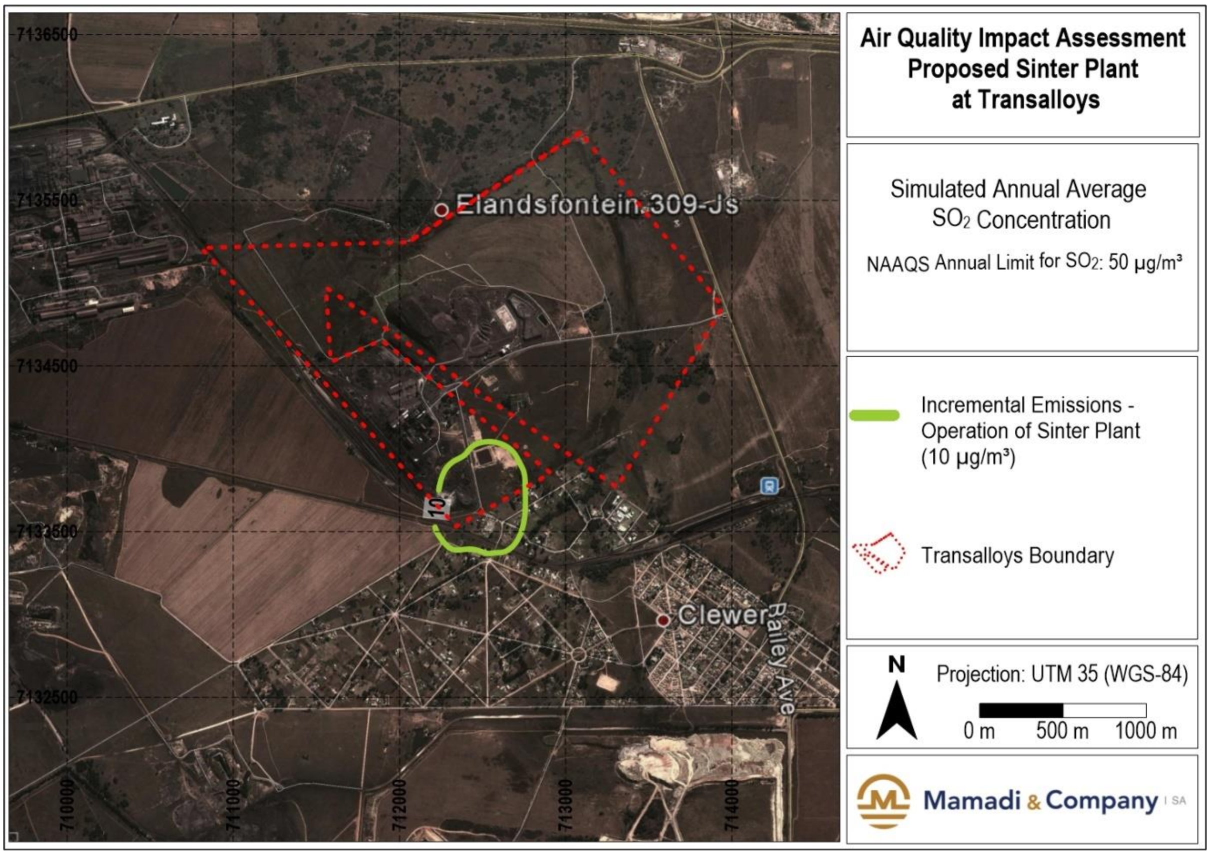


Figure 24 Simulated annual average SO_2 concentrations due to Scenario 1 (incremental emissions – Isopleth is lower than limit)

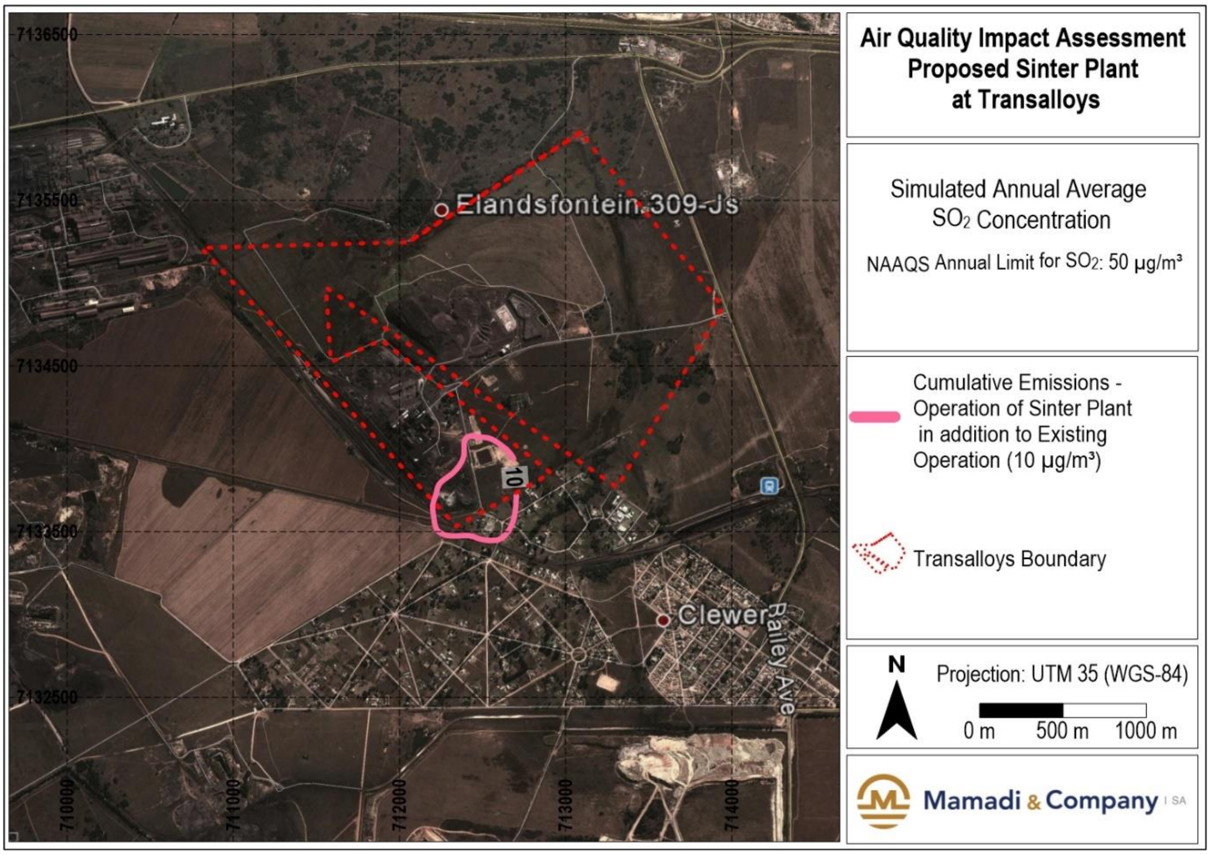


Figure 25: Simulated annual average SO_2 concentrations due to Scenario 2 (cumulative emissions – Isopleth is lower than limit)

5.4.2.5 SIMULATED MN CONCENTRATIONS

Mn impacts were determined for both Scenarios considered in this study. In the absence of NAAQS for Mn, reference was made to the WHO annual GV of 0.15 µg/m^3. It should be noted that the guideline value is set as a 'guideline' and not a "limit value" or a toxicity threshold. They serve as a benchmark beyond which caution should be exercised.

