Oparure Quarry South-Western Pit - Air Quality Assessment

Prepared for

Graymont NZ Limited

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Quality Control Sheet

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Limitations:

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Executive Summary

Graymont (NZ) Ltd (Graymont) operates the Oparure Quarry limestone extraction and processing facility, approximately 8 km west of Te Kūiti. Graymont is seeking approval under the Fast-track Approvals Act 2024 to expand the existing quarry via development of the Oparure Quarry South-Western Pit (SW Pit).
Pattle Delamore Partners Limited (PDP) has been engaged to assess the potential effects of the SW Pit and haul road (the Project) on air quality, noting that the principal air discharge associated with both pit development and ongoing operations is dust (predominantly soil and limestone particulates).

The area surrounding the SW Pit is dominated by rural land uses, with the exception of the existing Oparure Pit. Consequently, the receiving environment adjacent to the SW Pit is generally considered of low sensitivity to dust because of the low density of residential dwellings. Two dwellings within 500 m of the SW Pit boundary have been identified as sensitive receptors for this assessment. While not a formal part of the Fast Track Approval process, the owners of these two dwellings have been approached and provided written approval for the Project.

The dust effects assessment considers the FIDOL factors (frequency, intensity, duration, offensiveness, location) influencing dust effects from the development and operation of the SW Pit in accordance with the Good Practice Guide for Assessing and Managing Dust (Ministry for the Environment, 2016). This report also applies the Source-Pathway-Receptor concept as described in the Institute of Air Quality Management guidelines for assessment of mineral dust impacts (IAQM, 2016).

Good practice mitigation measures to control dust from the construction and operation of the SW Pit will be specified in a Dust Management Plan, which will include the use of water to suppress dust when required. An on-site meteorological instrument shall send text and email alert messages to staff to flag the occurrence of high dust risk conditions and to assist with proactive dust management.

Given the separation distances and proposed dust mitigation measures, the risk of dust impacts arising at the identified sensitive receptors is assessed as being negligible and the Project is considered unlikely to cause offensive or objectionable dust effects.

Beyond the sensitive receptors specifically covered in the assessment, the assessment demonstrates that dust amenity and health impacts in the area surrounding the SW Pit will be negligible.

Any measurable cumulative impact of dust from the concurrent development and operations of the Oparure and SW Pits will be limited to a low sensitivity area located within the site between the pits. Given the pit separation and the distance of the pits to the site boundary, any off-site cumulative effects will be negligible.

In summary, PDP concludes there are negligible amenity and health risks from airborne dust discharged from the SW Pit.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

Graymont (NZ) Ltd (Graymont) operates a limestone quarry and processing facility referred to as the Oparure Quarry pit, located approximately 8 km west of Te Kūiti.

Graymont is submitting a substantive application under the Fast-track Approvals Act 2024 for an expansion of the existing Oparure Quarry, being the Oparure Quarry South-Western Pit (SW Pit). Graymont has engaged Pattle Delamore Partners Limited (PDP) to prepare various technical assessments to support the application, including an assessment of the Project's effects on air quality.

The development and operation of the SW Pit will discharge dust which has the potential to impact on air quality and therefore the management of dust discharges is required.

This report provides a description of the area surrounding the SW Pit and assesses the potential air quality impact of the development and operation of the SW Pit.

This report has been prepared in accordance with the relevant elements relating to the impartial role of an expert witness detailed by the Environment Court's Expert Witness Code of Conduct.[1]

2.0 Project Background

2.1 Existing Quarry

Graymont's existing Oparure Quarry supplies limestone products to the domestic market in New Zealand and export markets across the South Pacific islands. The limestone products are used either directly or as feedstock for quicklime products in major industries including agriculture and animal health, roading and civil infrastructure, manufacturing (for example paper and leather), the steel industry, mining, water quality treatment and in wastewater treatment.

The quarrying operations and processing plant at Oparure Pit generally run 5:00 am to 6:00 pm Monday to Friday and 5:00 am to 1:00 pm on Saturday. The total weight of limestone extracted from the existing Oparure Pit and processed each year is between approximately 250,000 and 765,000 tonnes[2].

[1] Section 9 of the *Environment Court of NZ: Practice Note 2023.*

[2] Oparure Quarry, Southwestern Pit, Traffic Impact Assessment, Team Traffic report number 19081 dated June 2026.

Air discharges from the existing Oparure Quarry are authorised by resource consent AUTH142709.01.01, granted by Waikato Regional Council (WRC) in 2023. The Northern Pit extension of the Oparure Quarry is operating as a permitted activity under the WRC air plan rules. However, Schedule 1, attached to Graymont consents AUTH140960.01.01, AUTH140960.02.01, AUTH140960.03.01, AUTH140960.04.01 and AUTH140823.01.01, does have conditions which control the emissions and impacts of dust (condition numbers 31 to 35).

2.2 SW Pit

A detailed description of the quarrying activity, including the extent and nature of the SW Pit, is provided in the Assessment of Environmental Effects[3] (AEE) accompanying this report in the Fast Track Substantive Application.

Figure 1 and Appendix A show a plan of the SW Pit and its location relative to the current Oparure Pit. The two pits will be linked by a haul road with the Oparure Pit processing the limestone resource extracted from the SW Pit. The SW Pit will be developed in stages over the 35-year duration that is being sought for the air discharge consent.

Limestone quarried from the SW Pit will be processed using the same fixed plant processing area and mobile crushing and screening plant that is currently operating in the Oparure Pit. The amount of limestone being processed will remain within the range of what has been historically processed at the existing Oparure Pit.

Once fully developed, the SW Pit will expose up to 40 ha of limestone (or disturb a total of up to 61 ha including highwall and rehabilitated landform). The SW Pit will be progressively rehabilitated by placing overburden into quarried areas over the life of the quarry.

The revised SW Pit footprint is smaller than an earlier proposed 88 ha Western Pit that PDP assessed dust effects from previously[4]. This assessment relates to the SW Pit footprint only, including the associated haul road shown in Figure 1 and Appendix A. Where this assessment refers to the earlier design extent, the assessment remains conservative for the reduced SW Pit footprint.

[3] Enspire 2026.

