AIR QUALITY
CONSULTING NZ

Technical Report

National Green Steel Limited

Proposed Green Steel Mill

Air Quality Assessment

Prepared for National Green Steel Limited

airqualityconsulting.co.nz

May 2025

Document Title: **National Green Steel – Assessment of Air Quality Effects**

Document Version: **Final**

Client: **National Green Steel Limited**

Project Number: **11146**

Date of issue: **21 May 2025**

Prepared by:

Jonathan Harland
Senior Air Quality Consultant

Reviewed and Authored by:

Peter Stacey
Managing Director

File Name: R001 National Steel - Air Quality Assessment - (Updated Draft)

Air Quality Consulting NZ Limited
9A Cajero Place, Green Bay
Auckland
New Zealand
Telephone: +64 21 614 842
Email: peter@airqualityconsulting.co.nz

Table of Contents

AIR QUALITY CONSULTING NZ

Appendices

Tables

Figures

Glossary of Abbreviations

AEE	Assessment of Environmental Effects
AQCNZ	Air Quality Consulting NZ Limited
AQNES	National Environmental Standards for Air Quality
ASU	Air Separation Unit
AWS	Automatic Weather Station
CCM	Continuous Casting Machine
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon dioxide
E	East
EAF	Electric Arc Furnace
FTAA	Fast Track Approvals Act
FTP	Fume Treatment Plant
GPG	Good Practice Guide
GPG ID	Good Practice Guide for Assessing Discharges to Air from Industry
GPG ADM	Good Practice Guide for Atmospheric Dispersion Modelling
GPG Dust	Good Practice Guide for Assessing and Managing Dust
H_2S	Hydrogen sulphide
kg/hr	Mass Flow Rate: kilograms per hour
km	Unit of distance: kilometre
km/h	Unit of speed: kilometre per hour
kW	Unit of Power: kilowatt
LFG	Landfill Gas
LPG	Liquefied Petroleum Gas
MfE	Ministry for the Environment
N	North
NES GHG	National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat Regulations 2023
N_2O	Nitrous Oxide
mg/Nm^3	Concentration standardised to normal conditions
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NZAAQG	New Zealand Ambient Air Quality Guidelines
OEHHA REL	California Office of Environmental Health Hazard Assessment Reference Exposure Limits
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 μm
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 μm
US EPA	United States Environmental Protection Agency
US EPA RfC	United States Environmental Protection Agency Inhalation Reference Concentrations
RAQT	Regional Air Quality Targets
RMA	Resource Management Act 1991

S	South
SO_2	Sulphur dioxide
TCEQ ESL	Texas Commission on Environment Quality Effects Screening Levels
tpa	Tonnes per annum
TSP	Total Suspended Particulate
TWA	Time Weighted Average
W	West
WES	Workplace Exposure Standard
WHO	World Health Organisation
WHO AQG	World Health Organisation air quality guideline (WHO AQG) Global Update 2005
WRC	Waikato Regional Council
$\mu g/m^3$	Unit of Concentration: micrograms per cubic metre
UTM	Universal Transverse Mercator
%	Percentage
m	Unit of distance: metre
m/s	Unit of speed: metre per second
m^3/s	Unit of flow: cubic metre per second

1 Introduction

National Green Steel Limited (**Green Steel**) is proposing to build and operate a 200,000 tonne per annum (**tpa**) Green Steel Mill at 61 Hampton Downs Road, Hampton Downs, Waikato (the **Site**). The Green Steel Mill will recycle scrap steel through a series of processing steps, starting with shredding to break down the material for easier handling and processing. The shredded steel will be melted in an Electric Arc Furnace (**EAF**), an efficient technology that uses high-temperature electric arcs to create molten steel. Once melted, the steel will be refined and shaped into various finished products, such as beams, channels, angles, and bars, which are commonly used in construction and manufacturing. This process aims to reduce waste and lower environmental impact compared to traditional steelmaking.

Green Steel has engaged Air Quality Consulting NZ Limited (**AQCNZ**) to undertake an assessment of the potential air quality effects associated with discharges from the proposed Green Steel Mill to support a resource consent application under the Fast-Track Approvals Bill for an air discharge consent.

This report should be read in conjunction with the Assessment of Environmental Effects (**AEE**) Report and resource consent application prepared by Kinetic Environmental Consulting Limited.

2 Assessment Approach

This report assesses the air quality effects associated with discharges to air from the operation of the proposed Green Steel Mill. Operational emissions have been assessed using atmospheric dispersion modelling to predict off-site concentrations of air pollutants. The modelling results have then been compared with appropriate health-effects-based assessment criteria to determine the potential for effects.

Fugitive dust discharges from the construction have been assessed using the FIDOL assessment method, whereby factors that influence dust emissions, such as **F**requency, **I**ntensity, **D**uration, **O**ffensiveness and **L**ocation, are each considered qualitatively.

This assessment has been undertaken in accordance with the Fifth Schedule of the Fast Track Approvals Act 2024 (**FTAA**), which specifies matters that should be considered in an assessment of the effects on the environment.

This assessment has also been undertaken in accordance with the following Ministry for the Environment (**MfE**) Good Practice Guides (**GPG**):

- Good Practice Guide for Assessing Discharges to Air from Industry[1] (**GPG ID**); and
- Good Practice Guide for Atmospheric Dispersion Modelling[2] (**GPG ADM**); and
- Good Practice Guide for Assessing and Managing Dust[3] (**GPG Dust**).

This assessment is set out as follows:

Section 3 Site Location

Section 4 Existing Environment

Section 5 Description of Activity

Section 6 Discharges to Air

Section 7 Assessment Criteria

Section 8 Background Air Quality

Section 9 Atmospheric Dispersion Modelling Methodology

Section 10 Assessment of Environmental Effects

Section 11 Conclusion

Section 12 Limitations

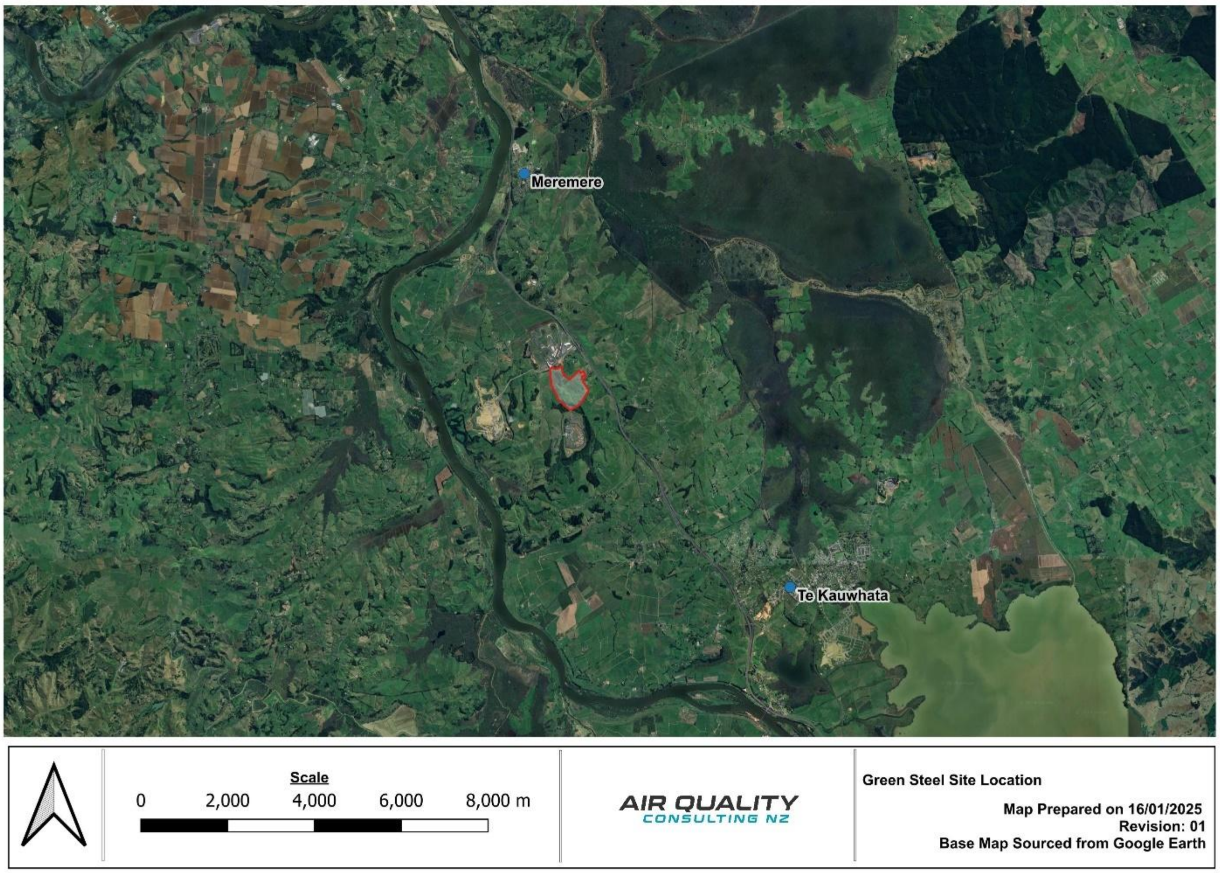
[1] Ministry for the Environment, Good Practice Guide for Assessing Discharges to Air from Industry, 2016
[2] Ministry for the Environment, Good Practice Guide for Atmospheric Dispersion Modelling, 2004
[3] Ministry for the Environment, Good Practice Guide for Assessing and Managing Dust, 2016

3 Site Location

The proposed location of the Green Steel Mill is 61 Hampton Downs Road, Hampton Downs, and is approximately 5 km southwest of Meremere and 8 km northwest of Te Kauwhata. The coordinates for the centre of the Site are approximately Universal Transverse Mercator (**UTM**) 329,615 m E, 5,863,143 m N, south.

The location of the proposed Site property boundary is shown as a red polygon in Figure 1.

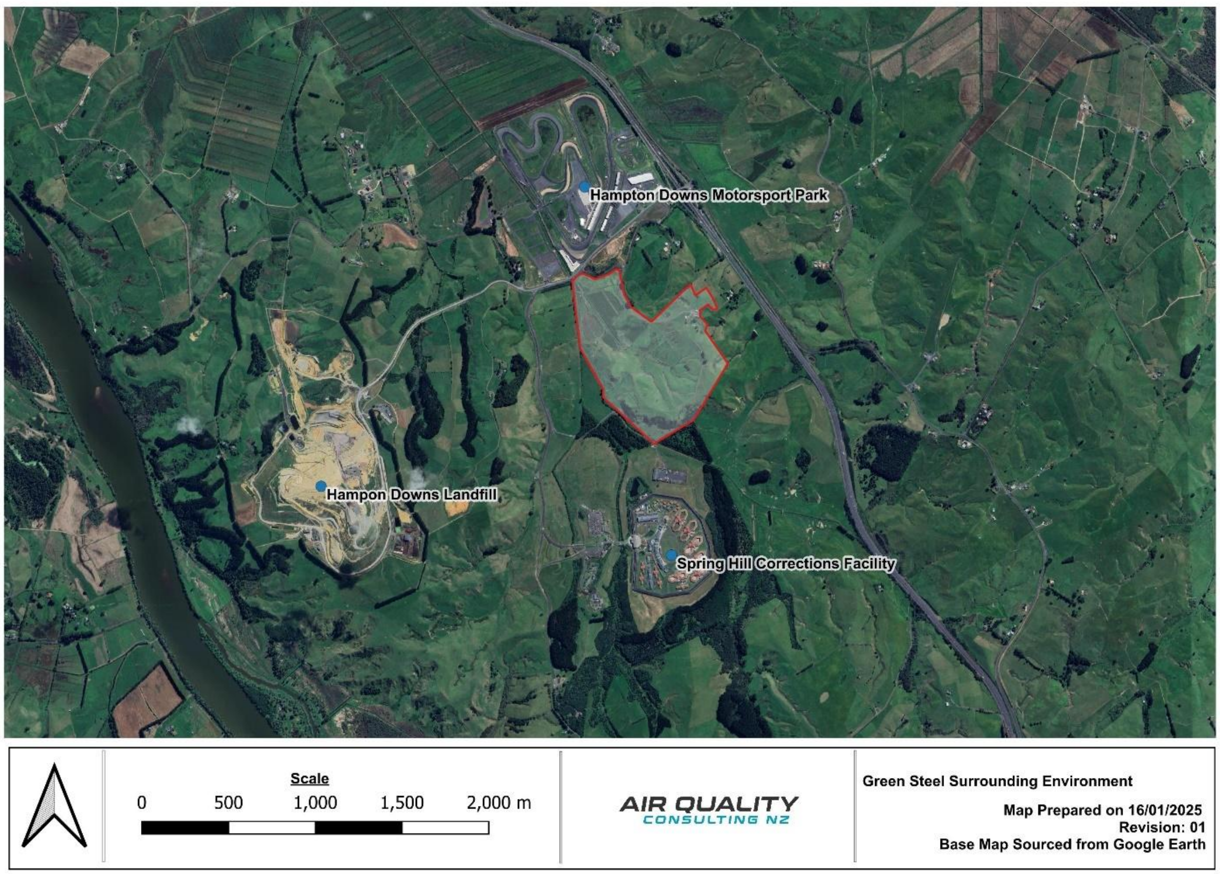
Figure 1: Site location



4 Existing Environment

Under both the operative and proposed Waikato District Plans the proposed site and the surrounding land is zoned Rural (Waikato) and General Rural, respectively. While the surrounding land is predominantly used for livestock grazing there is also notably the Hampton Downs Motorsport Park to the north of the site, Spring Hill Corrections Facility to the south and Hampton Downs Landfill to the southwest. The nearest dwelling is approximately 110 m to the east of the site boundary. Figure 2 shows the environment surrounding the Site.

Figure 2: Map showing the Site and its surrounding environment



4.1 Sensitive receptors

A sensitive receptor is defined as a location where people or surroundings may be susceptible to the effects of air pollution. These locations include:

- residential dwellings;
- retirement villages;
- food preparation and packaging
- aged care facilities;
- hospitals;
- public recreation areas;
- schools;
- early childhood education centres;
- marae;
- other cultural facilities;
- and sensitive ecosystems.

AQCNZ has identified the location of these sensitive receptors and has incorporated them into the modelling assessment as discrete receptors.

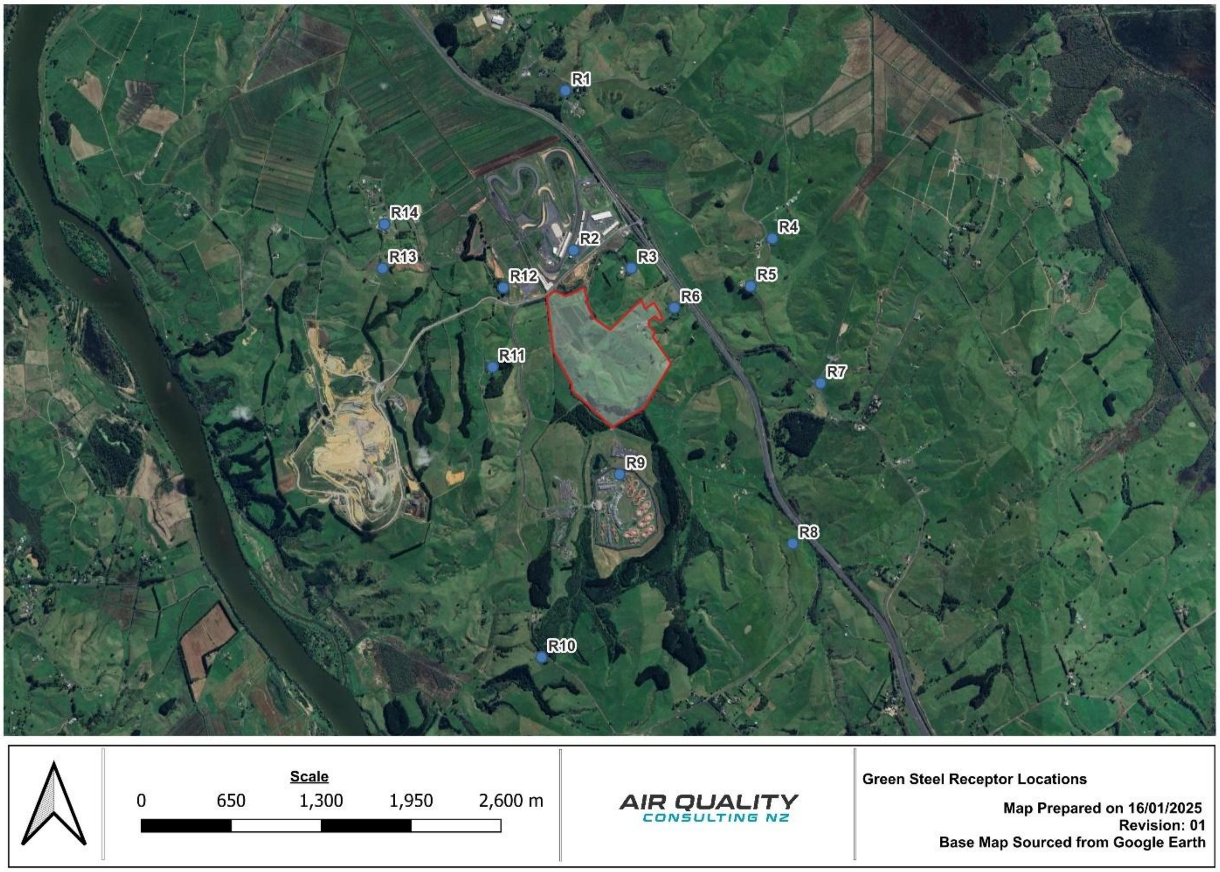
Table 1 presents the sensitive (discrete) receptors that AQCNZ has selected to assist in assessing the potential effects of the operation of the proposed Green Steel Mill. AQCNZ has not included all nearby dwelling locations as discrete receptors for practical purposes. Instead, these locations have been visually identified in the model with the maximum predicted off-site concentrations presented to ensure that the potential effects at all these locations are assessed. Likewise industrial and commercial activities such as Hampton Downs Landfill have not been included in this assessment as specific sensitive receptors, acknowledging that people are present at these sites, effects at these locations are covered when assessing maximum off-site concentrations against the relevant assessment criteria.