A summary of simulated annual average Mn concentrations is provided in Table 40. The areas over which annual concentrations exceed the WHO GV are presented in Figure 26. The annual average Mn concentrations due to Scenario 1 emissions are low and within WHO GV at AQSRs, however Mn concentrations due to Scenario 2 emissions exceed the WHO GV off-site by a considerable margin, affecting AQSRs such as Clewer, and Kwa-Guqa. Furnace building fugitives, vehicle entrained dust on paved and unpaved roads, and crushing and screening contribute most notably to simulated Mn concentrations (Figure 27).

According to van Niekerk & Fourie (2017), an exposure assessment of the modelled manganese concentrations based on Human Health Risk Assessment (conducted by INFOTOX (Pty) Ltd) using the strict reference concentration of 0.2 µg/m^3 indicate a negligible risk of health effects over most of the areas surrounding Transalloys. Hence, the risk of a potential health impact associated with exposure to manganese contributed by the Transalloys facility for both scenarios cannot be viewed as significant (van Niekerk & Fourie, 2017).

Table 40: Summary of simulated Mn concentrations at the Transalloys boundary and AQSR

Averaging Period	AQSR	Scenario 1	Scenario 2
Simulated Annual Average Mn concentration (µg/m^3) WHO GV – 0.15 µg/m^3	Transalloys Boundary	0.13	13.6
	Clewer	0.10	2.74
	Kwa-Guqa	0.02	0.94
	Lynnville	0.01	0.57