[4] PDP. (August 2022). Air Quality Assessment – Proposed Graymont Pakeho Pit

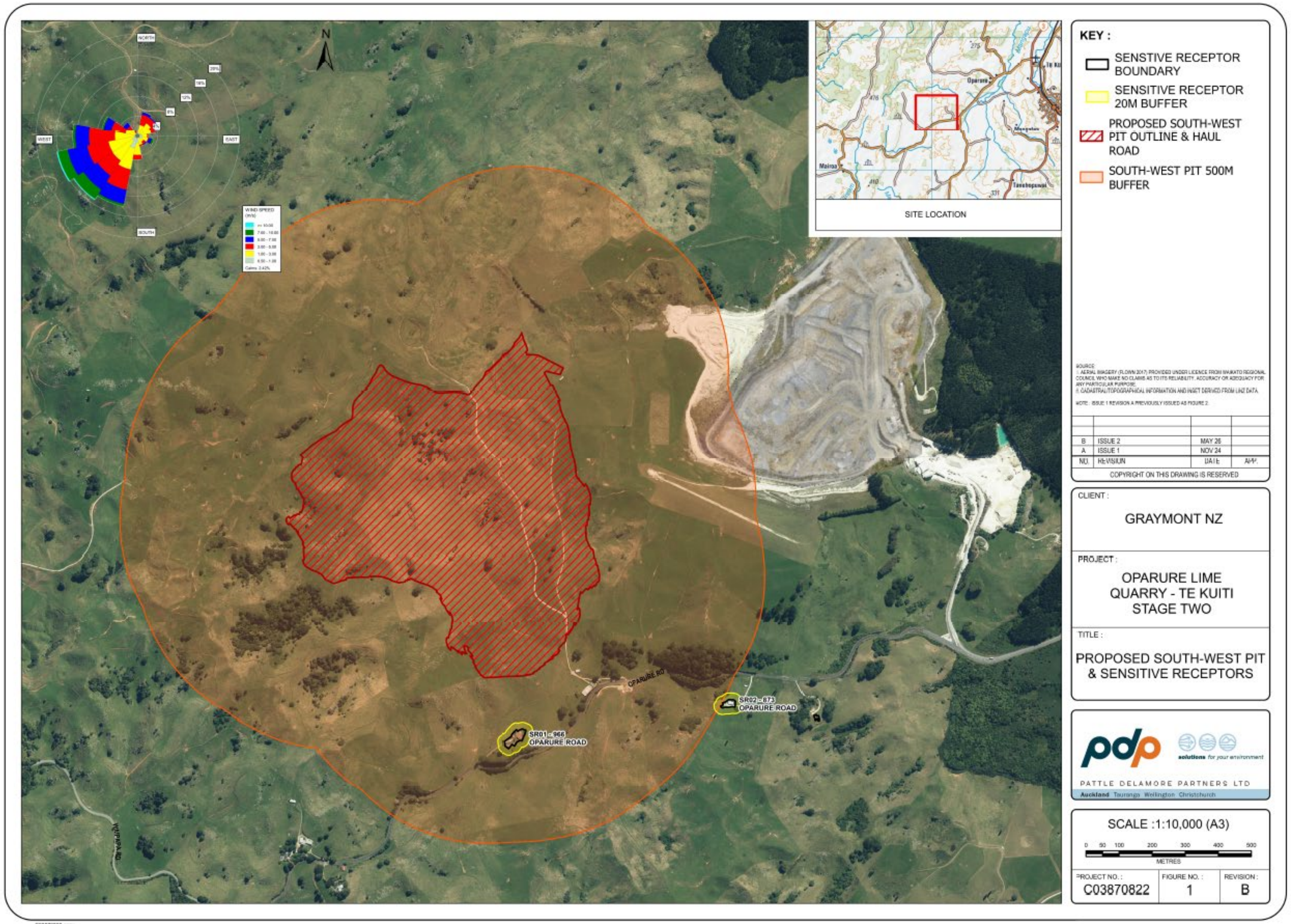

Figure 1: Extent of SW Pit, 500 m buffer and sensitive receptors in the surrounding area

3.0 Receiving Environment

3.1 Sensitivity of the Receiving Environment to Dust

The area surrounding the SW Pit is dominated by rural land uses, with the exception of the existing Oparure Pit. Consequently, the receiving environment adjacent to the SW Pit is generally considered of low sensitivity to the discharge of dust because of the agricultural and rural land use and low density of residential dwellings.

The Institute of Air Quality Management (IAQM) (2016) guidelines recommend that a dust impact assessment will almost always be required when there are relevant human and/or ecological receptors within 400 m of the dust source. The Environment Protection Authority Victoria guidelines for recommended separation distances (2024), which have been widely applied within New Zealand, recommend a separation distance of 500 m from sensitive receptors for 'quarrying, crushing, screening, stockpiling and conveying of rock, with blasting'. For this reason, the sensitive receptors within 500 m of the SW Pit boundary have been considered for this assessment.

There are two residential dwellings are situated on a farm or lifestyle blocks within 500 m of the SW Pit operations. The extent of the SW Pit and associated haul road, the receiving environment adjacent to the SW pit and the two identified residential locations are shown in Figure 1, which also shows the 500 m buffer from the SW Pit boundary and the wind rose for the area. Separation distances are measured from a notional boundary of 20 m from the sensitive receptor dwelling, these notional boundaries are also shown in Figure 1.

Table 1 summarises the location of these sensitive receptors, the range of wind directions (blowing from) for which they will be downwind, and the shortest distance to the SW Pit footprint including the haul road. The potential air quality effects on these two residential dwellings, SR01 and SR02, have been considered within the assessment of dust impacts in Section 7.0.

It is notable that the owner/occupiers of SR01 previously provided affected party sign off to Graymont for an earlier consent application for the larger-scale pit where the SW Pit is to be located. Although not part of the formal Fast Track Approval process, Graymont have approached and been given affected party sign off from the owner/occupiers of SR01 and SR02. For the purpose of completeness and to give context to the dust impacts at SR01 and SR02, this assessment considers the effects at both SR01 and SR02.

Table 1: Sensitive receptors located near to the SW Pit

Type	Identifier	Address / Coordinates	Shortest Distance to SW Pit[1]	Downwind direction[2] (°N)
House	SR01	966 Oparure Road	146 m	305 – 44
House	SR02	873 Oparure Road	496 m	272 – 13

Notes:
1. *Measurements based upon distance from notional boundary of 20 m from the house.*
2. *Based upon extent of SW Pit and associated haul road. See Figure 1.*

3.2 Existing Air Quality

The existing air quality in the area around the SW Pit is influenced by the dust and combustion products discharged from the Oparure Pit, the limestone processing area and by the background (non-anthropogenic) air quality. The existing air quality has been quantitatively assessed in detail by PDP (2020).[5] Oparure Quarry was granted air discharge consent AUTH142709.01.01 by WRC in July 2023.