The locations of the selected sensitive receptors are also presented graphically in Figure 3. The nearest residential receptor is approximately 110 m east of the site boundary. The nearest marae, school or childcare facility is at least 7.5 km from the Site.

Table 1: Sensitive Receptor Locations

Receptor ID	Receptor Location (UTM)		Receptor Name	Receptor Type	Distance from Main Stack	
	Easting (m)	Northing (m)			Distance (m)	Direction
R1	329,716	5,864,990	29 Foster Road	Dwelling	1,950	NNW
R2	329,774	5,863,835	Hampton Downs Motorsport Park	Recreational	800	NNW
R3	330,193	5,863,706	23 Hampton Downs	Dwelling	590	N
R4	331,212	5,863,921	96 Springhill Road	Dwelling	1,280	NE
R5	331,054	5,863,576	63 Springhill Road	Dwelling	980	ENE
R6	330,503	5,863,420	61B Hampton Downs Road	Dwelling	430	NE
R7	331,560	5,862,874	354 Whangamarino Road	Dwelling	1,380	E
R8	331,359	5,861,714	254 Hall Road	Dwelling	1,810	SE
R9	330,107	5,862,215	Spring Hill Corrections Facility	Correctional Facility	890	S
R10	329,543	5,860,893	403 Hall Road	Dwelling	2,300	SSW
R11	329,189	5,862,991	135 Hampton Downs Road	Dwelling	1,000	W
R12	329,267	5,863,566	136 Hampton Downs Road	Dwelling	1,000	WNW
R13	328,393	5,863,705	238 Hampton Downs Road	Dwelling	1,890	WNW
R14	328,406	5,864,023	21 Graham McRae Place	Dwelling	1,990	WNW

Figure 3: Map showing the Site and nearby receptors



4.2 Airshed

In 2005, regional councils and unitary authorities across New Zealand identified specific areas where air quality, particularly PM_{10} levels, could potentially exceed the limits set by the National Environmental Standards for Air Quality (**AQNES**). These areas were classified as airsheds to provide a framework for managing air pollution. Regional councils are responsible for monitoring air quality within these airsheds and implementing measures to ensure pollutant levels remain within NES AQ limits.

The Waikato Region has 21 designated airsheds. Of these, 20 are classified as urban airsheds, while the remaining one, known as the "rest of region" airshed, includes all areas not covered by the urban airsheds. The proposed Green Steel site is situated within the rest of region airshed. This airshed is not considered to be polluted due to the absence of significant sources of air emissions capable of exceeding the AQNES thresholds. The nearest urban airsheds to the proposed site are Tuakau, which is approximately 13 km to the northwest, and Huntly, around 20 km to the southeast.

As the proposed site is not located in or near a polluted airshed, the requirements of Regulation 17 of the AQNES do not apply to this application.

4.3 Local Meteorology

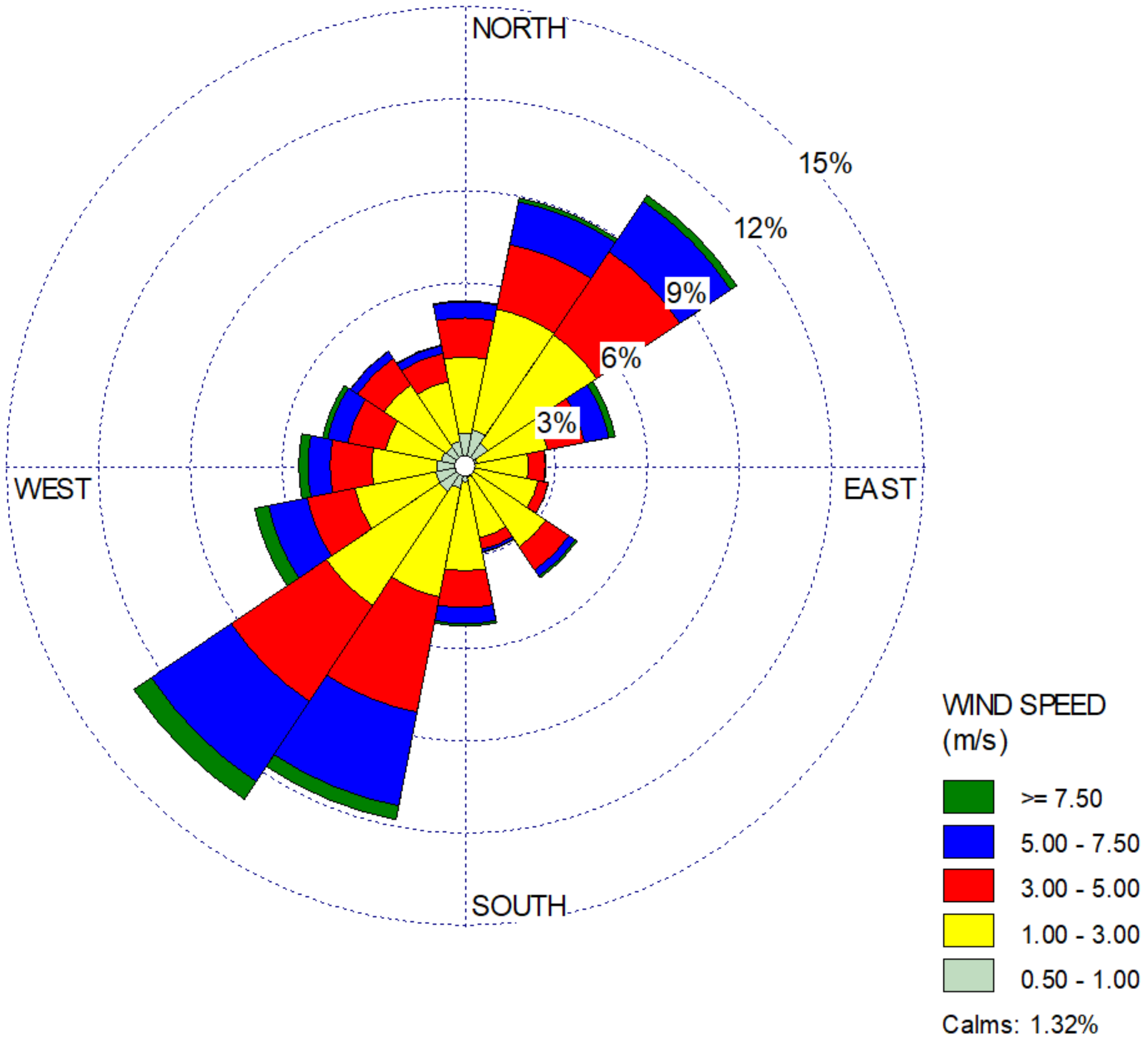
Wind plays a crucial role in the transport and dispersion of air pollutants. The nearest publicly available meteorological data for this site is from Patumahoe, located approximately 25 km northwest. However, due to the significant distance and differences in terrain, it was determined that this data would not accurately reflect the local meteorological conditions at the proposed site.

Therefore, AQCNZ obtained data from Enviro NZ who operate an on-site Automatic Weather Station (**AWS**) at Hampton Downs Landfill that measures wind speed and direction at a height of 10 m. As the AWS is situated approximately 1.2 km west of the proposed Green Steel site, AQCNZ considers it a suitable source for representing the local meteorological conditions at the site.

The windrose from the Hampton Downs Landfill application, covering the period from 1 January 2021 to 31 December 2023, is reproduced in Figure 4 to represent the expected conditions at the proposed Green Steel site.

The prevailing winds measured by the station come from the southwest and northwest, consistent with typical wind patterns in the Auckland and North Waikato regions. The station measures a range of wind speeds, with the average wind speed for this site being 3 m/s. Calm conditions (winds < 0.5 m/s) occur 1.3% of the time during this period.

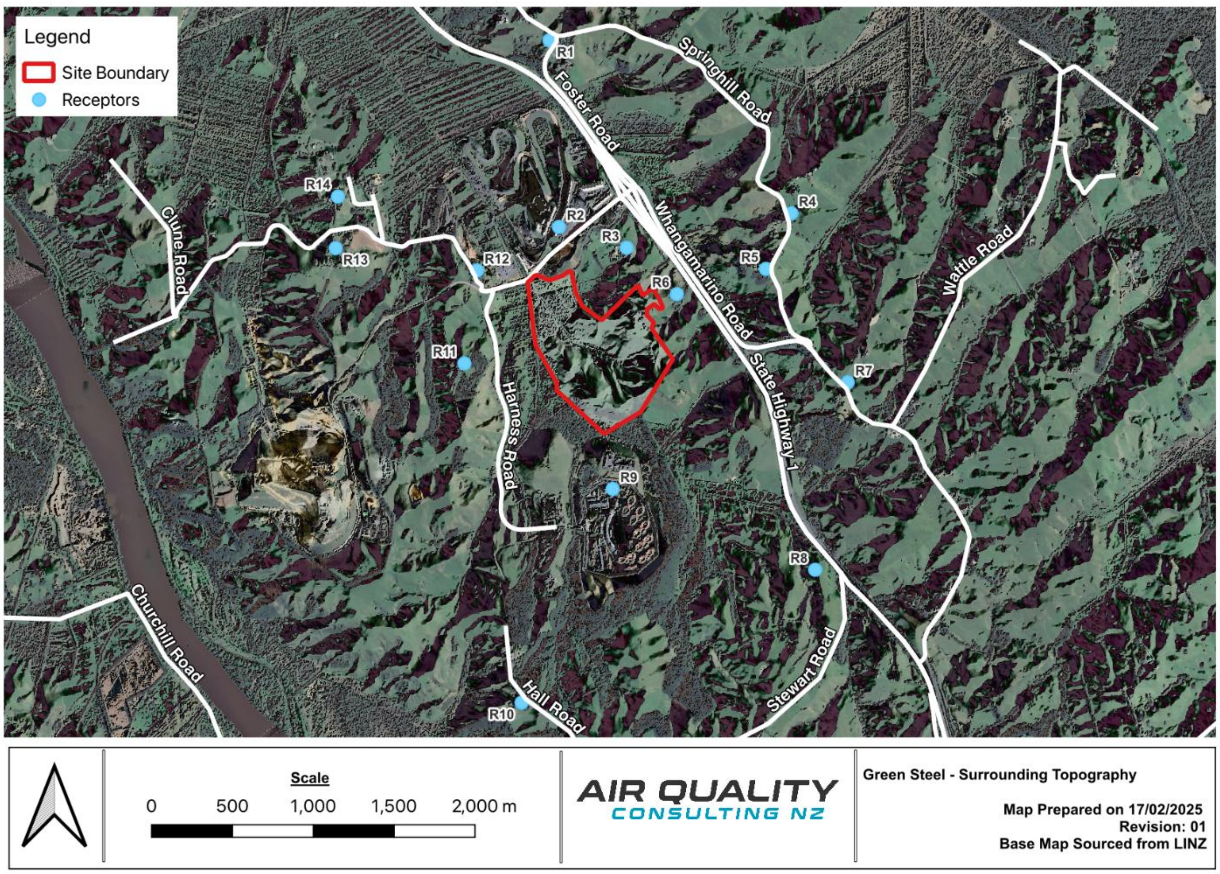
Figure 4: Hampton Downs Landfill AWS wind data presented as a windrose (1 January 2021 and 31 December 2023)



4.4 Topography

On a local level, the terrain surrounding the site can significantly impact the meteorological conditions, particularly wind speed and direction. The proposed site and much of the surrounding Hampton Downs area are primarily characterised by a mix of rolling landforms, with the terrain flattening to the north. To the west, the terrain rises to a maximum height of 85 m above sea level, dominated by man-made features from the landfilling operations, before descending towards the Waikato River. To the south, the terrain also rises to similar elevations as to the west. To the east, the terrain consists of low-lying hills, elevated to around 45 m above sea level, which places the site within a low valley.

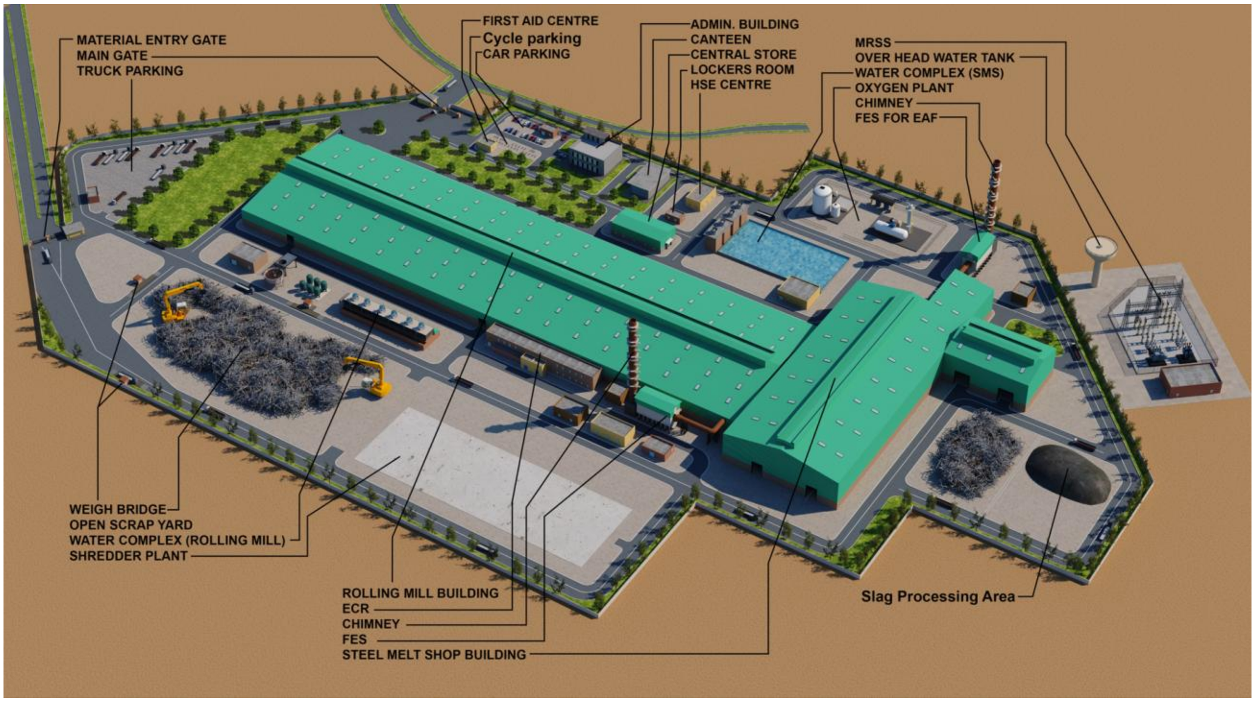
Figure 5: Surrounding Topography



5 Description of Activities

This section provides a summary description of the proposed activities. The general layout of the Green Steel Mill is illustrated in Figure 6.

Figure 6: General layout of the proposed Green Steel Mill



5.1 Scrap Steel Processing

Green Steel proposes to process scrap steel on-site for use as raw material in the Green Steel Mill. While the exact process has yet to be finalised, it is expected to be similar to operations at Green Steel's Wiri site, where scrap car bodies are primarily processed by shredding them into smaller pieces, which are then separated into ferrous and non-ferrous fractions. The scrap processing facility is anticipated to incorporate the following process: a pre-shredder and shear, main shredder, conveyors, sorting units, and air treatment systems.

5.1.1 Pre-shredding

It is likely a pre-shredder will be used to reduce raw materials into intermediate-sized pieces before they are fed into the main shredder. This will operate at a low speed of approximately 6 RPM, the pre-shredder generates no emissions of dust, floc, or metals. Its design also significantly reduces the risk of explosions in the main shredding system. In the very unlikely event of an ignition caused by the contents of a gas cylinder or fuel tank, the open environment of the pre-shredding process minimises the likelihood of explosive ignition.

In addition to the pre-shredder, larger material may require shearing. The shearer is a very simple low speed guillotine that creates minimal dust and no other discharge to air and is only used to cut large solid metal items into smaller pieces that are suitable for further size reduction in the main shredder.

5.1.2 Main Shredder

Material from the pre-shredder and shearer will be conveyed directly into the main shredder, which will consist of counter-rotating drums fitted with fixed hammers or cogs. The shredded material is then transferred to a Zig-Zag Separator, where lighter non-metallic materials (floc) are separated and collected in a cyclone separator. Floc will be stored outdoors in a stockpile and removed daily for disposal at a monofill elsewhere on the site. Heavier metallic materials will be processed through a rotary magnetic separator, which separates ferrous and non-ferrous components. The ferrous material will be stockpiled on-site to be used in the Green Steel Mill whereas the non-ferrous metals will be baled and taken off-site for sale.

5.2 Green Steel Mill

The facility is a steel production plant that includes a Steel Melt Shop, Rolling Mill, and an Oxygen Plant, all designed to incorporate advanced technologies for efficiency and emissions control.

5.2.1 Steel Melt Shop

The proposed Steel Melt Shop will contain a 30-ton Electric Arc Furnace (**EAF**) with eccentric bottom tapping and continuous scrap charging via a horizontal conveyor. Scrap is preheated using furnace off-gases in a closed-loop system, which reduces energy consumption. The Steel Melt Shop will also include a 30-ton Ladle Furnace, which refines and prepares liquid steel after it is melted in the EAF. The Ladle Furnace adjusts the steel's chemical composition through alloying, ensuring the desired properties such as strength and corrosion resistance, while also homogenising the temperature and composition for consistency. It removes impurities like sulphur through desulphurisation, improving the steel's quality and reliability. Additionally, the Ladle Furnace acts as a buffer between the EAF and the Continuous Casting Machine (**CCM**), ensuring a steady flow of liquid steel and flexible production scheduling.