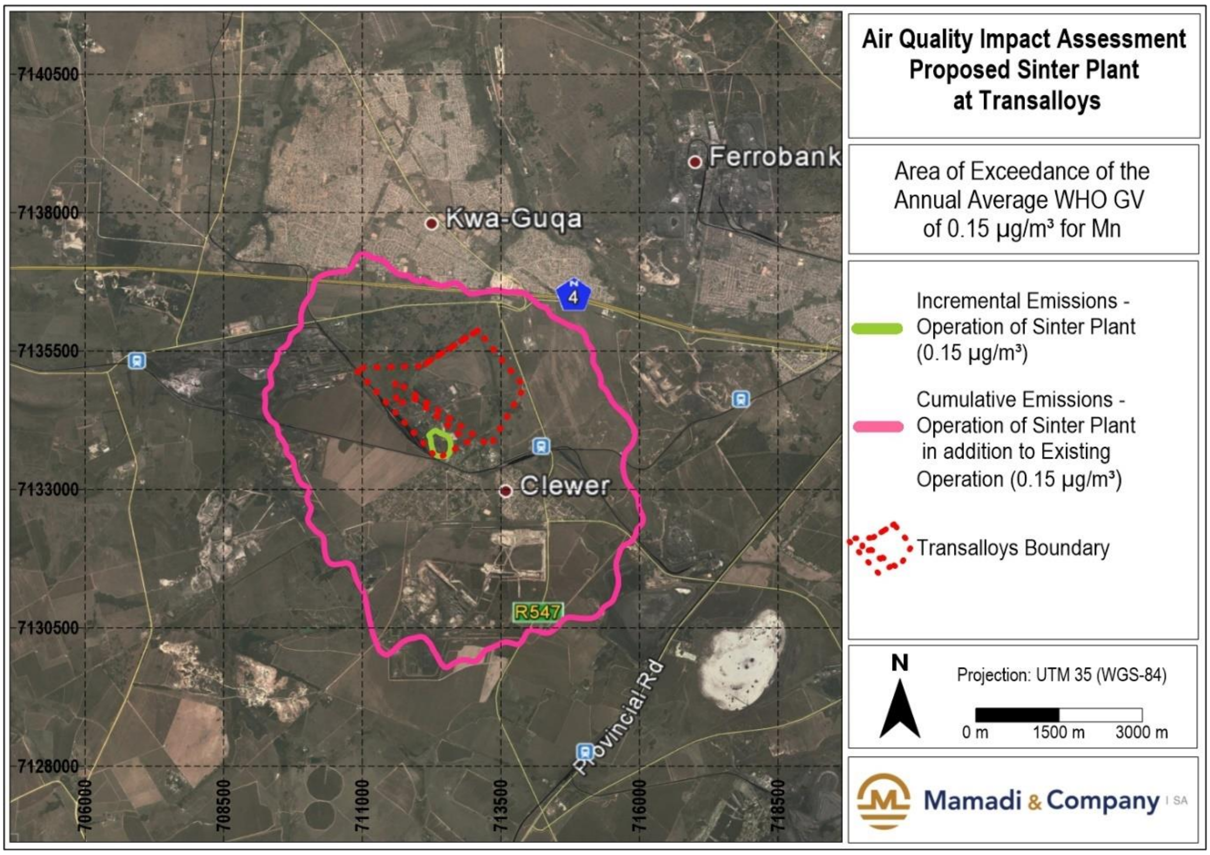


Figure 26: Area of exceedance of the annual average WHO GC for Mn

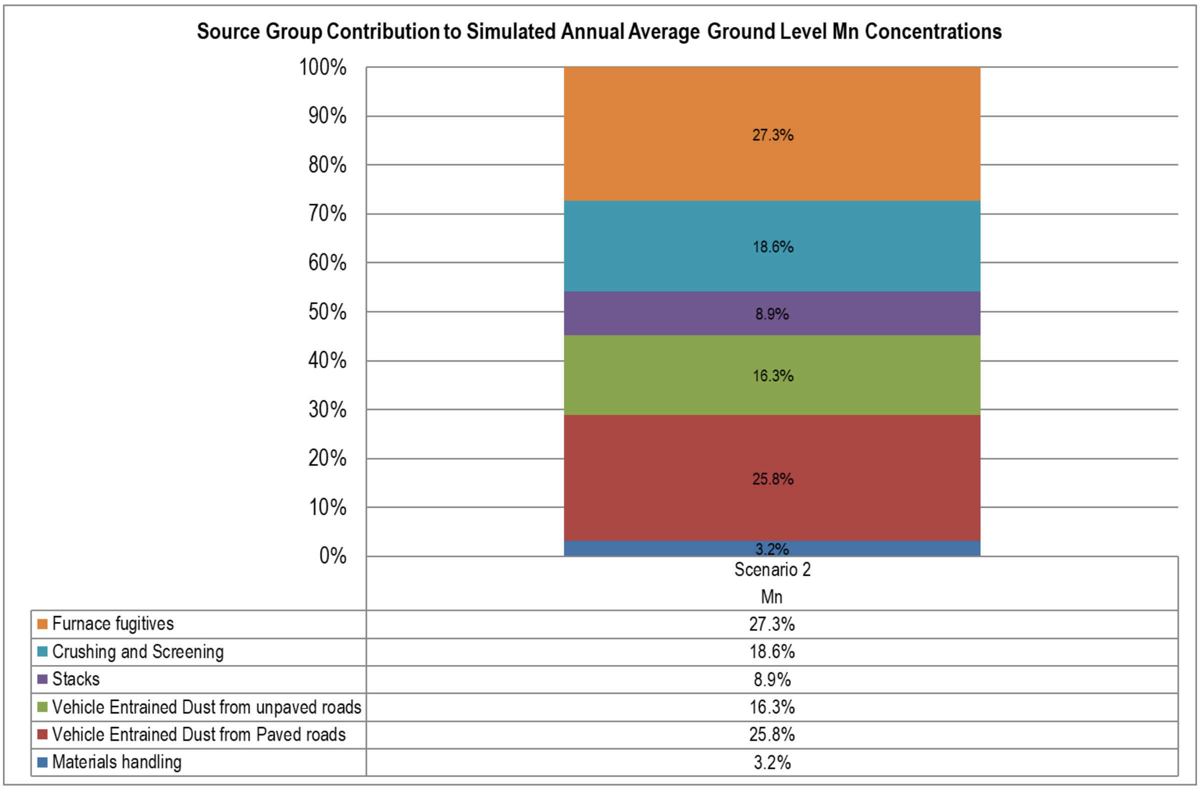


Figure 27: Source group contributions to simulated annual average Mn concentrations

5.5 ANALYSIS OF EMISSIONS' IMPACT ON THE ENVIRONMENT (DUSTFALL)

5.5.1 MEASURED DUSTFALL RATES

Dustfall rates measured between October 2015 and October 2020 are presented in Figure 28 (refer to Figure 13 for location of the Transalloys sampling locations). The residential dustfall limit of 600 mg/m^2-day was only exceeded at the FPP – Stand Block location (a non-residential location) during October 2016. FPP – Stand Block is located close to crushing and screening operations, as well as material handling activities at the siding and conveyors. All other dustfall measurements are below the residential dustfall limit of 600 mg/m^2-day for the period October 2015 to October 2020.

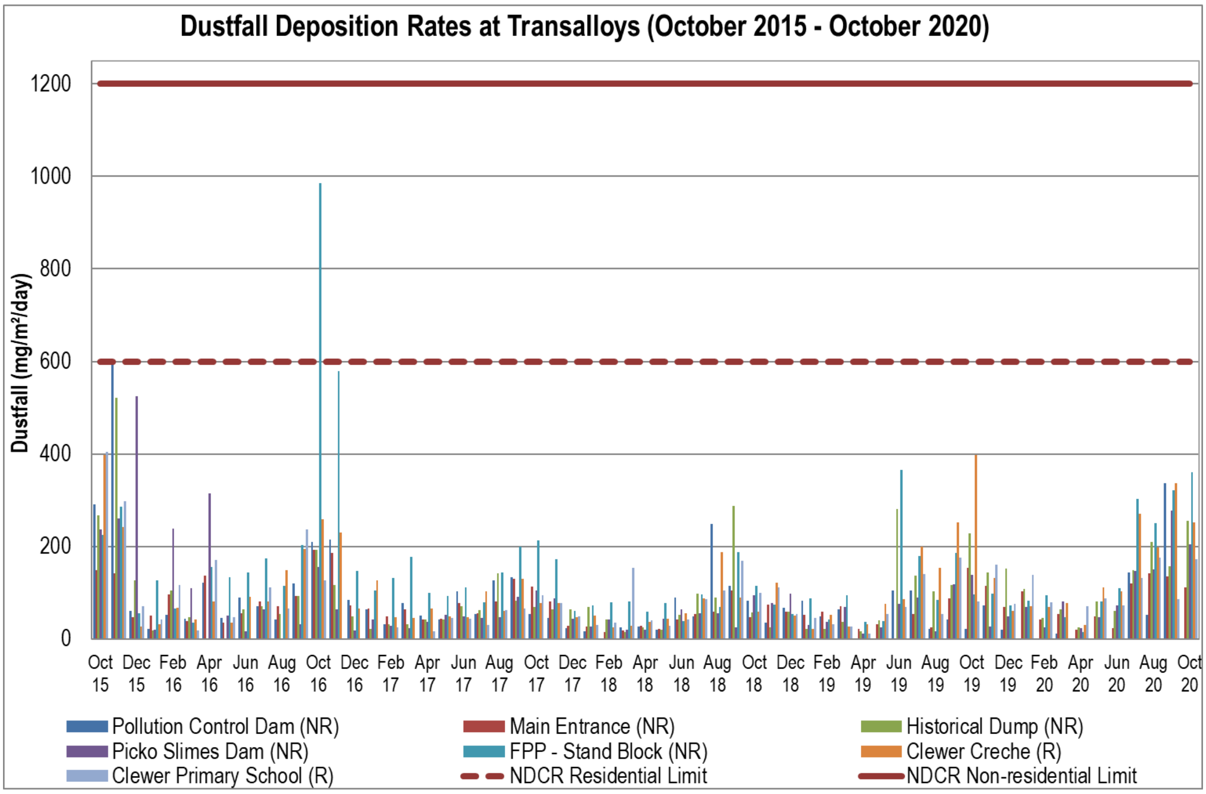


Figure 28: Measured dustfall rates at Transalloys for October 2015 to October 2020 ("NR" and "R" indicates non-residential and residential locations respectively)

5.5.2 SIMULATED DUSTFALL RATES

Simulated daily dustfall deposition rate due to Scenarios 1 and 2 is presented in Figure 29 and Figure 30 respectively. Simulated dustfall rates due to Scenario 1 and Scenario 2 emissions did not exceed dustfall limits at the Transalloys boundary or at the AQSRs. Stacks/baghouses paved and unpaved roads, and furnace building fugitives contribute most notably to dustfall rates at Transalloys boundary and at AQSRs (Figure 31).