The potential for health effects from exposure to PM_{10}, SO_2 and NO_2 discharged as a result of the Oparure Quarry, limestone processing operations and background concentrations were assessed as less than minor (negligible). The assessment was based on the comparison of dispersion modelling (cumulative) results with the relevant health impact criteria.

The Oparure Quarry was assessed as having less than minor (negligible) amenity effects on air quality as a result of dust discharges and readily complies with the general permitted activity condition 6.1.8 in the Waikato Regional Plan. This assessment is supported by the fact that the Oparure Quarry has been operating in this location since around 1981 and there are no records of dust complaints received during this time.

3.3 Meteorological Conditions

3.3.1 Wind Monitoring Data Sources

An on-site meteorological monitoring station was commissioned at the Oparure Pit site in July 2019. PDP has assessed the data collected from this on-site station and compared it to other reference monitoring data collected by NIWA at nearby Te Kūiti to assess the meteorological conditions of the proposed SW Pit site. A wind rose diagram depicting the wind directions and strengths recorded at the Te Kūiti monitoring location from 2019 to 2024 is shown in Appendix C. A comparison of the on-site and Te Kūiti wind roses show that the wind direction

[5] Air Quality Assessment – Oparure Quarry. PDP 2020. Job Reference C03870802.

patterns are very similar, but the windspeeds for the on-site station are higher. The dust assessment PDP undertook for the Oparure Pit was based on the on-site data October 2019-June 2022.

PDP planned to update the dust assessment for the SW Pit to incorporate the on-site wind data up until March 2026. However, the updated onsite data demonstrated an unusual shift to the recorded predominant wind directions and average speeds as compared to the earlier 2019 to 2022 data set. In the later 2023 to 2026 dataset, the predominant wind directions had shifted about 30 degrees and the average wind speeds were about 0.5 m/s lower than previously monitored. Following this observation, PDP carefully reviewed the July 2023 to March 2026 on-site data and site maintenance record. In this review process PDP did not identify any reasons for the shift in data or any required fixes.

After considering the options available for the wind data sets which could be used for the SW pit dust assessment, PDP has returned to the October 2019 to June 2022 on-site data. The key reasons for PDP's preferred option are:

1) The wind direction pattern for this period closely reflects the wind direction pattern recorded at Te Kūiti. Therefore, PDP considers the 2019 to 2022 on-site data provides a good representation of the regional patterns of wind directions.
2) The average and peak wind speeds recorded on-site from October 2019 to June 2022 are higher than both the Te Kūiti and on-site data from July 2023 to March 2026. Therefore, using the October 2019 to June 2022 on-site data provides a conservative wind speed data for the dust assessment.

PDP's investigation into the on-site data is not yet resolved. PDP recommends that Graymont undertake a field and/or a laboratory calibration for the instrument as the next steps. PDP will continue work with Graymont to move this issue forwards.

3.3.2 Meteorological Data for Dust assessment

Figure 2 shows the wind rose for Graymont quarry for October 2019 to June 2022. It shows the prevailing south-westerly winds, followed by winds from the west, south and north east.

Figure 3 shows the average daily pattern in wind speeds at the Graymont quarry from October 2019 to June 2022. This shows that the average wind speed is highest in the afternoon and early evening with an expected peak between 3pm and 6pm.