Emissions from the Steel Melt Shop will be managed by a comprehensive Fume Treatment Plant (**FTP**) that captures primary and secondary emissions from the EAF, Ladle Furnace, and associated material handling systems. The FTP will use water-cooled ducts and dust storage silos before ultimately discharging via a baghouse, which will have a 55 m high stack.

5.2.2 Rolling Mill

Within the Rolling Mill building the Section-cum-Bar Mill will process hot billets from the melt shop into structural steel sections and bars. This operation includes equalising furnaces for maintaining billet temperature, reversible and continuous rolling mill stands for shaping billets, and cooling beds, cutting equipment, and tying machines for producing finished products. The reheating furnaces in this process will use landfill gas (**LFG**) from Hampton Downs Landfill or alternatively compressed natural gas (**CNG**) or liquefied petroleum gas (**LPG**) as fuel. Air emissions from this area primarily arise from combustion processes in the reheating furnace which will be discharged via a 56 m high stack.

6 Discharges to Air

This section of the report identifies the various discharges to air associated with the Site, the contaminants discharged and the rate at which they are discharged.

The key discharges from the proposed Green Steel Mill are as follows:

- **Scrap steel processing –** The process of shredding scrap steel will primarily result in the discharges of particulate matter (**PM_{10} and $PM_{2.5}$**).
- **Steel Melt Shop –** Air from the EAF, Ladle Furnace, and material handling systems are collected and pass through water-cooled ducts and dust storage silos before being discharged via a baghouse with a 55 m high stack - The primary emissions include: PM_{10} and $PM_{2.5}$, oxides of nitrogen (**NO_x**), sulphur dioxide (**SO_2**), and carbon monoxide (**CO**). Although this source has the potential to emit metals such as lead and zinc, these emissions are expected to be minimal. AQCNZ considers the PM_{10} and $PM_{2.5}$ guidelines sufficient to protect against health effects, provided off-site concentrations remain within these limits. While no further detailed assessment of metal emissions has been undertaken, further discussion on potential metal effects has been provided in Section 10.1.6..
- **Rolling Mill –** Discharges to air from within the Rolling Mill building are exclusively related to the Reheating Furnace which will combust gas (LFG, CNG or LPG) to heat the billets so they can be formed into structural steel sections and bars. The primary discharges from this source will be particulate matter (PM_{10} and $PM_{2.5}$), NO_X, CO and SO_2.
- **Oxygen Plant –** The Air Separation Unit (ASU) in the Oxygen Plant, which supplies oxygen, nitrogen, and argon for steelmaking. The ASU processes include air compression, purification, and cooling, with minor emissions limited to potential nitrogen venting and minimal leaks of inert gases.
- **Construction of the Green Steel Mill –** The construction of the Green Steel Mill will involve significant earthworks, which have the potential to generate air discharges, primarily in the form of nuisance dust.
- **Monofil operations –** The disposal of waste floc into the monofil has the potential to generate nuisance dust from the placement of waste floc and cover material.
- **Slag –** Slag from steel processing will be either processed into aggregate to be used elsewhere, otherwise any slag not used for this purpose will be disposed of to landfill.
- **Fugitive dust from internal site roads –** There is some potential for wheel driven dust site roads, however given they will be sealed these discharges will be minimal. Consequentially no further assessment of these discharges has been undertaken.

AQCNZ considers the primary discharges from the site to be from the Steel Melt Shop baghouse (serving the EAF, Ladle Furnace, and general material handling within the Steel Melt Shop building), the Reheating Furnace within the Rolling Mill, and the shredding of scrap steel. Emissions from the Oxygen Plant are deemed negligible, as any discharge consists primarily of minor amounts of inert gas, predominantly nitrogen. Similarly, while nuisance dust may arise from handling scrap steel, the material's density and distance from the site boundary makes off-site effects unlikely. Consequently, discharges from these minor sources (the Oxygen Plant and scrap metal handling) have not been considered further in this assessment.

6.1 Scrap Steel Processing

Particulate from the shredder will be extracted through a large duct system that will maintain negative pressure during operation. The air will be directed to the main cyclone, where larger particulates and floc will be separated and collected. A recirculation fan will loop air between the Zig-Zag separator and the cyclone, while the main extraction fan, mounted at the wet scrubber's exit, will determine the airflow from the shredder. A wet scrubber will process air from the cyclone, and cleaned air will be discharged via a 10m high stack.

Traditional baghouses will not be used due to explosion risks and the presence of oils and water, which could damage or render bags ineffective. Instead, the shredder will employ a wet spray suppression system with a proprietary wetting agent to ensure materials remain thoroughly wet, effectively minimising fugitive dust, including floc (foam, plastic, upholstery etc.).

It is anticipated that there will be three main stockpiles of material on-site associated with the handling of scrap steel: ferrous, non-ferrous, and floc. The ferrous and non-ferrous stockpiles are not expected to generate significant dust or particulate discharges. As previously mentioned, the floc and fine material collected from the cyclone will be wet, resulting in minimal potential for airborne emissions under normal conditions. Provided that the floc remains damp and stored in an appropriate bin or bunker until it is transported off-site for disposal, no significant discharge from this source is expected.

6.2 Steel Melt Shop Discharges

The primary discharges to air from the Steel Melt Shop operations include particulates (PM_{10} and $PM_{2.5}$), NO_x, and SO_2, due to high temperatures, material composition, and chemical reactions. Particulate matter arises from the volatilisation and condensation of metals, entrainment of fine dust from raw materials, and ejection of particles during the melting and refining processes. Fine particulates, including metal oxides and carbon-based particles, can become airborne during the intense activity in the furnace. NO_x forms primarily through thermal mechanisms, where atmospheric nitrogen reacts with oxygen at the intense heat of the arc. SO_2 is produced through the oxidation of sulphur present in scrap steel, flux materials, or auxiliary fuels, with high furnace temperatures facilitating these reactions, particularly when sulphur-rich materials are used.

Emissions from the Steel Melt Shop will be managed through several control measures, including the FTP’s high-efficiency bag filters, water coolers and dust collection systems, which significantly reduce particulate and gaseous emissions. The proposed baghouse is rated for a maximum discharge concentration of 20 mg/m^3, with typical concentrations expected to be less than 5 mg/m^3. In addition to these emission controls, the stack has been designed, based on a series of atmospheric dispersion modelling studies, to discharge any remaining pollutants at a height of 55 metres. This ensures effective dispersion considering the surrounding terrain and minimises downwash from nearby buildings. Additionally, Green Steel will control emissions through strategies such as furnace temperature management, limiting sulphur content in raw materials, optimising oxygen injection, and implementing advanced control systems.

6.3 Rolling Mill

Discharges from the Rolling Mill are primarily related to the combustion emissions from the Reheating Furnace, mainly consisting of PM_{10} and $PM_{2.5}$, NO_x, and CO. Depending on the fuel used, particularly in the case of LFG, SO_2 may also be a significant component of the discharge.

NO_x comprises of both nitric oxide (**NO**) and nitrogen dioxide (**NO_2**), with discharges from combustion processes predominantly producing NO, which are slowly converted to NO_2 in the atmosphere. As the guideline for NO_x is based on NO_2, a percentage of NO_2 must be assumed. AQCNZ has followed the guidance outlined in the GPG ID for estimating NO_2 discharges, which is detailed further in Section 8.4. Combustion emissions will be discharged via a 56 m high stack designed with sufficient height and efflux velocity to adequately disperse the emissions.

6.3.1 Greenhouse Gas Emissions

Greenhouse gas (**GHG**) emissions, primarily carbon dioxide (**CO_2**), however, to a lesser extent methane (**CH_4**) and nitrous oxide (**N_2O**) will be produced as a result of burning either LFG or CNG in the Reheating Furnace. When released into the atmosphere, these gases contribute to the 'greenhouse effect,' leading to climate warming. However, the primary goal of the proposal is to produce Green Steel, which generates significantly lower GHG emissions compared to traditional steelmaking. In line with this objective, Green Steel is making a concerted effort to reduce GHG emissions wherever possible, which is why LFG is being considered as the primary fuel source for the Reheating Furnace. LFG, a waste product, when collected and combusted, has a lower potential for climate warming compared to its release directly from the landfill into the atmosphere as methane. As LFG is not a fossil fuel, it is exempt from the National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat (**NES GHG**)[4]. To provide Green Steel with the flexibility to include CNG and LPG in its fuel mix, an Emissions Plan has been prepared by Lumen Limited to meet NES GHG obligations in the event alternative fuels are used. While the exact fuel mix is currently unknown, the plan will ensure compliance with regulatory requirements.

6.4 Stack Discharge Parameters

The stack emission parameters used in the atmospheric dispersion model as part of this assessment are presented in Table 2.

Particulate emissions from the Steel Melt Shop have been estimated based on the manufacturer's specification for a maximum TSP emission concentration of 20 mg/Nm³. For PM_{10} and $PM_{2.5}$ emissions, US EPA AP-42, Chapter 12.5 considers that discharges of PM_{10} and $PM_{2.5}$ from an EAF with a baghouse would comprise of 76% and 74% of TSP, respectively. However, for conservatism, AQCNZ has assumed all PM_{10} and $PM_{2.5}$ are equal to TSP.

NO_x and SO_2 emissions from the Steel Melt Shop discharge have been provided by the plant designer. The other discharge parameters, such as stack dimensions, flow parameters and temperature, are based on information supplied by the manufacturer.

[4] Ministry for the Environment, Resource Management (National Environmental Standards for Greenhouse Gas Emissions from Industrial Process Heat), Regulations 2023

For combustion emissions from the Rolling Mill building, the Reheating Furnace may be fired using LFG, LPG, or CNG, with each fuel having a different emission profile. Emission rates for each fuel have been calculated using emission factors from the US EPA AP-42[5][6], except for SO_2 discharges from LFG combustion. SO_2 emissions have been estimated using a mass balance approach in accordance with AP-42 guidance, assuming that 100% of the sulphur in the LFG is converted to SO_2 during combustion.

In LFG, hydrogen sulphide (**H_2S**) is the primary source of sulphur, while other reduced sulphides are typically present at trace levels. These trace compounds are negligible compared to H_2S concentrations and are assumed to be zero. H_2S concentrations can vary significantly based on the type of waste accepted, with higher levels found in landfills that process large amounts of gypsum, industrial waste, and biosolids from municipal wastewater treatment plants. AQCNZ understands that the H_2S concentration at Hampton Downs is less than 500 ppm. Based on this, AQCNZ has assumed an H_2S concentration of 500 ppm for the gas to be used by Green Steel in the Rolling Mill.

Given the multiple fuel types that may be used, and to add conservatism to the assessment, the highest emission rate from the three fuel types has been used to represent a worst-case scenario.

Discharges from the processing of scrap steel via shredding are based on emission testing undertaken on National Steel Limited processing plant located in Wiri. It is expected that the proposed processing plant will be of the same size and nature of the plant operated in Wiri.

Overall, AQCNZ considers that the emission parameters adopted are conservative for the following reasons:

- When determining the emission rates the highest value has been used when one or more values exist.
- Whereas for parameters such as temperature and velocity, the lowest values have been adopted, which will result in poorer dispersion.
- NO_2 has been assumed to represent 20 percent of NO_x, whereas it is typically less than 10 percent.
- PM_{10} and $PM_{2.5}$ has been assumed to be equal to TSP. As PM_{10} and $PM_{2.5}$ are a component of TSP the actual emissions of PM_{10} and $PM_{2.5}$ will be lower.
- It is assumed that the plant will operate continuously, 24/7. While the Green Steel Mill will largely run without interruption, there will be periods when the plant needs to shut down for maintenance or operate at reduced capacity. It is anticipated that the plant will operate for 320 days per year. Consequently, the predicted annual off-site concentrations are likely to be overestimated. Similarly, while scrap processing is unlikely to occur on a 24/7 basis, it has been modelled as such for the purposes of this assessment.

[5] United States Environmental Protection Agency Fifth Edition, Volume I Chapter 1: External Combustion Sources. 1.4 Natural Gas Combustion.
[6] United States Environmental Protection Agency Fifth Edition, Volume I Chapter 1: External Combustion Sources. 1.5 Liquified Petroleum Gas Combustion

Table 2: Stack Emission Parameters

Parameter	Steel Melt Shop Baghouse	Reheating Furnace	Shredder
Stack height (m)	55	56	10
Stack diameter (m)	3.6	1.5	0.7
Exhaust airflow m^3/s (Actual)	204.6	32.8	14.4
Discharge Velocity (m/s)	20.1	18.3	19.6
$PM_{10}/PM_{2.5}$ Emission Rate (kg/hr)	14.7	0.34	0.1
NO_x Emission Rate (kg/hr)[7]	6.3	2.9	-
CO Emission Rate (kg/hr)	-	1.6	-
SO_2 Emission Rate (kg/hr)	6.3	2.88	-

6.5 Construction and Monofil Emissions

6.5.1 Dust Emissions

Particulate matter (or dust) generated from construction activities and placement of waste floc generally falls into two categories: suspended and deposited particulate.

The term Total Suspended Particulate (TSP) is commonly used to describe the total amount of suspended particulate in the atmosphere at any one time. Individual particles typically become visible at approximately 50 µm, and particulate discharges in this size range (greater than 50 µm) are generally associated with nuisance effects rather than health effects. It is the fine suspended particulate, generally, less than 10 µm in diameter (PM_{10}) (a subset of TSP), which is associated with health effects as the particulate matter can penetrate deep into the lungs of humans and animals.

Nuisance dust effects often relate to dust clouds obscuring visibility and soiling of clean surfaces such as cars, washing and, buildings/windows, etc.

There is also the potential for nuisance dust to lead to the contamination of rainwater collection systems and increased dust deposition inside houses. These effects can lead to additional cleaning requirements, reduced ability to enjoy outdoor living areas and overall reduced amenity values.

Excessive dust emissions can also adversely affect plant life due to reduced photosynthesis, increased incidence of plant pests and disease, reduced effectiveness of pesticide sprays, and crop soiling effects.

Generally speaking, TSP does not travel further than 250 m from the source of dust during periods where the wind is less than 5 m/s.

Particulates with an aerodynamic diameter less than 10 µm (PM_{10}) have the ability to enter the alveoli in the lungs and cause respiratory health effects.

PM_{10} and $PM_{2.5}$ discharges are normally associated with combustion activities, such as vehicle emissions and domestic home heating, however these size fractions have also been found to be

[7] NO_2 was assumed to be 20 percent of NO_x.

associated with vehicle haul roads (through the grinding and pulverizing of material as vehicles travel along the roads). The Site will feature unsealed site roads during construction, however they will be appropriately maintained (through regular replacement of fresh aggregate); therefore, PM_{10} and $PM_{2.5}$ emissions from this source will be minimal. Additionally, given the nature of waste floc, the waste material from the shredding process, it is unlikely to contribute to PM_{10} and $PM_{2.5}$ emissions.

Overall, AQCNZ considers the potential for PM_{10} and $PM_{2.5}$ discharges from the Site to be very low to negligible, providing that the proposed mitigation measures are implemented.

The controls used to manage dust emissions will be developed by the contractor engaged to undertake the earthworks, however AQCNZ has provided a summary of the expected controls in Section 6.6.

6.6 Construction Dust Mitigation Measures

While the exact mitigation measures will be developed by the contractor awarded to undertake the earthworks, the following measures should be implemented at a minimum.

- Material that is placed in temporary stockpiles that will not be disturbed for more than three months will be vegetated or covered with hydroseed or mulch as soon as practicable;
- As much vegetation as possible will be retained;
- The height of spoil disposal/stockpile areas will be minimised;
- Stockpiles will be oriented to maximise wind sheltering as much as practicable;
- A water cart will be used on surfaces to supress dust during the construction phase of the project;
- Vehicle speeds will be restricted;
- Inactive stockpiles will be dampened if they are producing visible dust emissions;
- The number of exposed surfaces will be limited as much as possible;
- Placement of material that can generate dust will be restricted during extremely windy conditions;
- Clean aggregate will be used on selected sections of site roads to reduce the dust potential associated with vehicles moving over the soils that make up the base material;
- Finished areas where vegetation has been removed will be covered with hydroseed, mulch, or aggregate as soon as practicable;
- Sufficient water will be made available to fill the water cart. Noting that the water cart may require filling every 30 minutes (~30,000 L/hour) during dry conditions;
- The weather conditions will be reviewed at the beginning of the day, with suitable mitigation measures being made available during dry windy conditions;
- If visible dust is observed beyond the site boundary, the activity generating the dust will be identified and mitigation implemented. The activity will not be restarted until appropriate dust mitigation controls have been put in place and are identified as effective;
- Site haul roads are to be maintained through the regular replacement of clean aggregate material; and the condition of the haul road will be monitored daily through visual inspection.

6.7 Disposal of Waste Floc into the Monofil

The following mitigation measures will be adopted during the disposal of waste floc into the on-site monofils.

- Waste floc transported from the processing plant will be delivered to the monofil in a damp state to minimise dust emissions;
- Material placed in the monofil will be compacted immediately, reducing the potential for airborne dispersion;
- If necessary, additional water will be applied to the material within the monofil to prevent it from drying out;
- Additional mitigation measures, such as misting cannons and temporary screens, will be implemented as required to further control dust emissions;
- At the end of each day, waste floc will be covered with either soil or tarpaulins to prevent dust emissions overnight;
- If intermediate cover remains undisturbed for more than three months, or once final cover is placed, it will be vegetated or covered with hydroseed or mulch as soon as practicable.

7 Assessment Criteria

7.1 Regulatory Assessment

An assessment of the relevant objectives, policies and rules provided in the Regional and District Council plans are not included in this technical assessment. These requirements are assessed in the AEE.