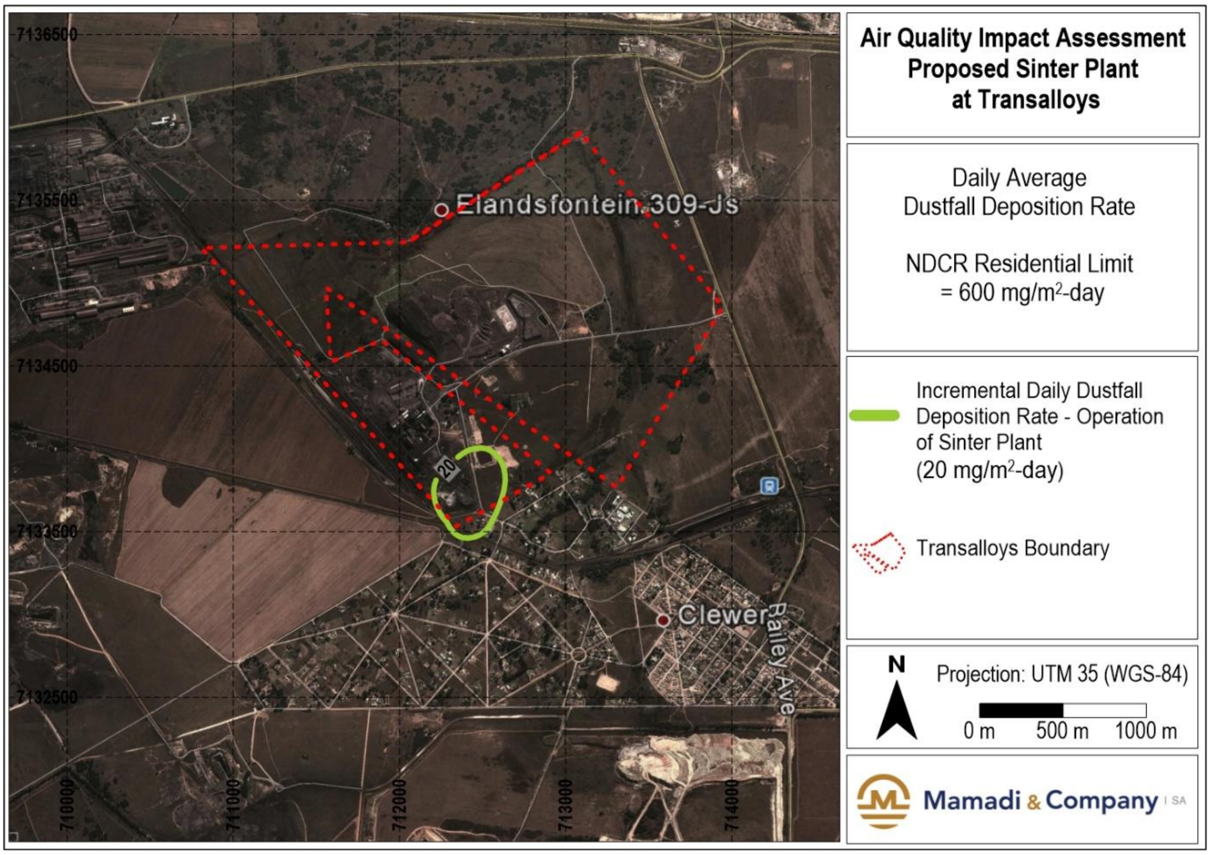


Figure 29: Simulated daily dustfall deposition rate residential dustfall limit (incremental emissions – Isopleth is lower than limit)