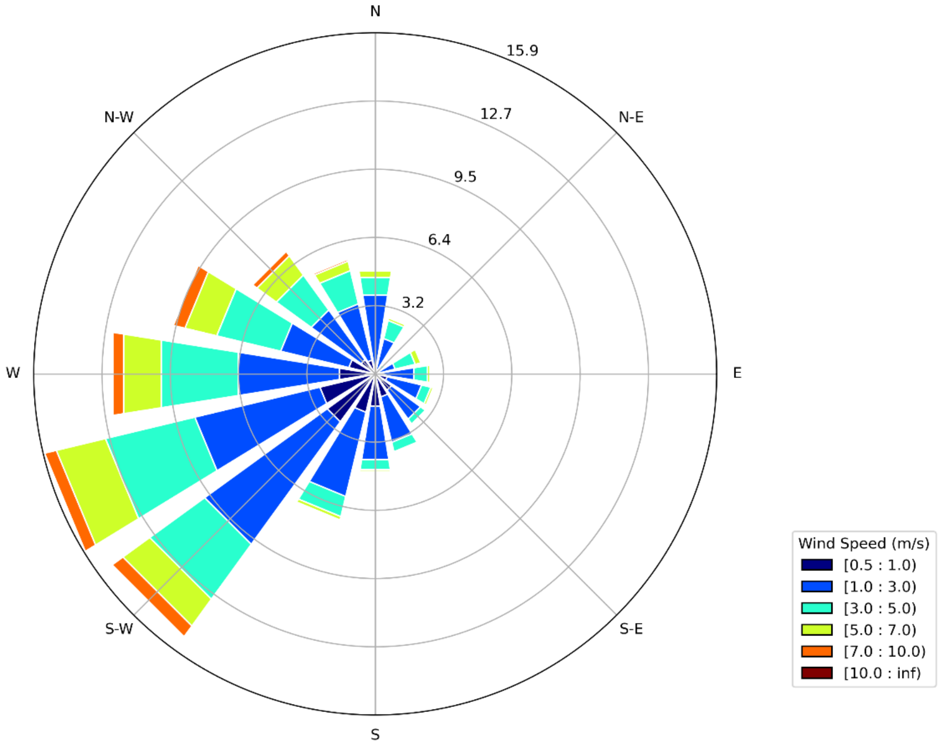

Figure 2: Wind Rose: Graymont on-site October 2019-June 2022

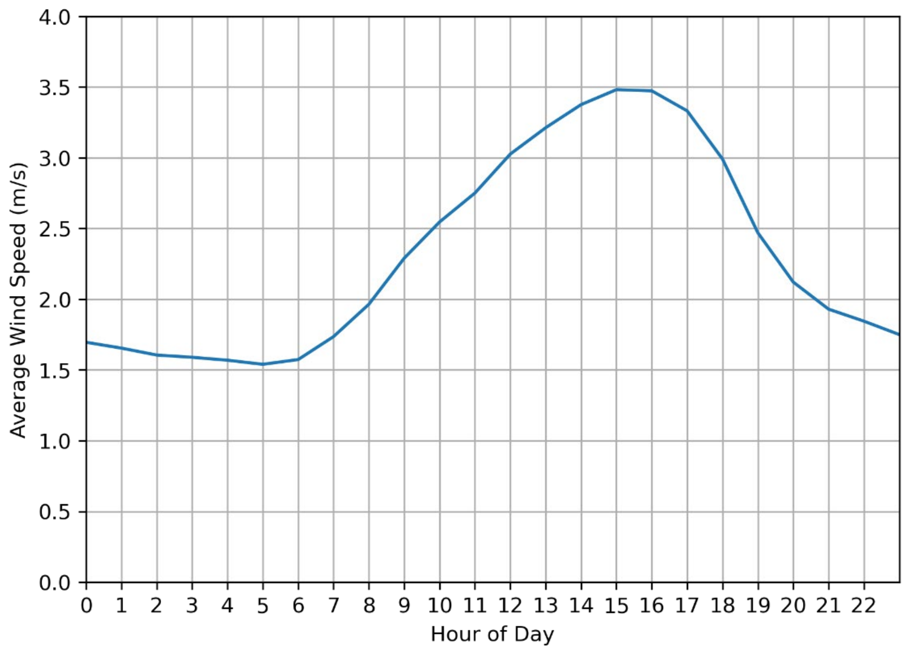

Figure 3: Diurnal pattern of windspeed annual average October 2019-June 2022

Rainfall has a significant influence on whether dust emissions will occur because a wet or damp ground surface will not generate dust emissions. For calculation of whether a day had wet or dry ground conditions, a day when wet ground conditions occurred was defined as one where the daily evaporation (Penman ET) exceeded the daily rainfall by no more than 1 mm. This allows for some minimal moisture storage within the surface layer. A day with dry ground conditions and thus a potential for dust generation was then taken as any day when wet ground conditions had not occurred.

The data set from the on-site station was used for this assessment as it reported lower rainfall than the Te Kūiti EWS site, so offered a more conservative approach for the dust assessment. The percentage of dry days per month was calculated using this data set for the same period as the analysed wind data above (2019-2022). The monthly frequency of wet days is shown in Figure 4. The monthly frequency of days with precipitation above 1mm is shown in Figure 5. This shows that there are the highest number of wet days in the late autumn, winter, and early spring months of April to September, and more days expected with dry ground conditions in the October to March period.

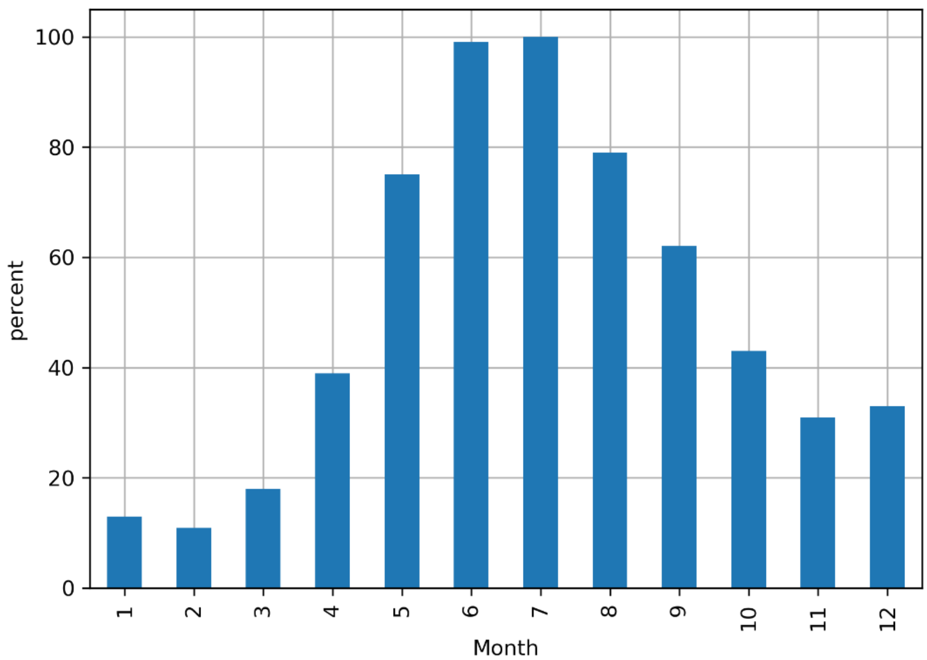

Figure 4: Monthly percentage of wet days (Te Kūiti Data, October 2019 – June 2022)

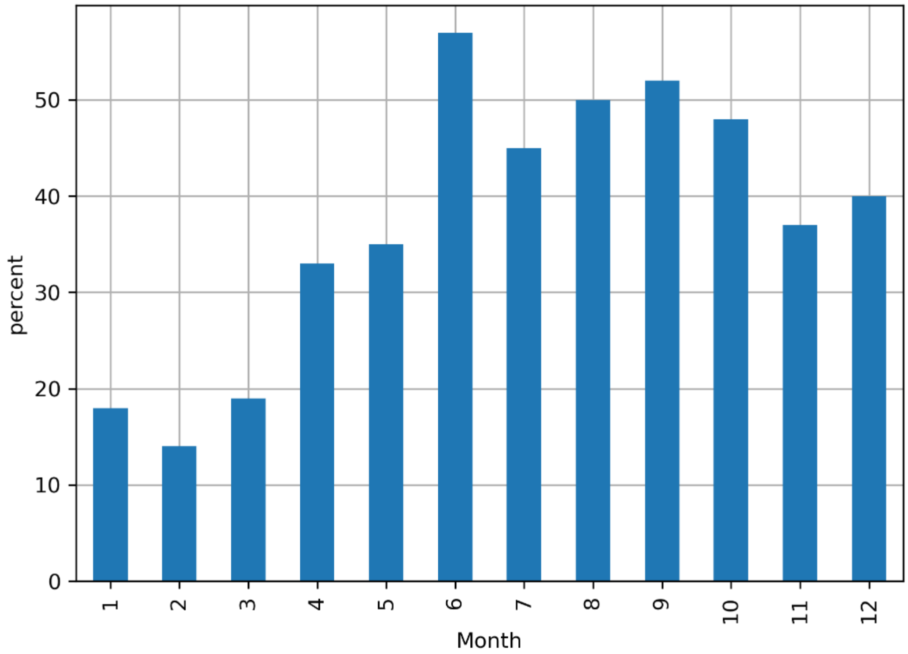

Figure 5: Monthly percentage of days with precipitation of > 1mm October 2019-June 2022

4.0 Potential Sources of Air Contaminant Discharges

The principal emission to air on the Project site is dust. Dust is a generic term commonly used to describe wind-borne particles (e.g. soil or minerals) up to 100 microns (µm) in size.