7.2 Ambient Air Quality Health Standards/Guidelines

The GPG ID recommends an order of priority when determining the most appropriate assessment criteria to be used for air quality assessments. The documents below set out the minimum requirements that ambient air quality should meet to protect human health and the environment. This order of priority for the pollutants of concern is outlined by MfE as follows:

- Ministry for the Environment, Resource Management (National Environmental Standards for Air Quality) Regulations, 2004 (**AQNES**)[8];
- Ministry for the Environment, Ambient Air Quality Guidelines (2002 update) (**NZAAQG**)[9];
- Regional Air Quality Targets (**RAQT**); and,
- World Health Organisation Air Quality Guideline (**WHO AQG**) Global Update 2005[10].

If there are no New Zealand or WHO standards or guidelines, the GPG recommends that ambient air quality criteria from other jurisdictions are used. These are as follows, in order of priority:

- California Office of Environmental Health Hazard Assessment Reference Exposure Limits (OEHHA REL)[11];
- US Environmental Protection Agency's Inhalation Reference Concentrations (**US EPA RfC**)[12];
- Texas Effects Screening Levels (**TCEQ ESL**)[13]; and
- Workplace Exposure Standards Time Weighted Average (**WES-TWA**)[14].

In February 2020, the Ministry for the Environment (MfE) initiated a public consultation on proposed changes to the Ambient Air Quality National Environmental Standards (AQNES). These changes aimed to introduce new standards for ambient $PM_{2.5}$ concentrations, aligning them with the World Health Organization's (WHO) 2005 Air Quality Guideline values for both 24-hour and annual averages. Although these amendments have not yet been adopted, the anticipated $PM_{2.5}$ standards have been incorporated into this assessment.

AQCNZ has reviewed the available air quality standards and guidelines in the order specified by the GPG ID and summarised the applicable air quality assessment guidelines in this assessment

---

[8] Ministry for the Environment, Resource Management (National Environmental Standards for Air Quality), Regulations 2004
[9] Ministry for the Environment, Ambient Air Quality Guidelines (2002 update)
[10] WHO 2006. Air Quality Guidelines Global Update 2005, Particulate matter, ozone, nitrogen dioxide and sulphur dioxide. Copenhagen: WHO Regional Office for Europe. World Health Organisation Regional Office for Europe.
[11] California Office of Environmental Hazard Assessment http://www.oehha.ca.gov/air/allrels.html
[12] US EPA http://www.epa.gov
[13] https://www.tceq.texas.gov/toxicology/esl
[14] Worksafe New Zealand Workplace exposure standards and biological exposure indices, April 2022

in Table 3. These criteria have been used to assess the effects at any location at or beyond the site boundary and at sensitive receptors, as identified in Table 1.

Table 3: Ambient air quality guidelines relevant to the assessment

Pollutant	Averaging period	Air Quality Criteria ($\mu g/m^3$)	Sources
PM_{10}	24-hour	50	AQNES
	Annual	20	NZAAQG
$PM_{2.5}$	24-hour	25	WHO 2005
	Annual	10	WHO 2005
SO_2	1-hour	350	AQNES
	24-hour	120	NZAAQG
CO	1-hour	30,000	NZAAQG
	8-hour	10,000	AQNES
NO_2	1-hour	200	AQNES
	24-hour	100	NZAAQG

7.3 WHO 2021 Air Quality Guidelines

In September 2021, the World Health Organization (WHO) issued an update to its global air quality guidelines. This revision includes updated values for fine particulate matter (PM_{10} and $PM_{2.5}$), as well as sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). The new guidelines aim to provide recommendations for shaping air quality management policies. According to the guideline document, these recommendations "*are not legally binding standards; however, they do provide WHO Member States with an evidence informed tool that they can use to inform legislation and policy*."

As of now, the Ministry for the Environment (MfE) has not communicated a policy response in New Zealand regarding the WHO guidelines, which are not incorporated into either the Ambient Air Quality National Environmental Standards (AQNES) or the Ambient Air Quality Guidelines (AAQG). Consequently, the assessment of the effects of hazardous air pollutants has focused on the criteria outlined in Table 3. Nevertheless, the WHO 2021 guidelines are acknowledged in this assessment and discussed in relation to dispersion model predictions in Section 10. A summary of the WHO 2021 guidelines is provided below in Table 4.

.

Table 4: WHO 2021 air quality guidelines

Contaminant	Time average	Concentration (µg/m³)	Allowable annual exceedances
PM_{10}	24-hour	45	3-4
	Annual	15	-
$PM_{2.5}$	24-hour	15	3-4
	Annual	5	-
NO_2	Annual	10	-
	1 hour	200	3-4
SO_2	24-hour	40	3-4
CO	24 hours	4,000	3-4

7.4 Assessment Criteria for Dust

AQCNZ has used a qualitative approach, as recommended by the MfE GPG Dust to assess the potential for dust nuisance from earthworks during the construction phase of the project.

FIDOL Assessment Approach

The primary concern with dust is its ability to cause an effect that could be considered 'offensive' or 'objectionable'. Therefore, for the purposes of this assessment, the offensive or objectionable threshold is considered to be the assessment criteria for dust discharges.

To assess whether dust discharges have the potential to be offensive or objectionable, MfE GPG Dust recommends the FIDOL (frequency, intensity, duration, offensiveness, and location) assessment tool. The FIDOL factors concerning dust are summarised in Table 5.

Table 5: Dust FIDOL factors

FIDOL Factor	Description
Frequency	The frequency of dust discharges is how often an individual is exposed.
Intensity	Intensity relates to the concentration of dust impacts at receptor locations. Intensity is primarily characterised by the distance from the dust source, with dust intensity effects reducing with increasing distance.
Duration	The duration relates to the length of time that receptors are exposed to a potential dust event. Duration depends on wind conditions blowing dust from the Site to the receptor.
Offensiveness	Offensiveness relates to the nature of the dust being discharged.
Location	The sensitivity of locations in the receiving environment is characterised by land uses surrounding the Site.

8 Background Air Quality

The site and surrounding Hampton Downs area are located in a rural part of north Waikato, away from significant sources of air pollution such as major towns or cities and are therefore expected to have generally acceptable air quality. The primary sources of air pollutants near the proposed site include the Hampton Downs Landfill, approximately 1.2 km to the west; vehicles on the Waikato Expressway, about 500 m to the east; and activities at the Hampton Downs Motorsport Park. While the expressway and landfill may have some impact on air quality, the intermittent nature of motorsport activities makes it unlikely that they contribute significantly to emissions in the area. Minor activities such as backyard burning, home heating, and agricultural emissions may also cause localised effects on air quality. Background air quality concentrations for the Green Steel site can be determined through several methods, including:

- Regional Council Monitoring Data;
- Waka Kotahi Background Air Quality Dataset;
- Auckland Background Data[15]; and
- Proxy Method.

8.1 Regional Council Monitoring Data

While the site falls under the jurisdiction of the Waikato Regional Council (**WRC**), the nearest air quality monitoring station is located approximately 24 km away in the Auckland Region. Although this station is in a rural area, it is surrounded by significant horticultural activities, and the outskirts of Pukekohe are roughly 1 km away, making it unlikely to accurately represent background air quality for Hampton Downs.

Within Waikato, WRC operates several air quality monitoring stations, with the closest located in Hamilton, about 50 km from the site. However, this station is heavily influenced by urban discharges and is therefore not comparable to the conditions at Hampton Downs. Due to the lack of suitable nearby monitoring data, AQCNZ has chosen to use alternative sources of background data for this assessment, in line with the guidance provided in GPG ID.

8.2 Waka Kotahi Air Quality Data

The site is located within the Waerenga Census Area Unit of the Waka Kotahi dataset. The predicted particulate concentrations for each dataset were released in May 2022, and the predicted annual NO_2 concentrations were released in December 2020. The concentrations for these locations are provided in Table 6.

[15] Metcalfe, J., Wickham, L and Sridhar, S (2014). Use of background air quality data in resource consent applications. Prepared by Emission Impossible Ltd for Auckland Council. Auckland Council guideline document, GD2014/01

Table 6 Waka Kotahi Background Air Quality Data

Location	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		NO_2 (µg/m³)
	24-hour	Annual	24-hour	Annual	Annual
Waerenga	19.5	7.4	9.3	2.4	3

8.3 Auckland Council Background Air Quality Data

In 2014 AC published a guide for determining background concentrations of air pollutants, including carbon monoxide (CO) and sulphur dioxide (SO_2), which are not provided either by the Waka Kotahi dataset. While this data is based on monitoring data from Auckland, given that Auckland has a large population and that the dataset for CO is based on data from 1995 to 2013 and ambient CO concentrations have been declining for the past decade, CO background data from this period would provide a suitable conservative approach. Similarly, SO_2 concentrations have been declining in recent years. However, the Hampton Downs Landfill is a source of SO_2, which may result in background concentrations occasionally being higher than these levels. Further discussion on potential SO_2 concentrations is provided in Section 8.5.

Table 7: Auckland Council carbon monoxide and sulphur dioxide background concentrations

Pollutant	Averaging period	Value (µg/m³)
CO	1-hour	5,000
	8-hour	2,000
SO_2	1-hour	42
	24-hour	15

8.4 Proxy Method

The current recommended practice (as stated in the MfE GPG ID) to account for the atmospheric conversion of NO to NO_2 is to use either the Tier I screening method, or the Tier II proxy method, AQCNZ's preference is to adopt the Tier II proxy method to estimate cumulative NO_2 concentrations.

The proxy method assumes that nitric oxide is converted into nitrogen dioxide but that this process is limited by the availability of ozone as follows:

$$[NO_2] = [NO_X]mod \times F(NO_2) + [Proxy\ NO_2]$$

Where:

- $[Proxy\ NO_2]$ = combined nitrogen dioxide with ozone (as nitrogen dioxide equivalents) from a suitable background monitoring site.
- $[NOx]_{mod}$ = the nitrogen oxide concentration at the receptor estimated from the modelled nitrogen oxide emission
- $F(NO_2)$ = the mass fraction of nitrogen dioxide in the nitrogen oxides emissions from the source. F varies depending on the source.

The MfE GPG ID values of [Proxy NO_2] for non-roadside[16] sites are 95 µg/m^3 (1- hour average) and 75 µg/m^3 (24-hour average). AQCNZ has assumed that 20% of the NO_X emissions will comprise NO_2, i.e. $F(NO_2) = 0.2$.

8.5 Hampton Downs Landfill

Hampton Downs Landfill is anticipated to be a significant source of SO_2 in the surrounding area due to the high concentrations of H_2S in the LFG. When combusted in the on-site engines or flare, H_2S is converted to SO_2. To evaluate the potential off-site impacts, AQCNZ reviewed the landfill's recent air discharge application to WRC. The application assumes up to 16 engines operating simultaneously (currently there is only eight), a conservative estimate given that predicted gas production suggests only 14 engines are likely to be required.

Using the isopleths from the landfill's application, AQCNZ identified peak SO_2 contributions at sensitive locations downwind of the landfill and the proposed Green Steel site, summarised in Table 8.

If Green Steel uses LFG as fuel, SO_2 emissions from the Reheating Furnace would not contribute to cumulative effects, as the gas would already have been combusted at the landfill. Additionally, peak LFG generation is not expected until around 2052, meaning concentrations leading up to that time concentrations should be lower.

Table 8: Predicted maximum off-site concentration from Hampton Downs Landfill.

Pollutant	Averaging period	Value (µg/m^3)
SO_2	1-hour	100
	24-hour	20

[16] Non-roadside selected as the Site is not within 300m of a motorway or 150 m of an arterial road.

8.6 Summary

Based on the above, AQCNZ has adopted the highest background concentrations to provide a higher level of conservatism to this assessment. A summary of the background concentrations used for this assessment is presented in Table 9.

Table 9 Summary of background pollutant concentrations

Pollutant	Averaging period	Air Quality Criteria ($\mu g/m^3$)	Source
PM_{10}	24-hour	24.3	Patumahoe
	Annual	13.8	Patumahoe
$PM_{2.5}$	24-hour	10.9	Patumahoe
	Annual	5.3	Patumahoe
SO_2	1-hour	100	Hampton Downs Landfill
	24-hour	20	Hampton Downs Landfill
CO	1-hour	5,000	Auckland Council
	8-hour	2,000	Auckland Council
NO_2	1-hour	95	Proxy Method
	24-hour	75	Proxy Method
	Annual	3	Waka Kotahi

9 Atmospheric Dispersion Modelling Methodology

AQCNZ has undertaken meteorological modelling to provide representative data for inclusion in the atmospheric dispersion modelling assessment of air discharges.

This Section of the report presents the methodology used to model meteorological conditions at the Site

9.1 Modelling Methodology

A site representative, three-dimensional meteorological data set was developed using the CALMET (Version 7) diagnostic meteorological model. CALMET is a diagnostic meteorological model utilised to develop meteorological input files for the CALPUFF atmospheric dispersion model. The key model inputs include the following:

- One surface meteorological observation.
- Prognostic meteorological data was developed using The Air Pollution Model (TAPM) (v4) to provide upper air data.
- Land use and terrain data.

9.2 CALMET

CALMET (version 7) was used to resolve the wind field around the subject site to 200 meters spatial resolution. Upon completion of the broad-scale TAPM modelling runs, a CALMET simulation was set up to run for the model period, combining upper air data from TAPM with site-specific surface data.

CALMET was configured with settings selected in consideration of the guidance outlined in the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling (sic) Systems for Inclusion into the ‘Approved Methods for the modelling (sic) and Assessments of the Air Pollutants in NSW (NSW CALPUFF Guidance17). A summary of CALMET model settings is shown in Table 10. Appendix A presents examples of the CALPUFF input files.

Table 10: CALMET model settings

Parameter	Value
Modelled period	1 January 2021 – 31 December 2023
Mode	Hybrid (NOOBS = 1)
UTM zone	60
Domain origin (SW Corner)	Easting: 318.300 km Northing: 5852.000 km
Domain size	A 21 km by 21 km Cartesian grid was used at a resolution of 200 m.
Number of vertical levels	10
Vertical levels (m)	20, 40, 80, 160, 320, 640, 1200, 2000, 3000
CALMET settings for hybrid mode	TERRAD = 4.0 km RMAX1 = 12.0 km RMAX2 = 12.0 km RMIN = 0.1 km R1 = 12.0 km R2 = 12.0 km
Initial guess field	TAPM .m3d file used as an initial guess field for CALMET.
Surface data	Hampton Downs automated meteorological station NZTM 328,719 m E and 5,861,994m S
Land use data	New Zealand Land Cover Database (2018) v 5, produced by Landcare Research
Terrain data	Shuttle Radar Topography Mission (SRTM) 1 (Global ~30m) Version 3

9.3 TAPM-derived upper air data

TAPM (Version 4) is a prognostic model developed in Australia by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The TAPM prognostic model was run to obtain a coarse three-dimensional meteorological gridded dataset for the subject site for the selected model period. This dataset is based on synoptic observations, local terrain, and land use information with a resolution of 1,000 m. TAPM model parameters are summarised in Table 11.

Table 11: TAPM model parameters

Parameter	Value
Modelled period	1 January 2021 – 31 December 2023
Demain centre	UTM 60S: 329800 m E, 5863500m S Longitude: -37.0.35833º Latitude: 175.0750º
Number of vertical levels	25
Number of Easting grid points	25
Number of Northing grid points	25
Outer grid spacing	30,000 m x 30,000 m
Number of Grid Levels	Level 2 - 10,000 m Level 3 - 3,000 m Level 4 - 1,000 m

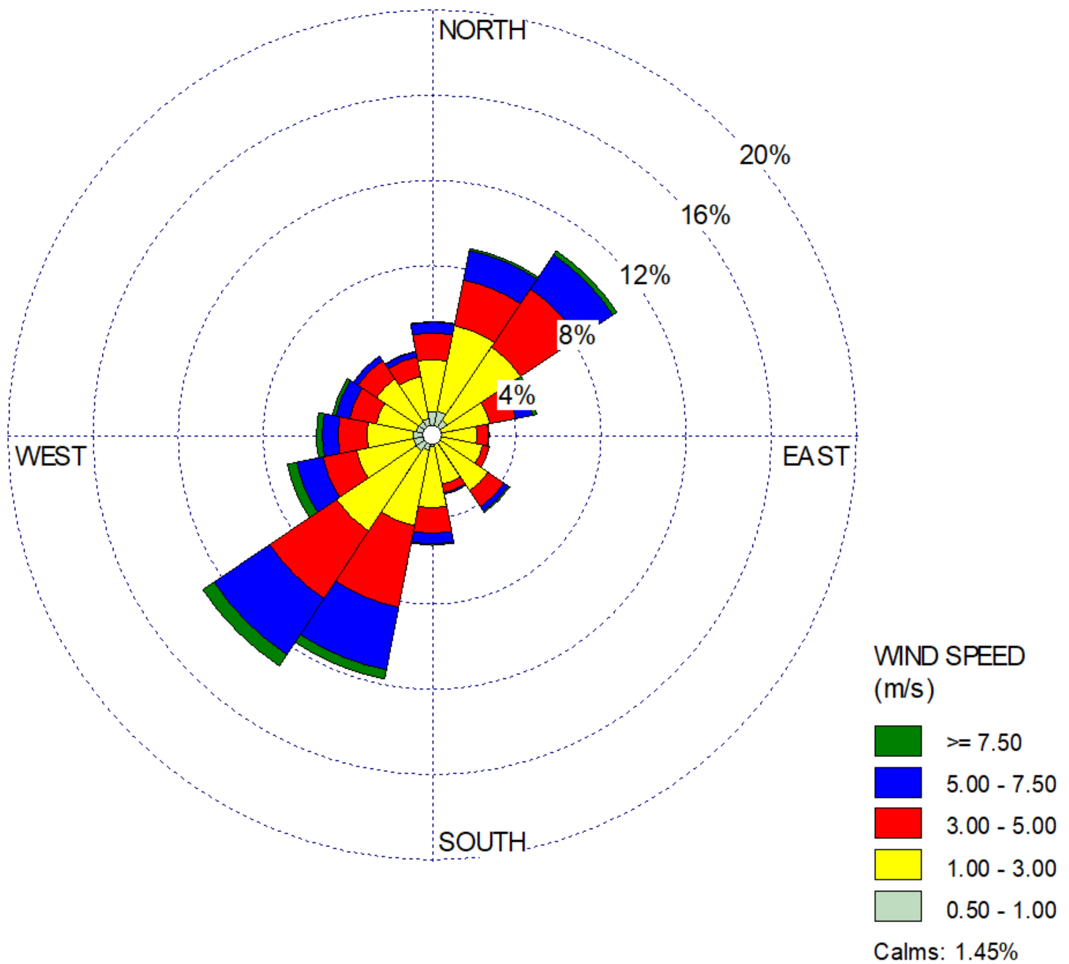
9.4 CALMET model outputs

9.4.1 Pattern of winds

A windrose extracted from the CALMET dataset at the Site's location is presented in Figure 7. The following is observed from the wind rose:

- The prevailing winds are predominantly from the southwest.
- The highest predicted wind speeds are from the southwest; however, these winds occur infrequently (~3.8%).
- Generally the windrose shows a good comparison in both wind directions and windspeeds when compared to Hampton Downs Landfill AWS observations.
- The Hampton Downs Landfill AWS observed slightly less calm conditions (1.3%) than those predicted by CALMET (1.45%) at the Site.