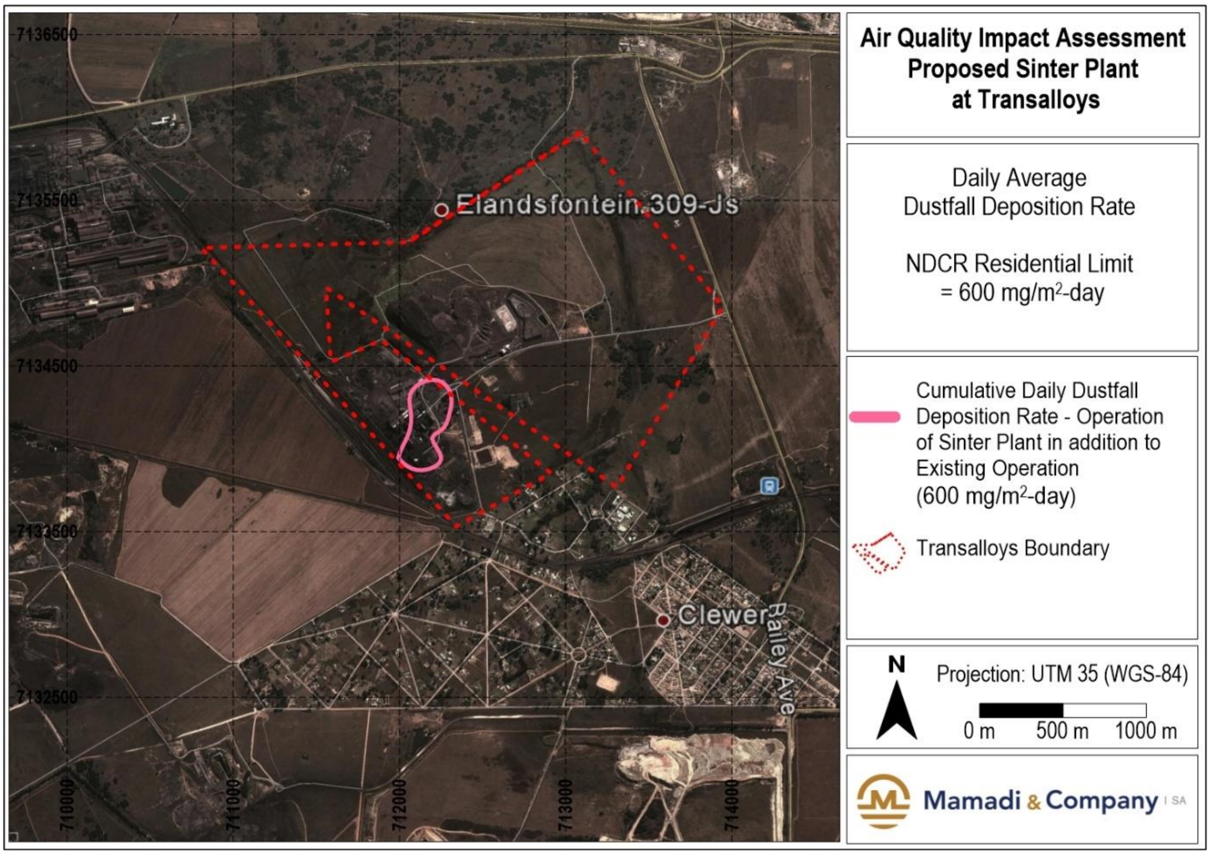
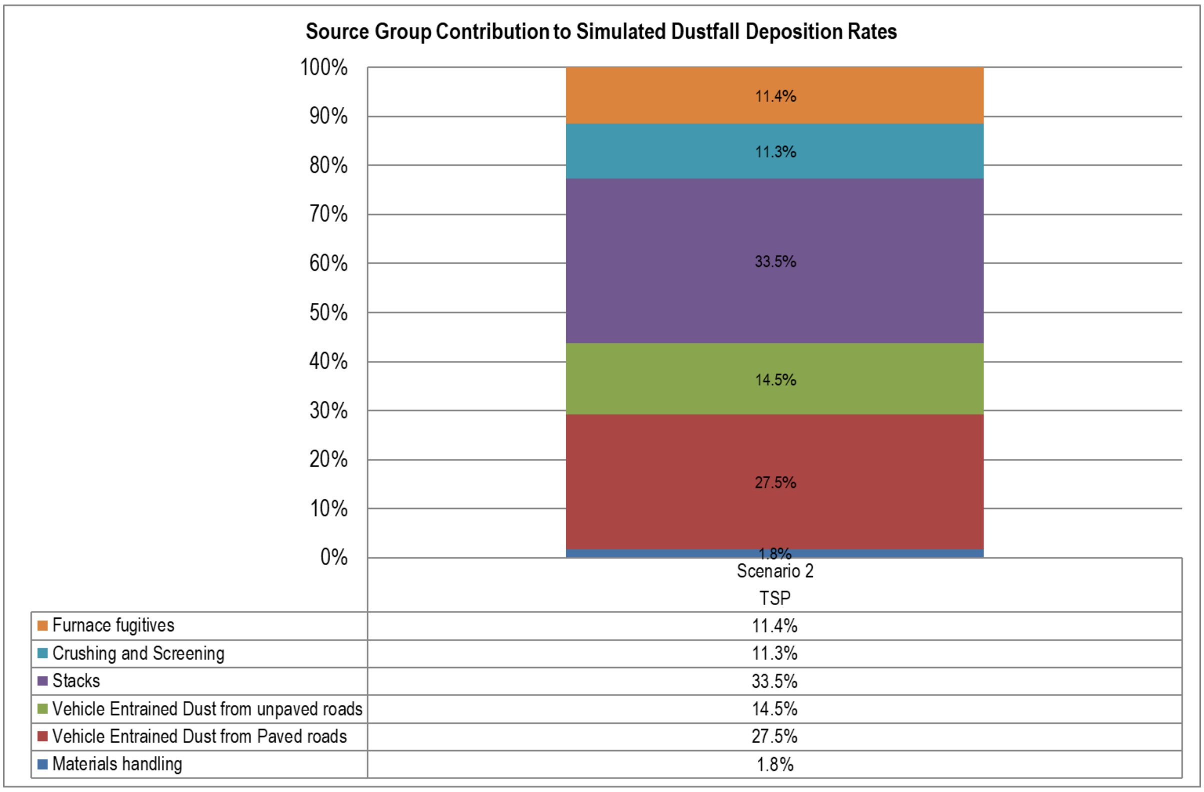


Figure 30: Simulated daily dustfall deposition rate residential dustfall limit (cumulative emissions)



	Scenario 2 TSP
Furnace fugitives	11.4%
Crushing and Screening	11.3%
Stacks	33.5%
Vehicle Entrained Dust from unpaved roads	14.5%
Vehicle Entrained Dust from Paved roads	27.5%
Materials handling	1.8%

Figure 31: Source group contributions to simulated dustfall rates

5.6 CONTRIBUTION OF SINTER PLANT IMPACTS TO TOTAL TRANSALLOYS OPERATION

The direct impact due to addition of the Sinter Plant (Scenario 1) to total Transalloys operation is presented in Table 41. Percentage contribution of Sinter Plant ranged between 3.0% and 7.6% for all particulate matter and manganese. This indicates that the impact of addition of the Sinter Plant will be minimal.

Table 41: Contribution of Sinter Plants Impacts to total Transalloys Operation

Pollutants	% Sinter Plant (Scenario 1) to total Transalloys Operation
$PM_{2.5}$	5.3%
PM_{10}	4.2%
TSP	7.6%
Mn	3.0%

6 COMPLAINTS

No complaints have been reported on the Transalloys complaints register from January 2014 to November 2020.

7 RECOMMENDED AIR QUALITY MANAGEMENT INTERVENTIONS

7.1 MAIN FINDINGS

The main findings of the impact assessment for the proposed Project are summarized below:

- Impact of the Project:
  - Sources of emission quantified included: materials handling; vehicles entrained PM on paved and unpaved roads; stack; building fugitives; and, crushing and screening.
  - Annual average PM_{10} concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at the plant boundary or off-site. More than the permissible 4 days exceeding the 24-hour limit value of 75 µg/m^3 is simulated at the Transalloys boundary, but not at Clewer or any other residential area.
  - Similarly, annual average $PM_{2.5}$ concentrations due to Scenario 1 and Scenario 2 emissions do not exceed NAAQS at the Transalloys boundary or off-site. More than the permissible 4 days exceeding the 24-hour limit value of 40 µg/m^3 occur at the Transalloys boundary, but not at Clewer or any other residential area.
  - Also, simulated dustfall rates due to Scenario 1 and Scenario 2 emissions indicates rates below the NDCR residential limits at the Transalloys boundary and at any AQSRs.
  - Simulated annual average and maximum hourly NO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the NO_2 NAAQS at the Transalloys boundary, and at all AQSRs.
  - Simulated annual average and maximum hourly SO_2 concentrations due to Scenario 1 and Scenario 2 emissions indicate concentrations below the SO_2 NAAQS at the Transalloys boundary, and at all AQSRs.
  - Finally, the annual average Mn concentrations due to Scenario 1 emissions are low and within WHO GV at AQSRs, however Mn concentrations due to Scenario 2 emissions exceed the WHO GV off-site by a considerable margin, affecting AQSRs such as Clewer, and Kwa-Guqa. However, findings of the human health risk assessment based on the simulated manganese concentrations indicates that potential health impact associated with exposure to manganese contributed by the Transalloys facility for both scenarios are not significant, and risk of health effects will be minimal or negligible (van Niekerk & Fourie, 2017).
  - The direct contribution of the proposed Sinter Plant to simulated ground level impacts due to cumulative Transalloys emissions ranged between 3.0% and 7.6%. This indicates that the impact of proposed Sinter Plant will be minimal or negligible.