Dust emissions at the Project site will be predominantly fugitive in nature (i.e. from area sources as opposed to point sources) and can vary substantially from day-to-day, depending on the level of activity, the specific operations being undertaken and the weather conditions. The scale (or magnitude) of potential dust impacts also depends on dust suppression and other mitigation measures applied by Graymont to control dust emissions on-site.

4.1 Dust

The following activities at the SW Pit have the potential to generate dust emissions:

- Site preparation – removal and stockpiling of soil and overburden;
- Mineral extraction (including blasting);
- Small scale mineral crushing and screening. It is noted that the limestone is primarily processed at the Oparure Pit;

- Materials handling and temporary storage (including soil, overburden and stockpiles of extracted minerals);
- Vehicle movements on unsealed site roads and yard surfaces (including vehicle track-out); and,
- Site remediation – replacing overburden and topsoil.

There are five primary factors which influence the potential for dust to be generated from the site. These are:

- Wind speed across the surface. Dust emissions from exposed surfaces generally increase with increasing wind speed. However, dust pick up by winds is only significant at wind speeds above 5 m/s (11 knots or a Beaufort scale number of 3 – see Appendix A of the Air Quality Management Plan (AQMP)). Above wind speeds of 10 m/s (20 knots) dust pick up increases rapidly;
- Moisture content of the material. Moisture binds particles together, preventing them from being disturbed by winds or vehicle movements;
- The area of exposed surface. The larger the area of exposed surfaces the more potential there will be for dust emission. Vegetated surfaces are less prone to wind erosion than bare surfaces;
- The percentage of fine particles in the material on the surface. The smaller the particle size of material on an exposed surface the more easily the particles are able to be picked up and entrained in the wind; and,
- Disturbances such as traffic and loading and unloading of materials. Vehicles travelling over exposed surfaces tend to pulverise any surface particles. Particles are displaced from rolling wheels and the surface. Dust is also sucked into the turbulent wake created behind moving vehicles.

4.2 Development of the SW Pit

Table 2 summarises the activities associated with development of the SW Pit that have the potential to discharge contaminants into the air.

Table 2: Summary of Quarry Development Activities and Associated Emissions

Activity	Potential Emissions
Overburden/topsoil stripping and bund construction	Dust
Loading and unloading trucks	Dust
Vehicle movements on haul roads and operational quarry area	Dust
Overburden and topsoil stockpiles	Dust

The development of the SW Pit is likely to be undertaken by a contractor. The type size and number of machines used during the site development process will be contractor dependant and vary significantly over time. To give an indication of the type, size and number of machines that will likely be used on site, the following list of machines may be used during the stripping phase (relatively high dust emissions) of the site development:

- One 110 tonne excavator;
- One 20 tonne excavator;
- Three to five 46 – 72 tonne dump trucks;
- One 50 tonne bulldozer; and
- One 26 tonne grader.

These vehicles and plant may not necessarily operate concurrently. In addition, one water cart will be used for dust suppression.

4.3 Operation of the SW Pit

Table 3 summarises the activities associated with operation of the SW Pit that have the potential to discharge contaminants into the air.

Table 3: Summary of Quarry Operation Activities and Associated Emissions

Activity	Potential Emissions
Limestone excavation works – including drilling and blasting	Dust
Loading and unloading trucks	Dust
Vehicle movements on haul roads	Dust
Dust from exposed unconsolidated surfaces – working areas	Dust
Mobile crusher and screening operation	Dust

The type size and number of machines used during the site operational phase of the site will vary significantly over time. The following list gives an indication of the type, size and number of machines that may be used at any one point in the operational phase of the SW Pit:

- Three hydraulic excavators (70, 13 and 12 tonnes);
- Two 65 tonne dump trucks;
- One mobile crusher and screen;
- Two loaders;
- One motor scraper (earthworks and landscaping);
- Up to two water carts (dust suppression); and
- Fuel truck (refuelling).

These vehicles and plant may not necessarily operate concurrently. At any stage during the development of the SW Pit and operation of the Oparure Pit, the total active area that may require dust suppression will not exceed that which two water carts can service. The focus of the water carts will be active areas close to the site boundary and/or relatively close to the site's sensitive receptors.

4.4 Discharges from Combustion Sources, Refuelling and Explosives

In addition to the dust sources described above, minor air emissions will be generated from combustion sources associated with the use and refuelling of heavy machinery and use of vehicles used to transport materials to and from the site, along with blasting.

The main emissions from heavy machinery burning diesel are oxides of nitrogen (NO_x) and fine particulate matter ($PM_{2.5}$ and PM_{10}) fractions. Based on our experience with assessing the impacts of vehicle emissions associated with roadway developments, the relative level of emissions from operations in the SW Pit is very low and the potential effects on air quality relative to the air quality guidelines and standards (National Environmental Standards for Air Quality (NESAQ) (MfE, 2004) & Ambient Air Quality Guidelines (AAQG) (MfE, 2002)) is considered as *de minimis*. Combustion source emissions are accordingly not considered any further in this assessment. As a good practice measure, vehicles used on site should follow a regular maintenance schedule to ensure that exhaust emissions and fuel use are minimised.

The main emissions to air from refuelling of storage tanks are volatile organic compounds (VOCs). The highest potential for emission of VOCs is from discharge of VOCs in the vapour phase from the airhead space of the storage tank by displacement during refuelling. These discharges are anticipated to be infrequent and short in duration. Following good practice measures including maintenance of a separation distance of at least 100 m between the storage tanks and the site boundary will ensure that potential effects on air quality at the site boundary relative to the AAQG (MfE, 2004) will be *de minimis*.