Figure 7: CALMET output windrose extracted for the site



9.4.2 Atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant, such as gas or particulate matter, to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill-Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories: stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and insolation (solar radiation) are used to define the stability category, as shown in Table 12. As these parameters vary from day to night, there is a corresponding variation in the occurrence of each stability category.

Table 12: Stability class description

Stability category	Wind speed range (m/s)	Stability characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of the day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud
D	≥6	Neutral atmospheric conditions. These occur during the day or night with stronger winds, during periods of total cloud cover or during the twilight period
E	3.4 – 5.4	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds
Notes: Data sourced from the Turner's Key to the P-G Stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am) E and F class stability classes are assumed to only occur at night, during Net Radiation Index categories of –2.		

Figure 8 shows the frequency of stability class for all hours of the model-generated data set. The following observations were made:

- Unstable atmospheres (classes A, B and C) occur approximately 37% of the time.
- Neutral atmosphere conditions (class D) occur approximately 30% of the time.
- Stable conditions (classes E and F) occur approximately 33% per cent of the time.

Stability class by hour of day for the site are presented in Figure 9. Nighttime hours are typically neutral (D class) to very stable (F class), while daytime hours are typically unstable to neutral (A, B, and C classes). The relatively high frequency of low mixing heights as presented in Figure 10, low wind speed conditions, and very stable conditions (especially at night) indicate the prevalence of temperature inversion conditions at the site (conditions where a warm layer of air traps cooler air at ground level). Temperature inversions can result in poor air dispersion.

Figure 8: Stability classes predicted by CALMET at the Site

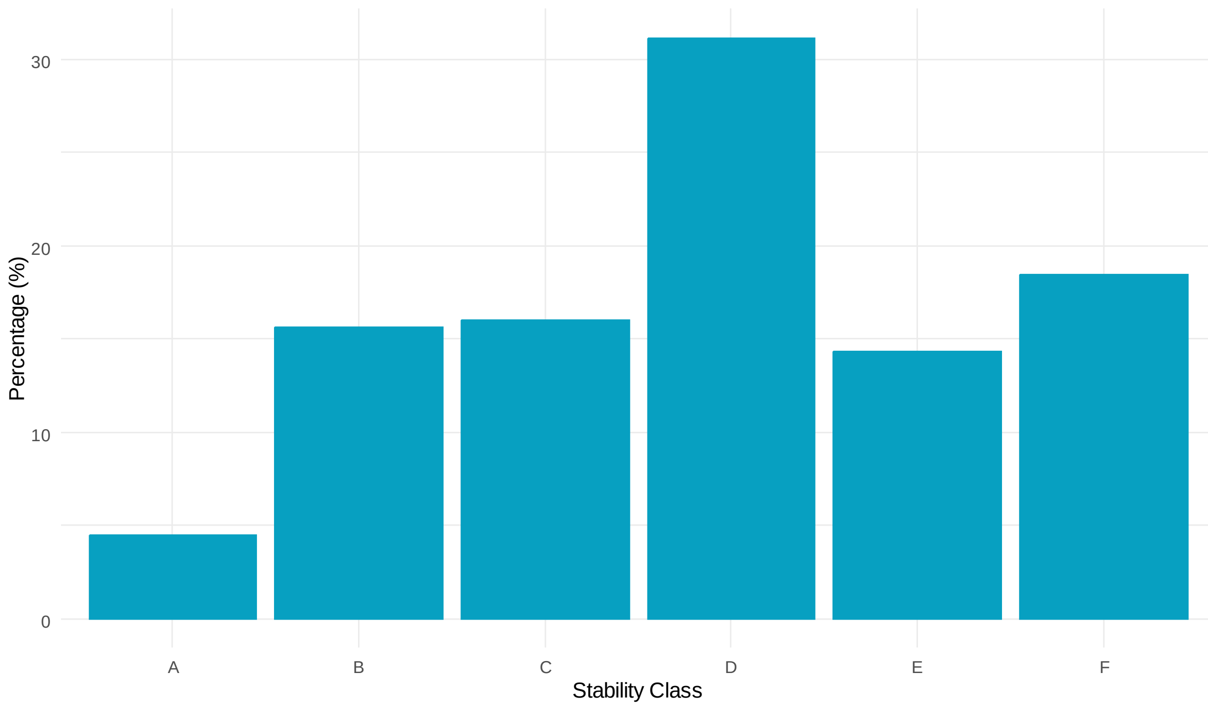
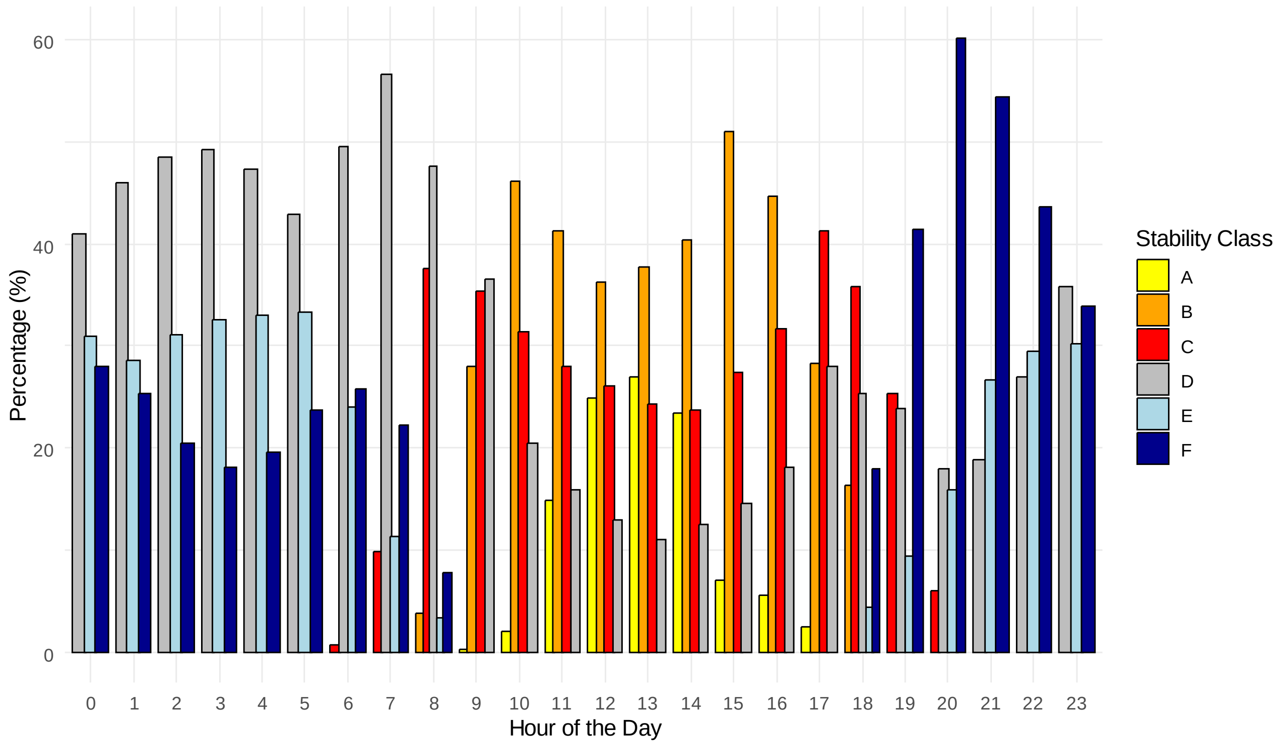


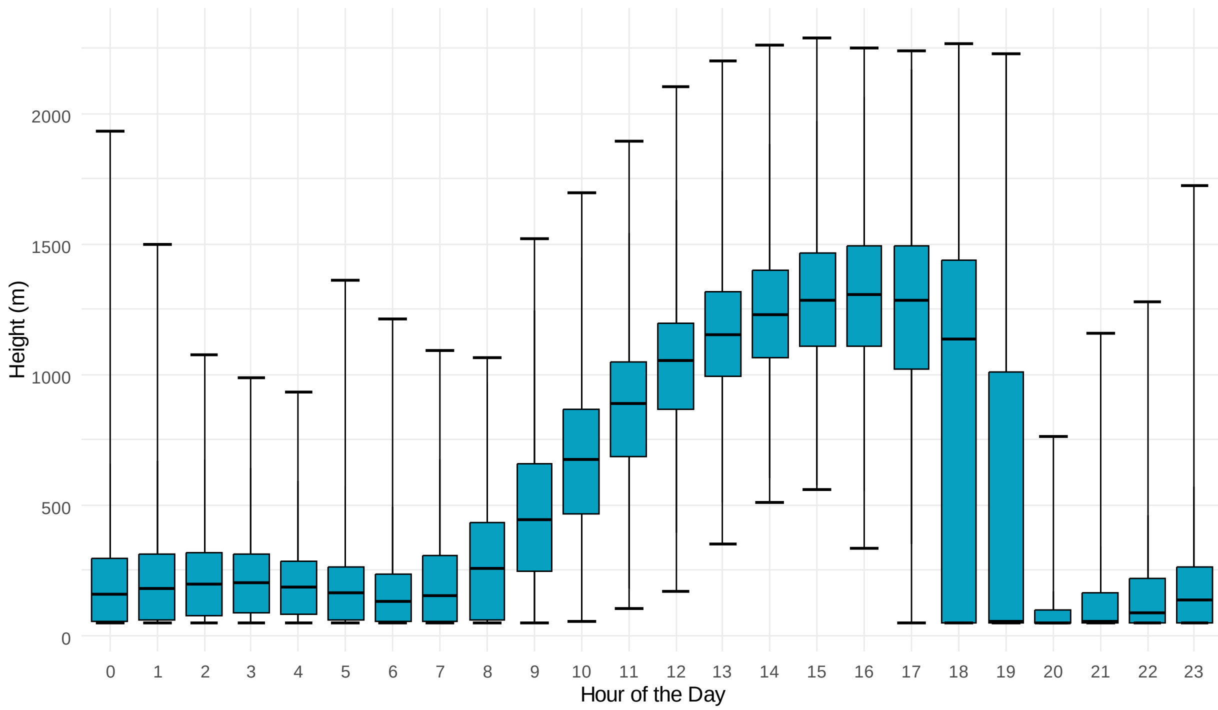
Figure 9: Stability class classification by hour of day at the project site



Mixing height signifies the height above the surface of the earth throughout which a pollutant can be dispersed. It is often associated with a sharp increase in temperature with height (inversion), and a sharp decrease in pollutant concentration (i.e., above the mixing height concentrations typically reduce).

A box plot of the mixing heights in the CALMET meteorological dataset developed at the Project site is shown in Figure 10. During the night and early morning hours, mixing heights are lower (minimum of around 50 m), increasing after sunrise to an average of around 1,200 m by the afternoon.

Figure 10: Mixing heights predicted by CALMET at the Site



9.5 Atmospheric dispersion modelling

The atmospheric dispersion modelling assessment was undertaken using CALPUFF Version 7, which has been used extensively in New Zealand and Australia and is a recommended model in the GPG ADM. The CALPUFF model has been configured in accordance with the guidance outlined in the MfE GPG ADM. Appendix A provides a summary of the CALPUFF model inputs.

Ground-level air concentrations were predicted over a nested 5 km grid (5 km at 200 m spacing, 1 km at 100 m spacings and 250 m at 50 m spacings).

10 Assessment of Environmental Effects

The maximum pollutant concentrations at offsite and receptor locations associated with the proposed Green Steel Mill point source discharges, including the background concentrations outlined in Section 8, are presented in the following subsections and are compared with the relevant assessment criteria outlined in Section 7.2.

10.1 Modelling Results

10.1.1 PM_{10}

Table 13 shows the highest off-site concentrations of PM_{10}, and Table 14 shows the highest concentrations at discrete receptor locations. In addition, a graphical presentation of the maximum 24-hour average PM_{10} ground-level concentrations from the Site is presented in Figure 11.

The modelling results show that the maximum off-site PM_{10} concentration is below the assessment criteria for both the 24-hour and annual averages at all sensitive receptor locations.

Given the predicted model results are below the relevant health-based assessment criteria, AQCNZ considers there is limited potential for PM_{10} emissions to cause adverse effects.

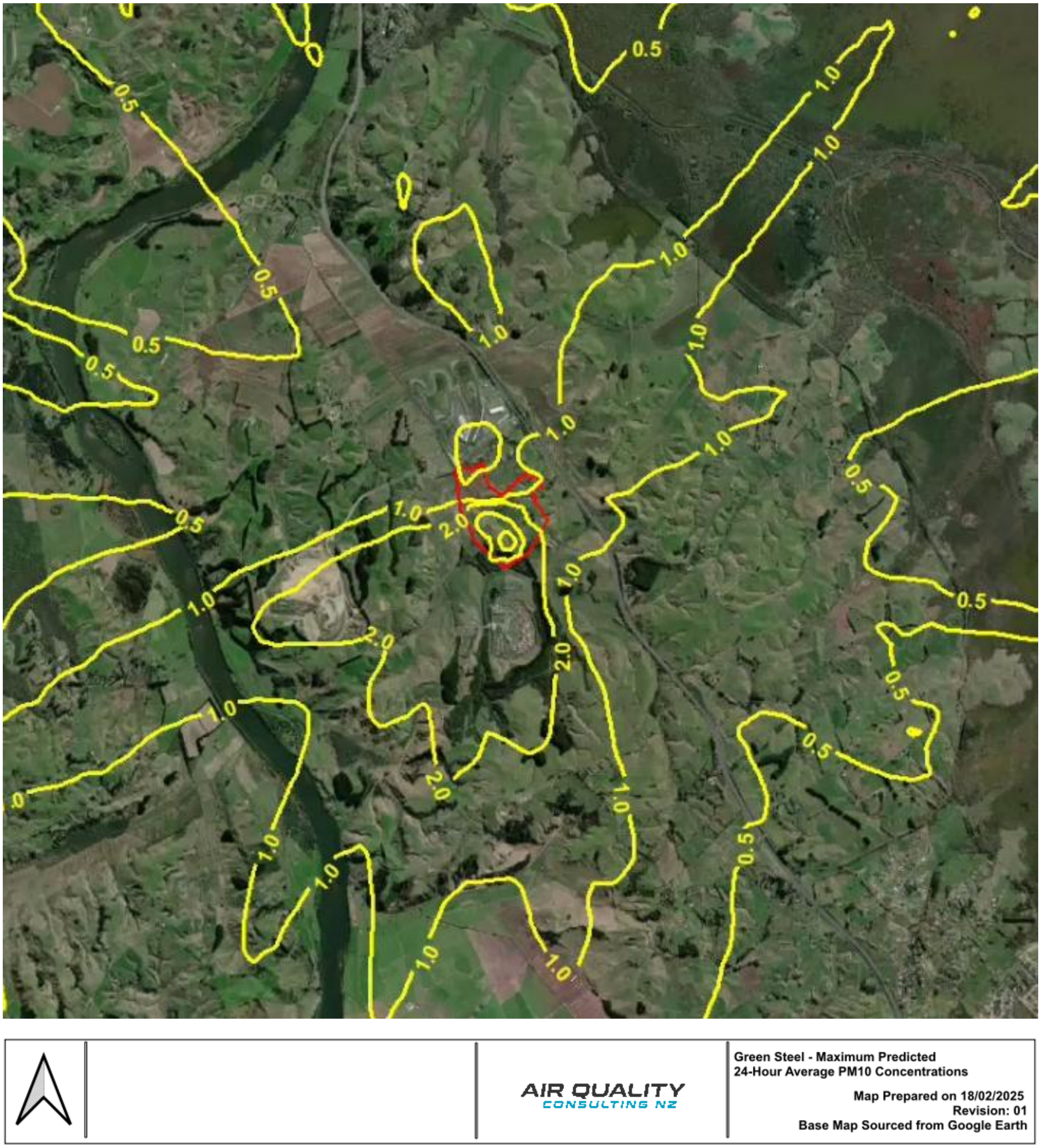
Table 13: Predicted Peak Off-site Ground Level PM_{10} Concentrations

Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m³)	Site + Background Concentration (µg/m³)	Assessment Criteria (µg/m³)
PM_{10}	24-hour	5.9	25.4	50
	Annual	0.2	7.6	20

Table 14: Predicted ground-level PM_{10} Concentrations at Discrete Receptors

Receptor Number	Type	24-hour average PM_{10} concentration (µg/m³)		Annual average PM_{10} concentration (µg/m³)	
		The Site	Site + Background	The Site	Site + Background
R1	Dwelling	1.0	20.5	0.04	7.4
R2	Recreational	1.1	20.6	0.04	7.4
R3	Dwelling	0.8	20.3	0.05	7.5
R4	Dwelling	1.5	21.0	0.12	7.5
R5	Dwelling	1.3	20.8	0.13	7.5
R6	Dwelling	1.1	20.6	0.11	7.5
R7	Dwelling	0.8	20.3	0.09	7.5
R8	Dwelling	0.7	20.2	0.05	7.4
R9	Correctional Facility	2.8	22.3	0.11	7.5
R10	Dwelling	2.8	22.3	0.08	7.5
R11	Dwelling	1.1	20.6	0.07	7.5
R12	Dwelling	0.8	20.3	0.04	7.4
R13	Dwelling	0.7	20.2	0.04	7.4
R14	Dwelling	0.7	20.2	0.03	7.4
Assessment Criteria		**50**		**20**	

Figure 11 Isopleth of the predicted maximum 24-hour average PM_{10} concentrations



10.1.2 $PM_{2.5}$

Table 15 shows the highest off-site concentrations of $PM_{2.5}$, and Table 16 shows the highest concentrations at discrete receptor locations. The modelling results show that the maximum off-site $PM_{2.5}$ concentration is below the assessment criteria for both the 24-hour and annual averages at all offsite locations, including sensitive receptors.