7.2 RECOMMENDATIONS

It is the specialist opinion that the proposed amendment may be authorised provided recommended air quality management measures are implemented to ensure the lowest possible impact on nearby AQSRs and the environment. The following mitigation, management and monitoring recommendations are suggested. These recommendations are principally offered for the existing operation (where applicable) and for the proposed Sinter Plant addition.

7.2.1 FURNACE BUILDING FUGITIVES

Furnace building fugitives were estimated to contribute notably to fine particulate matter (Mn inclusive) emissions. Its contribution to simulated ground level concentrations is also notable and is therefore currently considered the most significant source of PM, PM_{10}, $PM_{2.5}$ and Mn. There are however significant uncertainties in estimating furnace building fugitive emissions and emission factors which have been discussed in the emissions section. To address the uncertainty, a detailed furnace building fugitive emission measurement campaign should be conducted to confirm emissions from all existing furnace operations (Akinshipe & Bird, 2019).

Furnace building fugitives require individual engineering measures to be investigated for each source. It is recommended that such a program be undertaken at Transalloys. This may include process modifications and/or the installation of effective secondary suction hoods and cleaning technology to capture fumes not captured by the primary extraction circuit. The design for secondary suction hoods and cleaning technology for the proposed furnace addition (SAF 8 and 9) can be adopted and modified for the existing furnaces (Akinshipe & Bird, 2019).

7.2.2 CRUSHING AND SCREENING

Crushing and screening emissions were generally found to be the second or third most significant contributor to ambient pollutant concentrations. To reduce emissions from crushing and screening, enclosure, or the use of a telescopic chute with water sprays should be installed at the secondary screening plant and the jigging plant. Enclosure of crushing operations is very effective in reducing dust. The Australian NPI (NPI, 2011) indicates that a telescopic chute with water sprays would ensure 75% control efficiency and enclosure of storage piles where tipping occurs, would reduce the emissions by 99%.

7.2.3 STACK EMISSIONS

Table 42 summarises stack monitoring requirements for all point sources (scrubber stacks and baghouses). Transalloys currently conduct regular measurements as per AEL requirements on all outlets to keep the emissions inventory up to date and facilitate tracking of the efficiency of control measures and comparison with emission limits. These regular measurements should also be continued for future operations.

Table 42: Point source monitoring requirements

Point Source ID	Description	Listed Activity	Emission Monitoring Method Requirements	Sampling Frequency	Sampling Duration	Measured Parameters
P01	Open SAF 1 and 3, Bagfilter	4.9	Reporting Requirements under Section 21 of the NEMAQA (Act. 34 of 2004) state that an emission report for this source (Subcategory 4.9,4.6 and 4.5) is required annually. Sampling methodology should be selected from Schedule A of the Act listing methods for sampling and analysis. This is already in place for existing operation and should be continued upon addition of Sinter Plant for PM (i.e., EPA method 5), SO_2 (EPA method 6), NO_x (EPA method 7) and Mn	Already in Place (To be continued Annually)	60 minutes to 8 hours	PM, NO_2, SO_2 and Mn
P02	Open SAF 5 and 6 Bagfilter	4.9				
P03	Semi-open SAF 7 Bagfilter	4.9				
P06	CLU Converter Unit Bagfilter	4.6				
SP1	Proposed Sinter Plant Bagfilter	4.5		Annually (Once operational)	60 minutes to 8 hours	PM, NO_2, SO_2 and Mn
SP2	Proposed Sinter Plant Wet scrubber	4.5				

7.2.4 VEHICLE ENTRAINED DUST FROM PAVED AND UNPAVED ROADS

It is standard practice at Transalloys to utilise water trucks and chemical suppressants (Dustek) on all roads on site. These measures can be improved to target dust control with an efficiency between 75% and 90% (Cecala, et al., 2012). To ensure minimum emissions from road surfaces for future operations, the following mitigation measures should be maintained at Transalloys:

- Continue the regular and efficient application of water/chemical at an application rate greater than 2 litre/m^2-hour;
- Avoiding spillages of dusty materials onto road surfaces by covering trucks and keeping trucks dust free;
- Frequent sweeping of paved road surfaces, e.g. PM$_{10}$ certified sweeper (to ensure that dust is not simply re-deposited elsewhere); and
- Traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds.

7.2.5 AMBIENT AIR QUALITY MONITORING

Dustfall and PM_{10} are already measured on-site and in Clewer. It is proposed that ambient monitoring of other pollutants such as SO_2 and NO_2 (passive sampling) and $PM_{2.5}$ (gravimetric sampling) be conducted until trends become apparent. Also, the Mn content of measured PM_{10} concentrations and dustfall rates should be determined for future reference.

8 COMPLIANCE AND ENFORCEMENT HISTORY

No final directives or compliance notices relating to air quality have been issued to Transalloys in the last five years.

9 ADDITIONAL INFORMATION

Additional information is not available.

10 FORMAL DECLARATIONS

The following declarations are included as annexures to this report:

- Annexure A: a declaration of accuracy of information by the applicant.
- Annexure B: a declaration of independence by the practitioner preparing the AIR.

11 REFERENCES

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12 ANNEXURE: FORMAL DECLARATIONS

12.1 ANNEXURE A: DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: Transalloys (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, ____ *[duly authorised],* declare that the information information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at ______________________ on this _____ day of _____________________

____

SIGNATURE

____

CAPACITY OF SIGNATORY

12.2 ANNEXURE B: DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: **Ola Akinshipe**

Name of Registration Body: **South African Council for Natural Scientific Professions**

Professional Registration No.: **120628**

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act.

I, Ola Akinshipe declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer, the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1) (g) of this Act.

Signed at Midrand on this 14th day of March 2021.

SIGNATURE

Lead Specialist

CAPACITY OF SIGNATORY

13 CV OF SPECIALIST

Curriculum Vitae

Ola Akinshipe (PhD., Pr.Sci.Nat.)

Years of Experience

~ 11 years

Tertiary Qualifications

University of Pretoria: **2017**

PhD Chemical Technology (Air Quality)

University of Pretoria: **2013**

MSc Environmental Technology

University of Pretoria: **2012**

BSc (Honours) Environmental Technology

Olabisi Onabanjo University: **2008**

BSc (Honours) Microbiology

Company

Mamadi and Company SA

Level 1 BBBEE Contributor

Position

Executive: Strategic and Natural Resource Services Division

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Johannesburg 2193

Professional Registration

SACNASP – Environmental Science (Pr.Sci.Nat.)