Dust from the use of explosives during blasting is considered as part of the overall operational dust assessment below, but other air contaminants emitted from the explosives include trace amounts of combustion by-products generated at the time of detonation. Blasting events are infrequent, short in duration, and spatially limited, and the resulting gaseous air emissions disperse rapidly. Based on PDP's experience with quarry and open-cast mining operations, the relative contributions of these emissions to ambient air pollutant concentrations are negligible and are therefore considered to be de minimis. Emissions associated with explosive use are accordingly not considered further in this assessment.

5.0 Potential Impacts of Dust Discharge

As described in Section 4.1 – 4.3, pit development and operational activities can generate dust that, in some circumstances, can cause nuisance effects and impact on human health if not adequately controlled. The potential for adverse effects can be reduced to low levels with adequate dust control.

Dust deposition can also have an impact on plant life and ecosystems. This is discussed in the Terrestrial and Subterranean Ecology Assessment prepared by Blue Green Ecology (2026).

Dust nuisance is caused where dust has impacts on amenity (such as dust depositing on residential properties, windows and on motor vehicles) and reducing visibility. Human health effects can occur from exposure to PM_{10} and smaller fractions, which are respirable and can cause short and long-term illness (WHO, 2013). The finer fractions ($PM_{2.5}$ and smaller) are those which pose the greatest risk to human health. $PM_{2.5}$ is generally associated with combustion processes such as power plants, domestic fires, and motor vehicles.

The Ministry for the Environment's Good Practice Guide for Assessing and Managing Dust (MfE, 2016) provides an overview of the potential impacts of dust. The potential impacts of limestone dust are discussed in the following sections.

5.1 Nature of Dust Discharges

The composition of the dust particles discharged from the SW Pit will be predominantly:

- Soil - from pit development; and
- Limestone ($CaCO_3$) - from the operation of the pit.

Particulate matter associated with amenity (or nuisance) effects are generally larger particles, usually termed dust or total suspended particulate (TSP), which tend to settle out of the air quickly. MfE (2016) defines dust as particulate matter larger than 20 µm and notes that soil and road dust are generally larger than 10 µm in size.

The greatest proportion of dust released on-site is likely to comprise of larger dust particles (e.g. greater than 30 µm in diameter) which tend to settle within 100 m of an emission source (MfE, 2016, & Minerals Policy Statement 2 (MPS2), Office of the Deputy Prime Minister, 2005).

Particles less than 10 µm in diameter (PM_{10}) as a result of activities undertaken on the Project site are not a significant component, in terms of amount or effect, of the total dust emissions from quarrying as described by the Institute of Air Quality Management (IAQM, 2016).

Likewise, discharges to air of particles less than 2.5 µm in diameter ($PM_{2.5}$) are negligible from quarries (IAQM, 2016). In any case, general measures to control nuisance dust will also control the finer fractions.

Factors that influence dust emissions from quarry activities are:

- The size of particulates within the quarried material;
- Disturbances of potentially dusty material such as during excavation, loading and unloading of materials;
- Wind speed across any exposed surfaces;
- Moisture content of the material;
- The area of exposed unconsolidated surfaces; and,
- Frequency of rain events and the time between rain events.

Based on consideration of these factors, the highest relative dust emission rate has been identified as on-site vehicle movements on unsealed surfaces, and the lowest emissions are expected from overburden and topsoil stockpiles. Other proposed activities are associated with a medium relative dust emission rate.

5.2 Health Effects

Limestone dust is odourless and white or greyish in colour and has the following potential impacts on human health.

Contact with pulverised limestone or limestone dust may cause:

- Irritation of the eyes;
- Dryness and irritation of the skin; and
- Discomfort or constipation if swallowed in large quantities via inhalation.

Limestone dust in the PM_{10} fraction may be inhaled into the respiratory system. Inhalation of pulverised limestone or limestone dust may cause irritation of the respiratory system resulting in coughing and/or sneezing. Higher exposures may cause a buildup of fluid in the lungs with severe shortness of breath.

Limestone is not listed by the International Agency for Research on Cancer (IARC) as a carcinogen, but this product may contain trace amounts of crystalline quartz silica (<5%) (Tanner et al., 2026), which has been classified by IARC as (Group I) carcinogenic to humans when inhaled. Prolonged or repeated inhalation of respirable crystalline silica can also cause a lung disorder, silicosis. This issue is addressed in Section 8.0 of this report.

The potential health impacts of limestone can occur from high short-term or lower long-term exposures. The people most likely to experience these types of exposures are the employees at the quarry. Graymont Health, Safety and Environment management staff informed PDP that health impacts have not been observed in Graymont's Oparure Quarry workers. It is noted that Graymont implements dust controls including engineering, isolation and PPE controls to ensure compliance with the Workplace Exposure Standard for calcium carbonate and respirable crystalline silica. People located off-site will experience much lower and less frequent exposure than Graymont's Oparure Quarry workers. An assessment of the impact of dust on sensitive receptors in relatively close proximity to the SW Pit is provided in Section 7.0 and an assessment on the potential health impacts in Section 8.0.

5.3 Soiling and Amenity Effects

Dust emissions arising from the proposed activities undertaken on the Project site have the potential to cause nuisance beyond the site boundary. In the surrounding environment, dust/particulate has the potential to cause annoyance to neighbours by the soiling of property, in particular, windows, houses, cars and also washed clothes that have been hung out to dry (as opposed to health effects due to PM_{10} exposure).

The degree of amenity effects tends to increase with darkening colour of dust. For example, coal dust is considered more offensive than grey aggregate dust.

Dusty conditions can adversely affect people's ability to enjoy an outdoor environment. For most people, the major effect of nuisance dust is the increased requirement for cleaning.

Airborne dust can cause effects on visibility and is largely considered a matter of aesthetics. Visibility effects are usually only a concern in the immediate vicinity of the source. Extreme loss of visibility can also be a safety concern for road traffic and aircraft. These issues are addressed in Section 7.0.

6.0 Assessment Criteria

6.1 Dust Impact Assessment Criteria

Dust effects are the principal issue for this assessment, so the relevant assessment criterion is the MfE Dust Good Practice Guide (GPG), which is consistent with the general permitted activity condition in the Waikato Regional Plan (WRP) Rule 6.1.8(c):

> *There shall be no discharge of particulate matter that is objectionable to the extent that it causes an adverse effect at or beyond the boundary of the subject property.*

Meeting this criterion for this proposed quarry operation means that it will meet all the other criteria in WRP Rule 6.1.8 (a – e). Potential effects are assessed against the above criteria using the FIDOL factors as described in Section 7.1.