No contour plots have been generated for these results, as AQCNZ has assumed PM_{10} and $PM_{2.5}$ to be the same value, and therefore, the contour plot would be the same as Figure 11.

Given the predicted model results are below the relevant health-based assessment criteria, AQCNZ considers there is limited potential for $PM_{2.5}$ emissions to cause adverse effects.

Table 15 Predicted Peak Off-site Ground Level $PM_{2.5}$ Concentrations

Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m³)	Site + Background Concentration (µg/m³)	Assessment Criteria (µg/m³)
$PM_{2.5}$	24-hour	5.9	15.2	25
	Annual	0.2	2.6	10

Table 16: Predicted ground level $PM_{2.5}$ Concentrations at Discrete Receptors

Receptor Number	Type	24-hour average $PM_{2.5}$ concentration (µg/m³)		Annual average $PM_{2.5}$ concentration (µg/m³)	
		The Site	Site + Background	The Site	Site + Background
R1	Dwelling	1.0	10.3	0.04	2.4
R2	Recreational	1.1	10.4	0.04	2.4
R3	Dwelling	0.8	10.1	0.05	2.5
R4	Dwelling	1.5	10.8	0.12	2.5
R5	Dwelling	1.3	10.6	0.13	2.5
R6	Dwelling	1.1	10.4	0.11	2.5
R7	Dwelling	0.8	10.1	0.09	2.5
R8	Dwelling	0.7	10.0	0.05	2.4
R9	Correctional Facility	2.8	12.1	0.11	2.5
R10	Dwelling	2.8	12.1	0.08	2.5
R11	Dwelling	1.1	10.4	0.07	2.5
R12	Dwelling	0.8	10.1	0.04	2.4
R13	Dwelling	0.7	10.0	0.04	2.4
R14	Dwelling	0.7	10.0	0.03	2.4
Assessment Criteria		**25**		**10**	

10.1.3 NO_2

Table 17 shows the highest off-site concentrations of NO_2, and Table 18 shows the highest concentrations at discrete receptor locations. In addition, a graphical presentation of the 99.9th percentile 1-hour average NO_2 ground-level concentrations from the Site is presented in Figure 12.

The modelling results show that the maximum off-site NO_2 concentration is below the assessment criteria for both the 1-hour and 24-hour averages. The maximum off-site annual average NO_2 concentration, including background, was 3.1[17] µg/m³, which is below the assessment criteria of 40 µg/m³.

Given the predicted model results are below the relevant health-based assessment criteria, AQCNZ considers there is limited potential for NO_2 emissions to cause adverse effects.

Table 17: Predicted Peak Off-site Ground Level NO_2 Concentrations

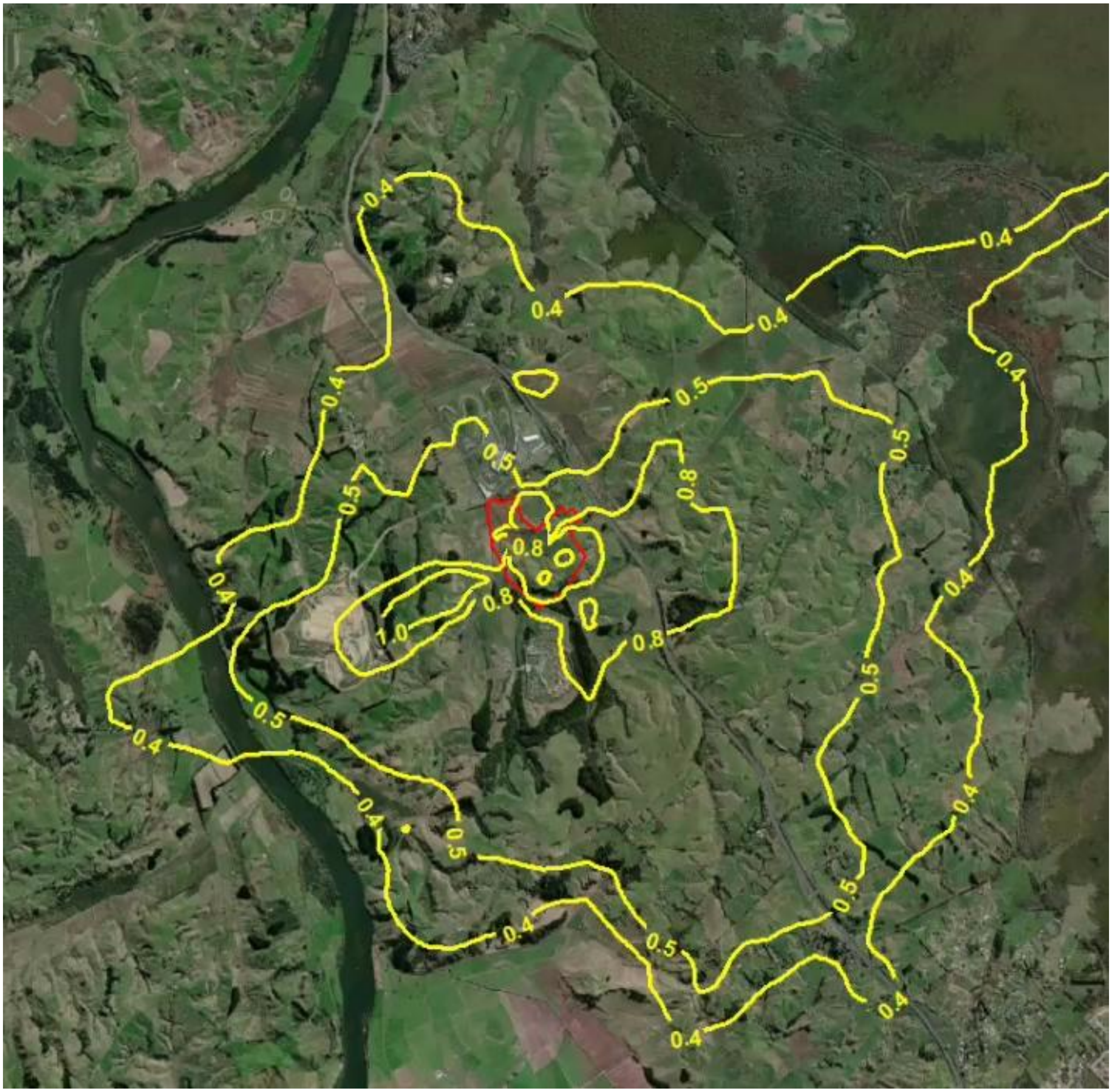
Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m³)	Site + Background Concentration (µg/m³)	Assessment Criteria (µg/m³)
NO_2	1-hour (99.9 %ile)	7.2 (NO_X)	96.4	200
	24-hour	5.7 (NO_X)	76.1	100

Table 18: Predicted ground-level NO_2 Concentrations at Discrete Receptors

Receptor Number	Type	99.9 %ile 1-hour average concentration (µg/m³)		24-hour average concentration (µg/m³)	
		NO_x from The Site	NO_2 Site + Background	NO_x from The Site	NO_2 Site + Background
R1	Dwelling	2.2	95.4	1.0	75.2
R2	Recreational	2.3	95.5	0.8	75.2
R3	Dwelling	2.5	95.5	1.0	75.2
R4	Dwelling	4.5	95.9	2.1	75.4
R5	Dwelling	4.2	95.8	2.4	75.5
R6	Dwelling	4.2	95.8	2.2	75.4
R7	Dwelling	4.6	95.9	2.1	75.4
R8	Dwelling	3.5	95.7	1.2	75.2
R9	Correctional Facility	3.2	95.6	1.8	75.4
R10	Dwelling	3.0	95.6	2.3	75.5
R11	Dwelling	3.3	95.7	1.9	75.4
R12	Dwelling	3.1	95.6	1.1	75.2
R13	Dwelling	2.8	95.6	1.6	75.3
R14	Dwelling	2.3	95.5	0.9	75.2
Assessment Criteria		**200**		**100**	

[17] Site contribution of NO_2 assumed to be 20 percent of the predicted annual average NO_X concentration.

Figure 12 Isopleth of the predicted 99.9 %ile1-hour average NO_2 concentrations



10.1.4 CO

Table 19 shows the highest off-site concentrations of CO, and Table 20 shows the highest concentrations at discrete receptor locations. The modelling results show that the maximum off-site CO concentration is below the assessment criteria for both the 1-hour and 24-hour averages.

No contour plots have been generated for these results, as the predicted concentrations are well below the relevant assessment criteria.

Given the predicted model results are below the relevant health-based assessment criteria, AQCNZ considers there is limited potential for CO emissions to cause adverse effects.

Table 19: Predicted Peak Off-site Ground Level CO Concentrations

Pollutant	Averaging Period	Predicted Concentrations (µg/m³)	Site + Background Concentration (µg/m³)	Assessment Criteria (µg/m³)
CO	1-hour	6.5	7,007	30,000
	8-hour	3.1	2,003	10,000

Table 20: Predicted ground-level CO Concentrations at Discrete Receptors

Receptor Number	Type	1-hour average CO concentration (µg/m³)		8-hour average CO concentration (µg/m³)	
		The Site	Site + Background	The Site	Site + Background
R1	Dwelling	2.4	7,002	0.6	2,001
R2	Recreational	2.5	7,003	0.9	2,001
R3	Dwelling	3.1	7,003	1.0	2,001
R4	Dwelling	3.5	7,003	1.8	2,002
R5	Dwelling	3.1	7,003	1.8	2,002
R6	Dwelling	3.1	7,003	2.0	2,002
R7	Dwelling	3.8	7,004	2.1	2,002
R8	Dwelling	3.2	7,003	1.7	2,002
R9	Correctional Facility	1.8	7,002	1.1	2,001
R10	Dwelling	1.6	7,002	0.6	2,001
R11	Dwelling	2.0	7,002	1.7	2,002
R12	Dwelling	3.0	7,003	1.3	2,001
R13	Dwelling	2.6	7,003	1.2	2,001
R14	Dwelling	2.4	7,002	0.9	2,001
Assessment Criteria		**30,000**		**10,000**	

10.1.5 SO_2

Table 21 shows the highest off-site concentrations of SO_2, and Table 22 shows the highest concentrations at discrete receptor locations. In addition, a graphical presentation of the maximum 1-hour average SO_2 ground-level concentrations from the Site is presented in Figure 13.

The modelling results show that the maximum off-site SO_2 concentration is below the assessment criteria for both the 1-hour and 24-hour averages.

Given the predicted model results are below the relevant health-based assessment criteria, AQCNZ considers there is limited potential for SO_2 emissions to cause adverse effects.

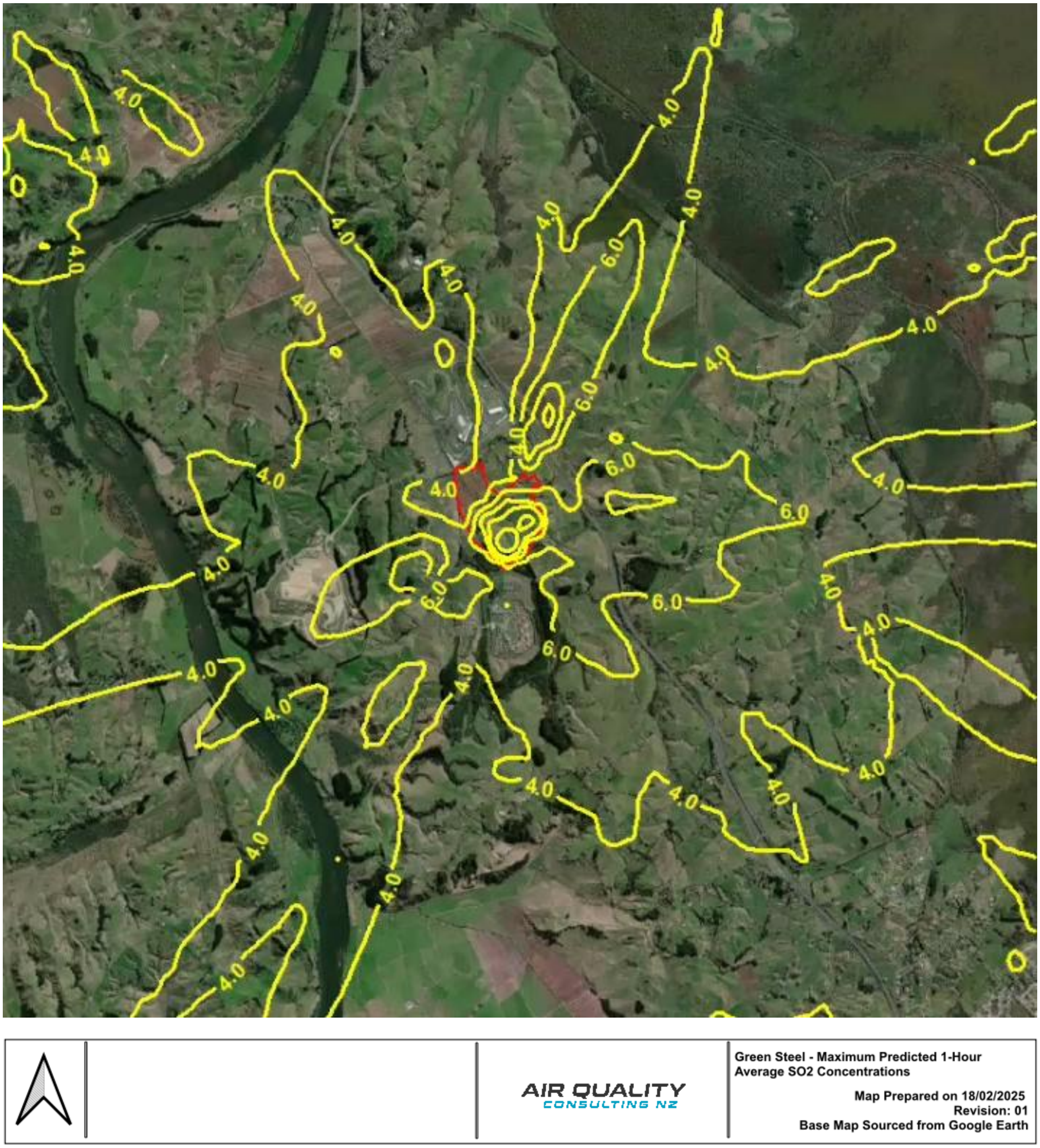
Table 21: Predicted Peak Off-site Ground Level SO_2 Concentrations

Pollutant	Averaging Period	Predicted Concentration (µg/m³)	Site + Background Concentration (µg/m³)	Assessment Criteria (µg/m³)
SO_2	1-hour	11.7	111.7	350
	24-hour	5.7	25.7	120

Table 22: Predicted ground-level SO_2 Concentrations at Discrete Receptors

Receptor Number	Type	1-hour average SO_2 concentration (µg/m³)		24-hr average SO_2 concentration (µg/m³)	
		The Site	Site + Background	The Site	Site + Background
R1	Dwelling	4.2	104.2	1.0	21.0
R2	Recreational	4.5	104.5	0.8	20.8
R3	Dwelling	5.6	105.6	1.0	21.0
R4	Dwelling	6.2	106.2	2.1	22.1
R5	Dwelling	5.6	105.6	2.4	22.4
R6	Dwelling	5.6	105.6	2.2	22.2
R7	Dwelling	6.8	106.8	2.1	22.1
R8	Dwelling	5.8	105.8	1.2	21.2
R9	Correctional Facility	3.9	103.9	1.8	21.8
R10	Dwelling	3.5	103.5	2.3	22.3
R11	Dwelling	3.9	103.9	1.9	21.9
R12	Dwelling	5.4	105.4	1.1	21.1
R13	Dwelling	4.7	104.7	1.6	21.6
R14	Dwelling	4.5	104.5	0.9	20.9
Assessment Criteria		**350**		**120**	

Figure 13 Isopleth of the predicted maximum 1-hour average SO_2 concentrations



10.1.6 Discussion on Potential Metal Emissions

As previously discussed, there is potential for metals such as zinc and lead to be discharged during the melting of scrap steel. AQCNZ considers that compliance with the PM_{10} and $PM_{2.5}$ guideline values will also provide protection against metal discharges. This justification is set out below.