Career Summary

Ola is an experienced, air quality, dispersion modelling, greenhouse and climate change specialist with multidisciplinary background in environmental technology, air quality engineering and microbiology. He has a passion for research and consulting in air quality, environmental impacts, human health assessment. Ola obtained a PhD. degree in Chemical Technology (Air Quality), an MSc and a BSc Honours degree in Environmental

Technology from the Chemical Engineering Department at the University of Pretoria; and a BSc Honours degree in Microbiology.

Ola has worked on various projects in South Africa, Suriname, Mozambique, Zambia, Tanzania, Kenya, Namibia, Botswana, Nigeria, Ghana, Malawi and Congo DR. These projects cut across various Government Agencies and industries, including mining and ore handling, metal recovery, power generation, exploration, chemical/metallurgical, petroleum and petrochemical, construction, clay brick, transport, processing, waste management/recycling. He has also gained widespread experience in the application of various air quality, environmental and safety guidelines published by local and international organizations such as USEPA, World Bank, European Commission, IFC, WHO, SADC, SA DEA, Australia DoE, UK Environment Agency.

Cumulatively, Ola has acquired over 11 years' experience in environmental and air quality monitoring, air quality management, planning and pollution control; air quality impact assessment, atmospheric dispersion modelling; noise and odour modelling; greenhouse gas emissions inventory and climate change assessment; project management; quantification of emission factors; as well as lecturing and facilitation of meetings and research projects. He has also developed technical and specialist skills in various international atmospheric, noise and odour modelling packages including US EPA's (AERMOD, AERMET, CALPUFF), UK model (ADMS), GasSim (odour emissions), R/Open Air for advanced data analysis; CadnaA and CONCAWE noise models).

Key Areas of Experience/Expertise

Over 11 years cumulative experience and expertise in:

- Air quality monitoring and laboratory analysis (ambient and indoor): stack and ambient monitoring – gravimetric and photometric; including dustfall, PM (all size fractions); passive sampling (including NO_2, SO_2, NH_3, VOCs, H_2S etc.); composite soil sampling, road silt content; airborne sampling for trace elements using ICP–MS, sampling for volatile and non–volatile acids, asbestos, crystalline silica, radionuclides and radioactivity etc. **~**
- Climate Change Assessment and Greenhouse gas inventory – Quantification of greenhouse gas inventory, climate change modelling and assessment
- Atmospheric emission inventory development for various industries – mining, ore handling, metal recovery, chemical, petroleum, gas exploration and refinery, power generation, construction, waste disposal/recycling, clay bricks, transportation etc.
- Atmospheric dispersion modelling, micro and meso–meteorology and atmospheric chemistry **~ 50 Projects**
- Source (including stack, volume and area sources) and ambient monitoring, quantification and development of emission factors and energy metrics from industrial processes

- Air quality impact assessment, AQMP, scoping, baseline and EIA studies using relevant standards including the SA air quality act, the National Environmental Management Act, as well as other local and international standards
- SA Atmospheric Emissions License and Atmospheric Impact Report application and submission
- Noise impact assessment and noise monitoring projects
- Cancer, non–cancer and human health risk assessments; odour assessment, management and mitigation
- Project management, proposals and quotations submissions; project reporting and reviews
- Environmental and Air Quality courses lecture facilitation
- Peer reviewer for scientific Journals – Journal of Environmental Management; International Journal of Environmental Science & Technology; Environment, Development & Sustainability; Chemical Engineering & Technology, etc.

General Project Summary and Experience

Ongoing Projects:

- **Project:** Quantifying and modelling the impacts of Sasol Offset Intervention Programmes. **Client:** Sasol South Africa. **Location:** Secunda and Sasolburg, South Africa
- **Project:** Development of the National Asbestos Management Strategy for South Africa. **Client:** Department of Environment, Forestries and Fisheries. **Location:** South Africa
- **Project:** Atmospheric Dispersion Modelling for 8 Shell DSA terminals in South Africa. **Client: Shell DSA**
- **Project:** Development of inventory and Management Strategy for lead and cadmium in South Africa. **Client:** Department of Environment, Forestries and Fisheries. **Location:** South Africa
- **Project:** Air Quality Modelling and Impact Assessment for the Sekhukhune District Municipality in the Limpopo Province. **Client:** Sekhukhune DM. **Location:** Sekhukhune DM, South Africa.

Completed Projects: Dispersion Modelling, Emission Inventories, Air Quality Monitoring, Air Quality Impact Assessments (AQIA) & Impact Reports (AIR), Development and Implementation of Management Plans

Core Activities and Deliverables: – Collection and analysis of operational, meteorological and pollution data – Quantifying air emissions from operations (emission inventories) – Dispersion modelling to Simulate ground level concentration of impacts using dispersion models – Conducting a health assessment and significance of the impacts of the project on environment and humans – Assessing mitigation and control options – Recommending management and mitigation options for the project. A list of completed project is given below:

Mining and Ore Handling – AQIAs, AIRs, baseline studies and management plans have been completed for various coal, manganese, platinum, uranium, copper, cobalt, andalusite, niobium, graphite, iron, vanadium, titanium and phosphate mines. These include Vlakfontein Coal, Alexander Coal Mine (Mpumalanga), Delmas coal mine, Pumpi copper and cobalt mine (Congo DR), Vlakfontein coal mine, Mokala manganese project (North West), Panda Hill Niobium project (Tanzania), Rhino Andalusite project (Limpopo), Hattinspruit Railway siding (Newcastle) Syrah Graphite (Mozambique), Ancuabe Graphite (Mozambique), Vlakfontein North Block (Mpumalanga), Husab Uranium (Namibia), Etango Project (Namibia), Rossing Uranium (Namibia), PMG Paling and Bishop Mines (Northern Cape), Vlakfontein South Block (Mpumalanga), Northam Iron and Titanium Ore (Limpopo), Manungu Colliery, SouthPort Cement Plant and Limestone Quarry (Nigeria), Anglo America's Modikwa Platinum Mine, Zandheuvel Phosphate Mine (Western cape) etc.

Metal Recovery – AQIA and AIR has been completed for the Transalloys ferromanganese furnace (eMalahleni), Rhino Andalusite Project (Limpopo), Actom John Thompson Foundry, Cape Town, Silicon Smelters, Limpopo.