6.2 Health Impact Assessment Criteria

6.2.1 PM_{10}

The relevant guidelines for assessing the off-site health effects of dust discharges from the SW Pit primarily relate to PM_{10} and are set out in the National Environmental Standards for Air Quality (MfE, 2004) and NZ Ambient Air Quality Guidelines (MfE, 2002) as follows:

- 50 µg/m³ as a 24-hour average, allowing one exceedance in a 12-month period (NESAQ, MfE, 2004); and
- 20 µg/m³ as an annual average (AAQG, MfE, 2002).

6.2.2 Respirable Crystalline Silica

There are no specific standards or guidelines for RCS in ambient air in New Zealand. The Ministry for the Environment (MfE 2016) recommends that applicable air quality assessment criteria are selected using a hierarchy. Based on this hierarchy, the most relevant international assessment criteria for RCS is:

- 3 µg/m³ RCS as an annual average, adopted from the California Office of Environmental Health Hazard Assessment Reference Exposure Level (COEHHA, 2005).

PDP has also reviewed the literature to identify an appropriate short-term health assessment criteria for RCS. This review found a Texas 24-hour average health assessment criteria of 24 µg/m³ (TCEQ 2020) was appropriate.

6.2.3 World Health Organisation Air Quality Guidelines

The World Health Organization (WHO) released new guidelines for PM_{10} which were 24-hour average 45 µg/m³ and annual average 15 µg/m³ (WHO 2021). The WHO guidelines are yet to be adopted by any regulatory body in NZ. However, for completeness, PDP has included an assessment of the predicted PM_{10} concentrations against these non-statutory population health guidelines.

6.3 Ecological Impact Criteria

The GPG indicates that at high dust loadings there is potential for dust deposition to have effects on plant life. These effects can include:

- Reduced photosynthesis due to reduced light penetration to the leaves;
- Increased incidence of plant pests and diseases;

- Reduced effectiveness of pesticide sprays due to reduced penetration; and,
- Rejection and downgrading of produce due to crop blemishing.

The impacts of dust on plants are variable and largely dependent on the chemical composition of the dust and plant type. It is difficult to determine a universal effects assessment criteria for the ecological effects of deposited dust. However, it is apparent that for most plant species, significant coating of dust would be required to diminish photosynthesis, with the toxicological responses to certain chemical species within the particles of greater importance. The relatively inert nature of the soil and limestone at Oparure Quarry is not expected to pose any toxicological risks to flora.

7.0 Assessment of Amenity Dust Impacts Development

Two potentially sensitive receptors have been identified for assessment of exposure to potential dust events as shown in Figure 1 and listed in Table 1.

7.1 Dust Assessment Methods

The assessment considers the FIDOL factors (frequency, intensity, duration, offensiveness, location) influencing dust events at the Project site and the ability of proposed mitigation measures to reduce these potential impacts. This is the approach recommended for assessment of nuisance dust effects in the MfE Dust GPG (2016), and specifically whether dust is likely to be objectionable to the extent that there is an adverse effect. This report also applies the Source-Pathway-Receptor (SPR) concept as described in the IAQM guidelines for assessment of mineral dust impacts (IAQM, 2016). Using the SPR assessment complements the FIDOL assessment method by providing an objective and semi-quantitative approach for determining the impact of each of the FIDOL factors. Together these two methods provide a robust and objective dust assessment.

7.2 Frequency

Figure 2 shows wind roses for the Oparure Quarry between October 2019 – June 2022. This shows the prevailing winds blow from the southwest and there are also significant winds from the west.

It was noted that careful consideration should be given to winds blowing from the north quadrant (towards the south) because the closest sensitive receptors are located in this direction. PDP's review of more recent June 2023 – January 2026 on-site data identified that the October 2019 – June 2022 data show a greater proportion of higher speed winds from the north quadrant toward the sensitive receptors and therefore provide a more conservative basis for the dust assessment.

Some seasonal variation is shown in Figure 6 with more westerlies and north-westerly winds occurring in spring.