However, to provide further reassurance, for lead, the NZAAQG set a limit of 0.2 µg/m³ as a three-monthly average. Based on the predicted maximum off-site annual PM_{10} concentration of 0.2 µg/m³ (as presented in Section 10.1.1), and assuming this value is representative of the three-monthly average and that the actual lead concentration is expected to be much lower, since lead will likely constitute only a small proportion of total particulates. Therefore, compliance with the NZAAQG for lead is expected.

In terms of zinc, there is no New Zealand based assessment criteria, however, the TCEQ ESL provides a short-term screening threshold of 20 µg/m³ (1-hour average). The predicted maximum 1-hour average off-site PM_{10} concentration is 10.8 µg/m³, which is well below the TCEQ ESL for lead. As with lead, because zinc is expected to make up only a small fraction of the particulate matter, off-site zinc concentrations will likely be well below levels of concern for human health.

10.1.7 Consideration of WHO 2021 Guidelines

While the WHO 2021 guidelines for PM_{10}, $PM_{2.5}$, NO_2, CO and SO_2 discussed in Section 7.3 have not yet been adopted in New Zealand, it is important to note that model predictions suggest the proposed plant emissions are unlikely to exceed these guidelines if they were to be implemented in the future. While the maximum predicted 24-hour average PM_{10} concentration of 15.2 µg/m³ is slightly higher than the WHO guideline of 15 µg/m³, the WHO guideline allows for 3 to 4 exceedances per year. As the second highest predicted 24-hour average PM_{10} concentration is less than 15 µg/m³ the proposed Green Steel Mill will comply with the WHO. Notwithstanding this, the location where the highest concentration occurs is in an area of vegetation where people are likely to be exposed for a substantial time with respect to a 24-hour period and it is therefore considered that the WHO 2021 is not applicable at this location.

10.2 Greenhouse Gas Assessment

Based on annual predicted fuel consumption for LPG and CNG the proposed Steel Mill will produce more than 2,000 tonnes of CO_2e/year. While the site may use LFG which would not trigger the NES GHG requirements, to provide flexibility in fuel types used in the Reheating Furnace, an Emission Plan has been prepared by Lumen Limited and is attached to the resource consent application.

10.3 Construction and Monofil Dust Discharges

The earthworks and activities associated with the construction of the platform and plant buildings have the potential to cause temporary dust nuisance effects. Additionally, the placement of waste floc may also contribute to dust-related nuisance effects if not properly managed.

Given the diffuse nature of these sources, emissions from these activities are difficult to determine and have, therefore, been qualitatively assessed using the FIDOL assessment methodology. The FIDOL assessment methodology is discussed in Section 7.4.

Site roads, parking, hard standing and temporary lay-down areas during construction would be formed and metaled but not sealed until after the majority of the construction has been completed. Consequently, these areas of the Site will initially have the greatest potential to generate dust along with the placement of waste floc into the monofil.

The site platform in which the majority of earthworks will take place is approximately 450 m from the closest receptor, however there might be some small auxiliary works that might occur 250 m from a receptor. Parts of the northeastern monofil will be within 150 m of a dwelling, though for the most part, both monofils will be located more than 250 m from any receptor. Based on the relatively large distances between dust-generating activities and sensitive receptor locations, there will likely be limited potential for dust nuisance effects, however there will be parts of the northeastern monofil that has some potential to result in dust effects if they are not control appropriately. However, the project will implement a range of dust controls to further mitigate this potential, as discussed in Section 6.6 and 6.7.

10.3.1 Combustion Emissions

In addition to dust, there will be minor emissions (products of combustion – NO_x, CO, PM_{10} and $PM_{2.5}$) associated with vehicle movements, however, these are considered to be negligible given the relatively low number of vehicle movements.

10.4 Assessment of Dust - Construction and Monofil Activities

As discussed previously, AQCNZ has undertaken a FIDOL assessment per the methodology contained in the MfE GPG Dust. This assessment is presented in the following sections.

10.4.1 Frequency

Frequency relates to how often dust discharges affect sensitive receptors. This is influenced by the frequency in which dust discharges occur and when suitable meteorological conditions exist.

Three parameters need to be established to determine the frequency of dust nuisance: the direction of sensitive receptors relative to construction activities, the frequency at which the wind blows in this direction with sufficient strength that dust can be carried and the frequency of dust discharges.

AQCNZ considers that only winds above 5 m/s have the potential to cause dust nuisance effects to sensitive receptors located off-site, given the buffer distances that surround the Site. Based on the information presented in Figure 4, winds above 5 m/s in the direction of any one receptor occurs less than ~4% of the time, which AQCNZ considers to be an infrequent occurrence.

The frequency of dust discharges is also related to specific activities that will occur. However, at the time of writing this report, while there is limited information, it is understood that the earthmoving will be undertaking over two earthworks seasons, which limits the frequency of when dust discharges could occur. However, if the mitigation measures mentioned in Section 6.6 are implemented, the frequency is considered low, particularly considering mitigation is proposed to be implemented during times of high winds blowing towards receptors.

Given all of the above, AQCNZ considers there is very limited potential for off-site dust nuisance to occur with any significant frequency. This is based on the large buffer distances, mitigation measures implemented and the low frequency of winds that have the potential to create dust nuisance.

10.4.2 Intensity

Intensity relates to the concentration of dust that is likely to be experienced at any potential receptor. Given the buffer distances and mitigation measures that will be implemented, off-site concentrations are expected to be low.

10.4.3 Duration

Duration relates to the length of time that dust discharges are likely to occur, the duration that strong wind is blowing towards any one off-site receptor, and the time that it takes to effectively mitigate any dust discharged beyond the boundary of the Site. In this case, AQCNZ considers that the duration that all of these factors occur concurrently would be very low/negligible.

10.4.4 Offensiveness

Offensiveness relates to the character of the dust, in this instance, the dust is from a natural source (i.e., soil or rock), which is consistent with other dust sources in the existing environment and therefore not considered overly offensive to receptors (as opposed to an unnatural dust source, i.e., fertiliser, coal dust, etc.). Whereas the waste floc may contain plastic, rubber, glass etc which is unnatural and therefore if experienced off-site is likely to be considered offensive.

10.4.5 Location

AQCNZ considers that there is limited potential for off-site effects to occur from construction activities, given the large distance to the nearest receptor (450 m from the main construction areas). However, when operations in the northeastern monofil occur within 250 m of a dwelling, there is some potential for off-site effects if not properly controlled.

The location of the dust discharges is mostly within a rural environment, which has a low sensitivity to dust discharges of this nature, which may be emitted from site activities. However, there are parts of the project that approach the limited nearby dwellings which have a high sensitivity to nuisance dust effects. Therefore it is essential that the mitigation measures identified in Section 6.6 and 6.7 are implemented effectively at all times.

10.4.6 Conclusion

Having assessed the proposed construction activities that have the potential to cause dust discharges against the FIDOL factors, AQCNZ considers that it is unlikely that dust from construction activities will cause dust nuisance effects at sensitive receptor locations providing the dust mitigation measures proposed are appropriately implemented. Consequently, effects from dust emissions will be less than minor.

10.5 Dust Management Plan Requirements

The above dust assessment is contingent on the minimum dust control measures described in section 6.6 and 6.7. AQCNZ expects these measures to be incorporated within the site DMP. Given that the risk of dust effects from construction and monofil activities is low, preparing a detailed DMP as part of this application is not considered necessary. Alternatively, AQCNZ recommends a resource consent condition requiring a DMP to be prepared and that this document should be developed in general accordance with MfE GPG Dust and incorporate the mitigation measures set out in this document. This document should then be provided to WRC for certification before the start of construction.

11 Conclusion

AQCNZ has undertaken an atmospheric dispersion modelling assessment in accordance with Ministry for the Environment's Good Practice Guide for Assessing Discharges to Air from Industry (2016) and the Good Practice Guide for Atmospheric Dispersion Modelling (2008) to assess the potential for air discharges from proposed Green Steel Mill to result in adverse effects.

The atmospheric dispersion model predicted ground-level pollutant concentrations for a range of air pollutants, including PM_{10}, $PM_{2.5}$, NO_2, CO, and SO_2.

The dispersion modelling results show that concentrations of the above pollutants are below the relevant health-based assessment criteria at off-site locations where people could be exposed and well below the criteria at the nearest sensitive receptor locations.

Additionally, the qualitative assessment of nuisance dust associated with construction phase and monofil activities of the project determined there to be limited potential for nuisance effects at off-site locations.

Based on the air quality assessment findings, AQCNZ considers there is limited potential for adverse health effects associated with air discharges and a low potential for nuisance effects from dust. Overall, AQCNZ considers the effects from Site activities to be less than minor.

12 Limitations

Air Quality Consulting NZ Limited has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of National Green Steel Limited, and only those third parties who have been authorised in writing by Air Quality Consulting NZ Limited to rely on this report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

Where this report indicates that information has been provided to Air Quality Consulting NZ Limited by third parties, Air Quality Consulting NZ Limited has made no independent verification of this information except as expressly stated in the report.

Air Quality Consulting NZ Limited assumes no liability for any inaccuracies in or omissions to that information.

This report was prepared between December 2024 and May 2025 and is based on the conditions encountered and information reviewed at the time of preparation. Air Quality Consulting NZ Limited disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A: CALMET/CALPUFF INPUT Files

CALMET Parameters

Hampton Downs
CALMET - with Hampton Downs data
2021-2023

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
GEODAT	Input file of geophysical data (GEO.DAT)	GEO.DAT
SRFDAT	Input file of hourly surface meteorological data (SURF.DAT)	SURF.DAT
CLDDAT	Input file of gridded cloud data (CLOUD.DAT)	CLOUD.DAT
METLST	Output file name of CALMET list file (CALMET.LST)	CALMET.LST
METDAT	Output file name of generated gridded met files (CALMET.DAT)	2022_CALMET.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NUSTA	Number of upper air stations	0
NOWSTA	Number of overwater stations	0
NM3D	Number of prognostic meteorological data files (3D.DAT)	1
NIGF	Number of IGF-CALMET.DAT files used as initial guess	0

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
IBYR	Starting year	2021
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	0
IBSEC	Starting second	0
IEYR	Ending year	2024
IEMO	Ending month	1
IEDY	Ending day	1
IEHR	Ending hour	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
IRTYPE	Output run type (0 = wind fields only, 1 = CALPUFF/CALGRID)	1
LCALGRD	Compute CALGRID data fields (T = true, F = false)	T
ITEST	Flag to stop run after setup phase (1 = stop, 2 = run)	2
MREG	Regulatory checks (0 = no checks, 1 = US EPA LRT checks)	0

INPUT GROUP: 2 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	UTM

INPUT GROUP: 2 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	60
UTMHEM	Hemisphere of UTM projection (N = northern, S = southern)	S
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-Region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	110
NY	Meteorological grid - number of Y grid cells	110
DGRIDKM	Meteorological grid spacing (km)	0.2
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	318.3000
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	5852
NZ	Meteorological grid - number of vertical layers	10
ZFACE	Meteorological grid - vertical cell face heights (m)	0.00,20.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
LSAVE	Save met fields in unformatted output file (T = true, F = false)	T
IFORMO	Type of output file (1 = CALPUFF/CALGRID, 2 = MESOPUFF II)	1
LPRINT	Print met fields (F = false, T = true)	F
IPRINF	Print interval for output wind fields (hours)	1
STABILITY	Print gridded PGT stability classes? (0 = no, 1 = yes)	0
USTAR	Print gridded friction velocities? (0 = no, 1 = yes)	0
MONIN	Print gridded Monin-Obukhov lengths? (0 = no, 1 = yes)	0
MIXHT	Print gridded mixing heights? (0 = no, 1 = yes)	0
WSTAR	Print gridded convective velocity scales? (0 = no, 1 = yes)	0
PRECIP	Print gridded hourly precipitation rates? (0 = no, 1 = yes)	0
SENSHEAT	Print gridded sensible heat fluxes? (0 = no, 1 = yes)	0
CONVZI	Print gridded convective mixing heights? (0 = no, 1 = yes)	0
LDB	Test/debug option: print input met data and internal variables (F = false, T = true)	F
NN1	Test/debug option: first time step to print	1
NN2	Test/debug option: last time step to print	1
LDBCST	Test/debug option: print distance to land internal variables (F = false, T = true)	F

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
IOUTD	Test/debug option: print control variables for writing winds? (0 = no, 1 = yes)	0
NZPRN2	Test/debug option: number of levels to print starting at the surface	1
IPR0	Test/debug option: print interpolated winds? (0 = no, 1 = yes)	0
IPR1	Test/debug option: print terrain adjusted surface wind? (0 = no, 1 = yes)	0
IPR2	Test/debug option: print smoothed wind and initial divergence fields? (0 = no, 1 = yes)	0
IPR3	Test/debug option: print final wind speed and direction? (0 = no, 1 = yes)	0
IPR4	Test/debug option: print final divergence fields? (0 = no, 1 = yes)	0
IPR5	Test/debug option: print winds after kinematic effects? (0 = no, 1 = yes)	0
IPR6	Test/debug option: print winds after Froude number adjustment? (0 = no, 1 = yes)	0
IPR7	Test/debug option: print winds after slope flow? (0 = no, 1 = yes)	0
IPR8	Test/debug option: print final winds? (0 = no, 1 = yes)	0

INPUT GROUP: 4 -- Meteorological Data Options		
Parameter	**Description**	**Value**
NOOBS	Observation mode (0 = stations only, 1 = surface/overwater stations with prognostic upper air, 2 = prognostic data only)	1
NSSTA	Number of surface stations	2
NPSTA	Number of precipitation stations	0
ICLDOUT	Output the CLOUD.DAT file? (0 = no, 1 = yes)	1
MCLOUD	Method to compute cloud fields (1 = from surface obs, 2 = from CLOUD.DAT, 3 = from prognostic (Teixera), 4 = from prognostic (MM5toGrads)	1
IFORMS	Surface met data file format (1 = unformatted, 2 = formatted)	2
IFORMP	Precipitation data file format (1 = unformatted, 2 = formatted)	2
IFORMC	Cloud data file format (1 = unformatted, 2 = formatted)	2

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
IWFCOD	Wind field model option (1 = objective analysis, 2 = diagnostic)	1
IFRADJ	Adjust winds using Froude number effects? (0 = no, 1 = yes)	1
IKINE	Adjust winds using kinematic effects? (0 = no, 1 = yes)	0
IOBR	Adjust winds using O'Brien velocity procedure? (0 = no, 1 = yes)	0
ISLOPE	Compute slope flow effects? (0 = no, 1 = yes)	1
IEXTRP	Extrapolation of surface winds to upper layers method (1 = none, 2 = power law, 3 = user input, 4 = similarity theory, - = same except layer 1 data at upper air stations are ignored)	1
ICALM	Extrapolate surface winds even if calm? (0 = no, 1 = yes)	0
BIAS	Weighting factors for surface and upper air stations (NZ values)	-1.0,-0.8,-0.5,0.0,0.0, 0.0,1.0,1.0,1.0,1.0

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
RMIN2	Minimum upper air station radius of influence for surface extrapolation exclusion (km)	4
IPROG	Use prognostic winds as input to diagnostic wind model (0 = no, 13 = use winds from 3D.DAT as Step 1 field, 14 = use winds from 3D.DAT as initial guess field, 15 = use winds from 3D.DAT file as observations)	14
ISTEPPGS	Prognostic data time step (seconds)	3600
IGFMET	Use coarse CALMET fields as initial guess? (0 = no, 1 = yes)	0
LVARY	Use varying radius of influence (F = false, T = true)	F
RMAX1	Maximum radius of influence in the surface layer (km)	12
RMAX2	Maximum radius of influence over land aloft (km)	12
RMAX3	Maximum radius of influence over water (km)	0
RMIN	Minimum radius of influence used in wind field interpolation (km)	0.1
TERRAD	Radius of influence of terrain features (km)	4
R1	Relative weight at surface of step 1 fields and observations (km)	12
R2	Relative weight aloft of step 1 field and observations (km)	12
RPROG	Weighting factors of prognostic wind field data (km)	0
DIVLIM	Maximum acceptable divergence	5E-006
NITER	Maximum number of iterations in the divergence minimization procedure	50
NSMTH	Number of passes in the smoothing procedure (NZ values)	2,9*4
NINTR2	Maximum number of stations used in each layer for interpolation (NZ values)	10*99
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
FEXTR2	Multiplicative scaling factor for extrapolation of surface observations to upper layers (NZ values)	10*0
NBAR	Number of barriers to interpolation of the wind fields	0
KBAR	Barrier - level up to which barriers apply (1 to NZ)	10
IDIOPT1	Surface temperature (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	-1
IDIOPT2	Temperature lapse rate used in the computation of terrain-induced circulations (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPT	Upper air station to use for the domain-scale lapse rate (between 1 and NUSTA)	-1
ZUPT	Depth through which the domain-scale lapse rate is computed (m)	200
IDIOPT3	Initial guess field winds (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPWND	Upper air station to use for domain-scale winds	-1
ZUPWND	Bottom and top of layer through which the domain-scale winds are computed (m)	1.0, 1.00
IDIOPT4	Read observed surface wind components (0 = from SURF.DAT, 1 = from DIAG.DAT)	0
IDIOPT5	Read observed upper wind components (0 = from UPn.DAT, 1 = from DIAG.DAT)	0

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
LLBREZE	Use Lake Breeze module (T = true, F = false)	F
NBOX	Lake Breeze - number of regions	0