Petroleum/Chemical/Exploration Industry – AQIAs have been completed for Sasol's Petroleum Sharing Agreement and LPG Project (Mozambique; Inhassoro Early Oil Project (Mozambique); Sasol EIA Industrial Park (Mozambique); Sasol EIA Condensate Transport (Mozambique), Tetra4 Molopo Gas Project (Free State); Flexilube refinery plant (Gauteng), East London Plastic recycler (Eastern Cape) and Vanchem Vanadium Products (eMalahleni).

Noise Impact Assessment – Noise impact assessments and noise monitoring studies have been completed for Pumpi Copper and Cobalt Mine (Congo DR), Mokala Manganese Project (Hotazel), Panda Hill Niobium Project (Tanzania), Syrah Graphite and Ancuabe Graphite (Mozambique), Lonmin Platinum Noise Monitoring, SouthPort Cement Plant and Limestone Quarry, Ewekoro, Nigeria; Raumix Aggregates at Crushco, Willows, Rossway, Rosslyn Quarries (Gauteng).

Power Generation – AQIAs have been completed for: – KiPower Project, Delmas – Transalloys power station (eMalahleni) – Kuyasa power station (Delmas) – NamPower Paratus/Anixas Project, Namibia – Koffiefontein Solar Power Project, Free State.

Biogas Co–generation – AQIAs have been completed for: – Biogas Co–generation Plant Development at Fishwater Flats Wastewater Treatment Works, Port Elizabeth – EcoFarm Sugar Mill and Cogeneration Plant (Mozambique).

Urban Centers – Air Quality Monitoring, Modelling, Assessment, Management and Planning have been conducted for City of Johannesburg AQMP in 2016 – Leuwpoort Residential Area Development – Highlands Precinct Residential Area Development, Lethabong.

Waste Recovery and Management – AQIAs have been completed for: – East London Plastic Recycler Project – Meyerton Medical Waste Incinerator – Vissershok, Bellville and Coastal Park landfills (Western Cape) – Fishwater flats WWTW (PE) – Eskom's Ash disposal Project.

Clay Brick Industry and Construction Projects – AQIAs and research studies conducted in the clay brick industry include: – Koffiefontein Bricks EIA Project, Free State – Atmospheric Emission License Application for 25 clay brick factories in South Africa (2013) – Emission inventory tool' for Brickmaking Clamp Kilns (MSc research) – Quantification of atmospheric emissions from clamp kilns in the South African clay brick industry (PhD research: Stack emissions monitoring, emission inventory and emission factors calculation and emission parameter delineation; energy efficiency analysis and AQMP).

Several Environmental, Meteorology and Air Pollution Monitoring Projects – Ambient and stack monitoring projects have been undertaken in the following industries: clay brick, chemical, mining (coal, copper and cobalt, uranium etc.) These include: – Dustfall monitoring and management projects; – PM_{10} and $PM_{2.5}$ monitoring and reporting; – Asbestos sampling, crystalline silica, road silt content analysis and reporting; – Passive and soil sampling projects and meteorology monitoring projects.

Completed Projects: Climate Change Assessment, Greenhouse gas (carbon footprint) Quantification

Core Activities and Deliverables: – Collection and analysis of operational, meteorological and pollution data – Quantifying carbon / greenhouse gas emissions from operations – Simulating ground level concentration of impacts using dispersion models – Conducting a health assessment and significance of the impacts due to change in climate as result of the Project future scenarios – Assessing mitigation and control options – Recommending management and mitigation options for the project. A list of completed project is given below:

- Air Quality Specialist Report for the Proposed Saramacca Power Plant Project, Saramacca, Suriname. **Client:** Staatsolie, Suriname. **Location:** Suriname.
- Air Quality Specialist Report for the KiPower Project, Delmas. **Client:** Delmas Coal. **Location:** Delmas.
- Air Quality Specialist Report for the Alexander Underground Mine, Mpumalanga. Client: Anglo American. **Location**: Mpumalanga.
- Quantification of Greenhouse gas emissions at Husab Mine, Namibia. **Client:** Swakop Uranium. **Location:** Namibia

Quantification of Greenhouse gas emissions and air dispersion modelling at Tetra4 Molopo Gas Exploration Project. **Client:** Tetra4. **Location:** Welkom, Free State.

Peer–reviewed Scientific Articles / Publications / Conference Proceedings

- **Published Article:** Akinshipe, O and Kornelius, G (2018) Quantification of Atmospheric Emissions and Energy Metrics from Simulated Clamp Kiln Technology in the Clay Brick Industry. Environmental Pollution, 236: 580 – 590. DOI: 10.1016/j.envpol.2018.01.074.
- **Published Article:** Akinshipe, O and Kornelius, G (2017) The quantification of atmospheric emissions from complex configuration sources using reverse dispersion modelling. Int. J. Environ. Sci. Technol. 14 (11), 2367 – 2378. DOI: 10.1007/s13762–017–1316–0.
- **Published Article:** Akinshipe, O and Kornelius, G (2017) Chemical and Thermodynamic Processes in Clay Brick Firing Technologies and Associated Atmospheric Emissions Metrics – A Review. J Pollut Eff Cont 5:190. doi: 10.4176/2375–4397.1000190.
- **Conference Presentation:** National Association for Clean Air Conference, Sandton, South Africa 2017: Alternative Energy Use for Clamp Kilns – Propane Gas Firing to Reduce Emissions.
- **Conference Presentation:** National Association for Clean Air Conference, Nelspruit, South Africa 2016: Provisional Findings of Atmospheric emissions in the South African clay brick industry.
- **Conference Presentation:** National Association for Clean Air – Clean Air Conference, Bloemfontein, South Africa 2015: Atmospheric emissions in the clay brick industry; conference proceedings.
- **Conference Presentation:** IUAPPA – World Clean Air Congress, Cape Town, South Africa 2013: The Development of an 'emission inventory tool' for Brickmaking Clamp Kilns; conference proceedings.

Courses Lectured / Facilitated

Essential Air Quality Course for Professionals in Environmental positions

– Introduction to Air Pollutants and their Characteristics – Impacts of Air Pollutants on Receiving Environments – National Environmental Management: Air Quality Act and its Implementation – Air Pollution and Climate Change

2011 to 2013: Lecturing/Teaching Assistant – Departments of Chemical Engineering and Chemistry (UP)

Fourth year students – Environmental Management (Water, Waste and Air Quality Management)
First year students – General Chemistry, Physical Chemistry, Inorganic Chemistry

Professional Affiliations

- South African Council for Natural Scientific Professions – Pr.Nat.Sci. (Environmental Science)
- National Association for Clean Air, South Africa (NACA) – Member