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**
CONSTB	Mixing height constant: neutral, mechanical equation	1.41
CONSTE	Mixing height constant: convective equation	0.15
CONSTN	Mixing height constant: stable equation	2400
CONSTW	Mixing height constant: overwater equation	0.16
FCORIOL	Absolute value of Coriolis parameter (1/s)	0.0001
IAVEZI	Spatial mixing height averaging? (0 = no, 1 = yes)	1
MNMDAV	Maximum search radius in averaging process (grid cells)	1
HAFANG	Half-angle of upwind looking cone for averaging (degrees)	30
ILEVZI	Layer of winds used in upwind averaging (between 1 and NZ)	1
IMIXH	Convective mixing height method (1 = Maul-Carson, 2 = Batchvarova-Gryning, - for land cells only, + for land and water cells)	1
THRESHL	Overland threshold boundary flux (W/m**3)	0
THRESHW	Overwater threshold boundary flux (W/m**3)	0.05
ITWPROG	Overwater lapse rate and deltaT options (0 = from SEA.DAT, 1 = use prognostic lapse rates and SEA.DAT deltaT, 2 = from prognostic)	0
ILUOC3D	Land use category in 3D.DAT	16
DPTMIN	Minimum potential temperature lapse rate (K/m)	0.001
DZZI	Depth of computing capping lapse rate (m)	200
ZIMIN	Minimum overland mixing height (m)	50
ZIMAX	Maximum overland mixing height (m)	3000
ZIMINW	Minimum overwater mixing height (m)	50
ZIMAXW	Maximum overwater mixing height (m)	3000
ICOARE	Overwater surface fluxes method	10
DSHELF	Coastal/shallow water length scale (km)	0
IWARM	COARE warm layer computation (0 = off, 1 = on)	0
ICOOL	COARE cool skin layer computation (0 = off, 1 = on)	0
IRHPROG	Relative humidity read option (0 = from SURF.DAT, 1 = from 3D.DAT)	1
ITPROG	3D temperature read option (0 = stations, 1 = surface from station and upper air from prognostic, 2 = prognostic)	2
IRAD	Temperature interpolation type (1 = 1/R, 2 = 1/R**2)	1
TRADKM	Temperature interpolation radius of influence (km)	500
NUMTS	Maximum number of stations to include in temperature interpolation	5
IAVET	Conduct spatial averaging of temperatures? (0 = no, 1 = yes)	1
TGDEFB	Default overwater mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default overwater capping lapse rate (K/m)	-0.0045

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**
JWAT1	Beginning land use category for temperature interpolation over water	999
JWAT2	Ending land use category for temperature interpolation over water	999
NFLAGP	Precipitation interpolation method (1 = 1/R, 2 = 1/R**2, 3 = EXP/R**2)	2
SIGMAP	Precipitation interpolation radius of influence (km)	100
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01

CALPUFF Parameters

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
PUFLST	CALPUFF output list file (CALPUFF.LST)	CALPUFF.LST
CONDAT	CALPUFF output concentration file (CONC.DAT)	CONC.DAT
DFDAT	CALPUFF output dry deposition flux file (DFLX.DAT)	DFLX.DAT
WFDAT	CALPUFF output wet deposition flux file (WFLX.DAT)	WFLX.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NMETDOM	Number of CALMET.DAT domains	1
NMETDAT	Number of CALMET.DAT input files	16
NPTDAT	Number of PTEMARB.DAT input files	0
NARDAT	Number of BAEMARB.DAT input files	0
NVOLDAT	Number of VOLEMARB.DAT input files	0
NFLDAT	Number of FLEMARB.DAT input files	0
NRDDAT	Number of RDEMARB.DAT input files	0
NLNDAT	Number of LNEMARB.DAT input files	0
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-01-01-00-0000-2021-03-10-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-03-10-00-0000-2021-05-18-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-05-18-00-0000-2021-07-25-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-07-25-00-0000-2021-10-02-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-10-02-00-0000-2021-12-09-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2021-12-09-00-0000-2022-02-16-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-02-16-00-0000-2022-04-25-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-04-25-00-0000-2022-07-03-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-07-03-00-0000-2022-09-09-00-0000.DAT

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-09-09-00-0000-2022-11-16-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2022-11-16-00-0000-2023-01-24-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2023-01-24-00-0000-2023-04-02-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2023-04-02-00-0000-2023-06-10-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2023-06-10-00-0000-2023-08-17-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2023-08-17-00-0000-2023-10-25-00-0000.DAT
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET_2023-10-25-00-0000-2024-01-01-00-0000.DAT

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
METRUN	Run all periods in met data file? (0 = no, 1 = yes)	0
IBYR	Starting year	2021
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	0
IBMIN	Starting minute	0
IBSEC	Starting second	0
IEYR	Ending year	2024
IEMO	Ending month	1
IEDY	Ending day	1
IEHR	Ending hour	0
IEMIN	Ending minute	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
NSPEC	Number of chemical species modeled	4
NSE	Number of chemical species to be emitted	4
ITEST	Stop run after SETUP phase (1 = stop, 2 = run)	2
MRESTART	Control option to read and/or write model restart data	0

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
NRESPD	Number of periods in restart output cycle	0
METFM	Meteorological data format (1 = CALMET, 2 = ISC, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)	1
MPRFFM	Meteorological profile data format (1 = CTDM, 2 = AERMET)	1
AVET	Averaging time (minutes)	60
PGTIME	PG Averaging time (minutes)	60
IOUTU	Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MGAUSS	Near field vertical distribution (0 = uniform, 1 = Gaussian)	1
MCTADJ	Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)	3
MCTSG	Model subgrid-scale complex terrain? (0 = no, 1 = yes)	0
MSLUG	Near-field puffs modeled as elongated slugs? (0 = no, 1 = yes)	0
MTRANS	Model transitional plume rise? (0 = no, 1 = yes)	1
MTIP	Apply stack tip downwash to point sources? (0 = no, 1 = yes)	1
MRISE	Plume rise module for point sources (1 = Briggs, 2 = numerical)	1
MTIP_FL	Apply stack tip downwash to flare sources? (0 = no, 1 = yes)	0
MRISE_FL	Plume rise module for flare sources (1 = Briggs, 2 = numerical)	2
MBDW	Building downwash method (1 = ISC, 2 = PRIME)	2
MSHEAR	Treat vertical wind shear? (0 = no, 1 = yes)	0
MSPLIT	Puff splitting allowed? (0 = no, 1 = yes)	0
MCHEM	Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD w/ISORROPIA, 7 = RIVAD w/ISORROPIA CalTech SOA)	0
MAQCHEM	Model aqueous phase transformation? (0 = no, 1 = yes)	0
MLWC	Liquid water content flag	1
MWET	Model wet removal? (0 = no, 1 = yes)	1
MDRY	Model dry deposition? (0 = no, 1 = yes)	1
MTILT	Model gravitational settling (plume tilt)? (0 = no, 1 = yes)	0
MDISP	Dispersion coefficient calculation method (1= PROFILE.DAT, 2 = Internally, 3 = PG/MP, 4 = MESOPUFF II, 5 = CTDM)	3
MTURBVW	Turbulence characterization method (only if MDISP = 1 or 5)	3
MDISP2	Missing dispersion coefficients method (only if MDISP = 1 or 5)	3
MTAULY	Sigma-y Lagrangian timescale method	0
MTAUADV	Advective-decay timescale for turbulence (seconds)	0
MCTURB	Turbulence method (1 = CALPUFF, 2 = AERMOD)	1
MROUGH	PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)	0
MPARTL	Model partial plume penetration for point sources? (0 = no, 1 = yes)	1
MPARTLBA	Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)	0

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MTINV	Strength of temperature inversion provided in PROFILE.DAT? (0 = no - compute from default gradients, 1 = yes)	0
MPDF	PDF used for dispersion under convective conditions? (0 = no, 1 = yes)	0
MSGTIBL	Sub-grid TIBL module for shoreline? (0 = no, 1 = yes)	0
MBCON	Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)	0
MSOURCE	Save individual source contributions? (0 = no, 1 = yes)	0
MFOG	Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)	0
MREG	Regulatory checks (0 = no checks, 1 = USE PA LRT checks)	0

INPUT GROUP: 3 -- Species List		
Parameter	**Description**	**Value**
CSPEC	Species included in model run	PM10
CSPEC	Species included in model run	NOX
CSPEC	Species included in model run	SO2
CSPEC	Species included in model run	CO

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	60
UTMHEM	Hemisphere (N = northern, S = southern)	S
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	110
NY	Meteorological grid - number of Y grid cells	110
NZ	Meteorological grid - number of vertical layers	10
DGRIDKM	Meteorological grid spacing (km)	0.2
ZFACE	Meteorological grid - vertical cell face heights (m)	0.0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0, 4000.0
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	318.3000
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	5852
IBCOMP	Computational grid - X index of lower left corner	17

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
JBCOMP	Computational grid - Y index of lower left corner	11
IECOMP	Computational grid - X index of upper right corner	105
JECOMP	Computational grid - Y index of upper right corner	97
LSAMP	Use sampling grid (gridded receptors) (T = true, F = false)	F
IBSAMP	Sampling grid - X index of lower left corner	1
JBSAMP	Sampling grid - Y index of lower left corner	1
IESAMP	Sampling grid - X index of upper right corner	2
JESAMP	Sampling grid - Y index of upper right corner	2
MESHDN	Sampling grid - nesting factor	1

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**
ICON	Output concentrations to CONC.DAT? (0 = no, 1 = yes)	1
IDRY	Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)	1
IWET	Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)	1
IT2D	Output 2D temperature data? (0 = no, 1 = yes)	0
IRHO	Output 2D density data? (0 = no, 1 = yes)	0
IVIS	Output relative humidity data? (0 = no, 1 = yes)	0
LCOMPRS	Use data compression in output file (T = true, F = false)	T
IQAPLOT	Create QA output files suitable for plotting? (0 = no, 1 = yes)	1
IPFTRAK	Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)	0
IMFLX	Output mass flux across specific boundaries? (0 = no, 1 = yes)	0
IMBAL	Output mass balance for each species? (0 = no, 1 = yes)	0
INRISE	Output plume rise data? (0 = no, 1 = yes)	0
ICPRT	Print concentrations? (0 = no, 1 = yes)	0
IDPRT	Print dry deposition fluxes? (0 = no, 1 = yes)	0
IWPRT	Print wet deposition fluxes? (0 = no, 1 = yes)	0
ICFRQ	Concentration print interval (timesteps)	1
IDFRQ	Dry deposition flux print interval (timesteps)	1
IWFRQ	Wet deposition flux print interval (timesteps)	1
IPRTU	Units for line printer output (e.g., 3 = ug/m**3 - ug/m**2/s, 5 = odor units)	3
IMESG	Message tracking run progress on screen (0 = no, 1 and 2 = yes)	2
LDEBUG	Enable debug output? (0 = no, 1 = yes)	F
IPFDEB	First puff to track in debug output	1
NPFDEB	Number of puffs to track in debug output	1000
NN1	Starting meteorological period in debug output	1
NN2	Ending meteorological period in debug output	10

INPUT GROUP: 6 -- Subgrid Scale Complex Terrain Inputs		
Parameter	**Description**	**Value**
NHILL	Number of terrain features	0
NCTREC	Number of special complex terrain receptors	0
MHILL	Terrain and CTSG receptor data format (1= CTDM, 2 = OPTHILL)	2
XHILL2M	Horizontal dimension conversion factor to meters	1.0
ZHILL2M	Vertical dimension conversion factor to meters	1.0
XCTDMKM	X origin of CTDM system relative to CALPUFF system (km)	0.0
YCTDMKM	Y origin of CTDM system relative to CALPUFF system (km)	0.0

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**
RCUTR	Reference cuticle resistance (s/cm)	30
RGR	Reference ground resistance (s/cm)	10
REACTR	Reference pollutant reactivity	8
NINT	Number of particle size intervals for effective particle deposition velocity	9
IVEG	Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)	1

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
MOZ	Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)	1
BCKO3	Monthly ozone concentrations (ppb)	80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00
MNH3	Ammonia background input option (0 = monthly, 1 = from NH3Z.DAT)	0
MAVGNH3	Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)	1
BCKNH3	Monthly ammonia concentrations (ppb)	10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
MH2O2	H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)	1
BCKH2O2	Monthly H2O2 concentrations (ppb)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
RH_ISRP	Minimum relative humidity for ISORROPIA	50.0
SO4_ISRP	Minimum SO4 for ISORROPIA	0.4
BCKPMF	SOA background fine particulate (ug/m**3)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
OFRAC	SOA organic fine particulate fraction	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15
VCNX	SOA VOC/NOX ratio	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00
NDECAY	Half-life decay blocks	0

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SYTDEP	Horizontal puff size for time-dependent sigma equations (m)	550
MHFTSZ	Use Heffter equation for sigma-z? (0 = no, 1 = yes)	0
JSUP	PG stability class above mixed layer	5
CONK1	Vertical dispersion constant - stable conditions	0.01
CONK2	Vertical dispersion constant - neutral/unstable conditions	0.1
TBD	Downwash scheme transition point option (<0 = Huber-Snyder, 1.5 = Schulman-Scire, 0.5 = ISC)	0.5
IURB1	Beginning land use category for which urban dispersion is assumed	10
IURB2	Ending land use category for which urban dispersion is assumed	19
ILANDUIN	Land use category for modeling domain	20
Z0IN	Roughness length for modeling domain (m)	.25
XLAIIN	Leaf area index for modeling domain	3.0
ELEVIN	Elevation above sea level (m)	.0
XLATIN	Meteorological station latitude (deg)	-999.0
XLONIN	Meteorological station longitude (deg)	-999.0
ANEMHT	Anemometer height (m)	10.0
ISIGMAV	Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)	1
IMIXCTDM	Mixing heights read option (0 = predicted, 1 = observed)	0
XMXLEN	Slug length (met grid units)	1
XSAMLEN	Maximum travel distance of a puff/slug (met grid units)	1
MXNEW	Maximum number of slugs/puffs release from one source during one time step	99
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2
SYMIN	Minimum sigma-y for a new puff/slug (m)	1
SZMIN	Minimum sigma-z for a new puff/slug (m)	1
SZCAP_M	Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)	5000000

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SVMIN	Minimum turbulence velocities sigma-v (m/s)	0.5, 0.50, 0.50, 0.50, 0.50, 0.500, 0.37, 0.37, 0.37, 0.37, 0.37, 0.370
SWMIN	Minimum turbulence velocities sigma-w (m/s)	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.20, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz across puff (1/s)	0, 0
NLUTIBL	TIBL module search radius (met grid cells)	4
WSCALM	Minimum wind speed allowed for non-calm conditions (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
TKCAT	Emissions scale-factors temperature categories (K)	265., 270., 275., 280., 285., 290., 295., 300., 305., 310., 315.
PLX0	Wind speed profile exponent for stability classes 1 to 6	0.07, 0.07, 0.1, 0.15, 0.35, 0.55
PTG0	Potential temperature gradient for stable classes E and F (deg K/m)	0.02, 0.035
PPC	Plume path coefficient for stability classes 1 to 6	0.5, 0.5, 0.5, 0.5, 0.35, 0.35
SL2PF	Slug-to-puff transition criterion factor (sigma-y/slug length)	10
FCLIP	Hard-clipping factor for slugs (0.0 = no extrapolation)	0
NSPLIT	Number of puffs created from vertical splitting	3
IRESPLIT	Hour for puff re-split	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
ZISPLIT	Minimum mixing height for splitting (m)	100.0
ROLDMAX	Mixing height ratio for splitting	0.25
NSPLITH	Number of puffs created from horizontal splitting	5
SYSPLITH	Minimum sigma-y (met grid cells)	1.0
SHSPLITH	Minimum puff elongation rate (SYSPLITH/hr)	2.0
CNSPLITH	Minimum concentration (g/m**3)	1.0E-07
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	0.0001
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-006
DSRISE	Trajectory step-length for numerical rise integration (m)	1.0
HTMINBC	Minimum boundary condition puff height (m)	500
RSAMPBC	Receptor search radius for boundary condition puffs (km)	10
MDEPBC	Near-surface depletion adjustment to concentration (0 = no, 1 = yes)	1

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
NPT1	Number of point sources	3

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
IPTU	Units used for point source emissions (e.g., 1 = g/s)	2
NSPT1	Number of source-species combinations with variable emission scaling factors	0
NPT2	Number of point sources in PTEMARB.DAT file(s)	0

INPUT GROUP: 14 -- Area Source Parameters		
Parameter	**Description**	**Value**
NAR1	Number of polygon area sources	0
IARU	Units used for area source emissions (e.g., 1 = g/m**2/s)	1
NSAR1	Number of source-species combinations with variable emission scaling factors	0
NAR2	Number of buoyant polygon area sources in BAEMARB.DAT file(s)	0

INPUT GROUP: 15 -- Line Source Parameters		
Parameter	**Description**	**Value**
NLN2	Number of buoyant line sources in LNEMARB.DAT file	0
NLINES	Number of buoyant line sources	0
ILNU	Units used for line source emissions (e.g., 1 = g/s)	1
NSLN1	Number of source-species combinations with variable emission scaling factors	0
NLRISE	Number of distances at which transitional rise is computed	6

INPUT GROUP: 16 -- Volume Source Parameters		
Parameter	**Description**	**Value**
NVL1	Number of volume sources	0
IVLU	Units used for volume source emissions (e.g., 1 = g/s)	1
NSVL1	Number of source-species combinations with variable emission scaling factors	0
NVL2	Number of volume sources in VOLEMARB.DAT file(s)	0

INPUT GROUP: 17 -- FLARE Source Control Parameters (variable emissions file)		
Parameter	**Description**	**Value**
NFL2	Number of flare sources defined in FLEMARB.DAT file(s)	0

INPUT GROUP: 18 -- Road Emissions Parameters		
Parameter	**Description**	**Value**
NRD1	Number of road-links sources	0
NRD2	Number of road-links in RDEMARB.DAT file	0
NSFRDS	Number of road-links and species combinations with variable emission-rate scale-factors	0

INPUT GROUP: 19 -- Emission Rate Scale-Factor Tables		
Parameter	**Description**	**Value**
NSFTAB	Number of emission scale-factor tables	0

INPUT GROUP: 20 -- Non-gridded (Discrete) Receptor Information		
Parameter	**Description**	**Value**
NREC	Number of discrete receptors (non-gridded receptors)	3031
NRGRP	Number of receptor group names	0