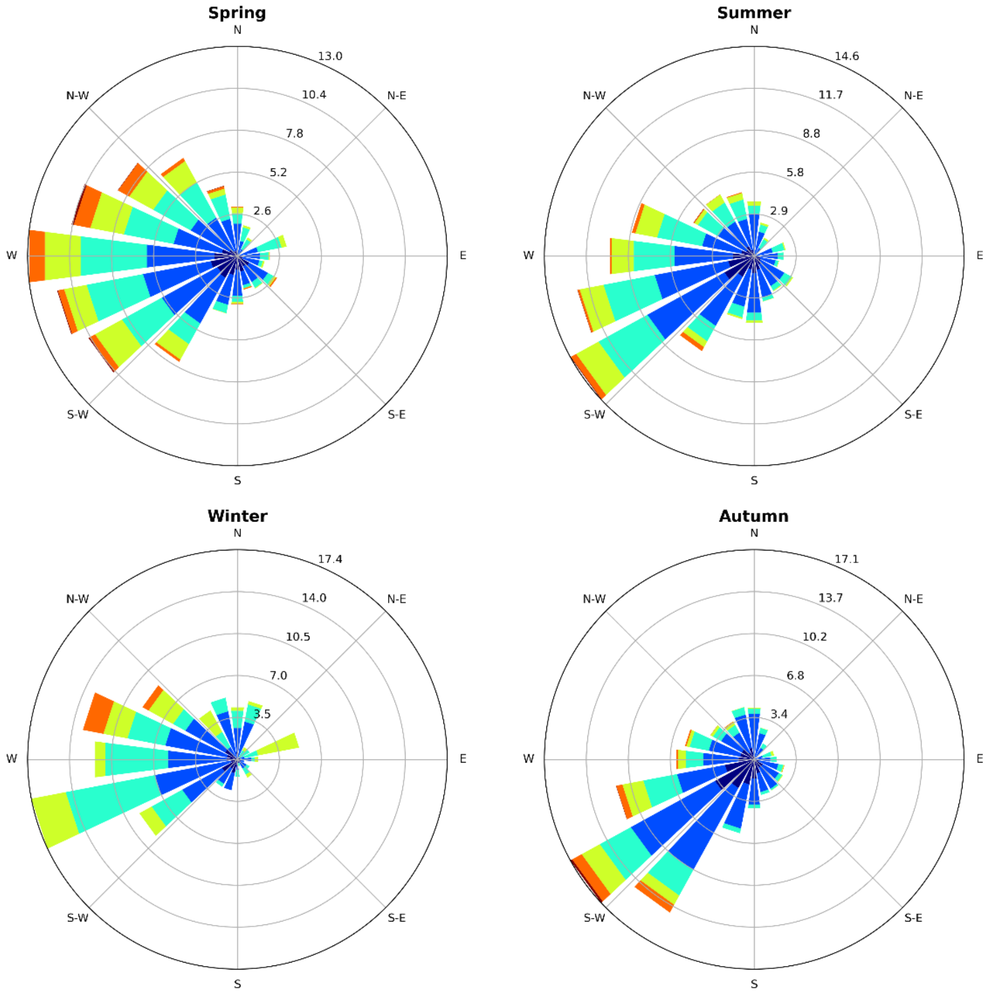

Figure 6: Seasonal wind roses for Graymont Quarry (October 2019-June 2022)

Figure 1 shows the locations of sensitive receptors SR01 and SR02 and their corresponding downwind impact arcs relative to the proposed operations (including the associated haul road). The downwind impact arcs shown indicate the wind directions considered when analysing which winds cause the sensitive receptor to be downwind from the proposed quarrying activities.

The method for classification of dry surface and wet surface days is described in Section 3.3. This classification was cross-referenced with surface wind data for the same date range to allow targeted analysis of dry days with wind speeds above specific values. These conditions are considered the highest risk for occurrence of potential dust events.

Table 4 shows the frequency with which the sensitive receptors are downwind from the SW Pit and then refines that assessment by considering the times when wind speeds are greater than 5 m/s and when these conditions coincide with dry surface days (i.e. the conditions which could cause dust to migrate beyond the site boundary and towards the nearest residential dwellings). The frequency at which the sensitive receptors are predicted to be downwind is very low at 0.24% for SR01 and 0.98% for SR02.

Table 4: Frequency that sensitive receptors are downwind from source

Sensitive Receptor		SR01	SR02
Shortest distance to SW Pit[1]		146 m	496 m
Time sensitive receptor is downwind (%)	**%**	12%	19%
	Number of hours/year	1058	1704
	Number of days/year	44	71
Time downwind with wind speeds above 5 m/s	**%**	1.4	3.1
	Number of hours/year	123	273
	Number of days/year	5	11
Time downwind with wind speeds above 5 m/s on dry days[2]	%	0.18%	1.00%
	Number of hours/year	16	88
	Number of days/year	0.7	3.7

Notes:

1. *Measurements based upon distance from notional boundary of 20 m from the house.*
2. *Dry day is defined as having less than 1 mm of rain.*

The IAQM guidelines state that for a 5% or lower frequency of winds > 5 m/s from the direction of the dust source on dry days towards a sensitive receptor, the wind frequency category is 'Infrequent'. Both of the sensitive receptors considered fall within the '**Infrequent**' exposure category.

7.3 Intensity

The intensity factor relates to the dust concentration at the receptor. We have evaluated this factor using the IAQM method for assessing pathway effectiveness in combination with considering the residual sources emissions (RSEs), i.e. with controls applied. An indicative intensity of the air discharge at the sensitive receptors has been obtained from dust deposition monitoring undertaken in close proximity to the existing Oparure Pit.

7.3.1 Pathway Effectiveness

The IAQM guidelines state that the distance between the dust source and the sensitive receptor is the primary factor influencing the pathway, with adjustments made depending upon the orientation of the receptor with respect to the prevailing wind and the topography, terrain, and physical features of the site.

A receptor that is 500 m or greater from any dust source is highly unlikely to experience any effects on amenity values. The Environment Protection Authority Victoria's recommended buffer distance for quarrying activities is 500 m (EPAV 2024). Guidance prepared by the Institute of Air Quality Management (IAQM 2016) for the assessment of dust from the minerals industry categorises receptors further than 200 m from a dust source as 'Distant' and those further than 100 m as 'Intermediate'.

The SR01 location is the closest identified sensitive receptor to the SW Pit at 146 m distance[6]. This is classified by the IAQM guidelines as an '**Intermediate**' receptor. Sensitive receptor SR02 is less than 500m from the closest boundary of the site so is at a greater distance than the IAQM classification of a '**Distant**' receptor.

These distances can be combined with the 'Infrequent' classification of winds using the matrix shown in Table 5. This gives an overall pathway effectiveness rating of 'Ineffective' for both sensitive receptors considered.

Table 5: Pathway Effectiveness (IAQM, 2016)

		Frequency of Potentially Dusty Winds			
		Infrequent	**Moderately Frequent**	**Frequent**	**Very Frequent**
Receptor Distance	**Close**	Ineffective	Moderately Effective	Highly Effective	Highly Effective
	Intermediate (SR01)	**Ineffective**	Moderately Effective	Moderately Effective	Highly Effective
	Distant (SR02)	**Ineffective**	Ineffective	Moderately Effective	Moderately Effective

Notes:
1. *Table as provided in IAQM (2016) – Table A3-4.*

The 'Ineffective' pathway classification can be combined with the Residual Source Emission type to estimate the Dust Impact Risk.

[6] Distance has been measured to a notional boundary 20 m from the walls of the house.

7.3.2 Residual Source Emission (RSE) determination

The second key factor in determining the intensity of potential dust impacts is determining the likely emission rate once mitigation measures have been applied, or the Residual Source Emission (RSE). According to the key factors for assessing RSEs listed in Section 5.1 of the IAQM guidelines, the characteristics of the proposed operations are:

- The scale of operations will be maintained at approximately the same level as that of the existing Oparure Pit, with SW Pit extraction replacing Oparure Pit extraction as the Oparure Pit is gradually closed;
- A staged quarrying operation has been proposed;
- The maximum extraction rate will be 1,000,000 tonnes per annum;
- The methods of working will be:
  - Topsoil and overburden stripped;
  - Topsoil and overburden stockpiled and used in rehabilitation within the previously quarried pit areas;
  - Benched excavation to desired pit depth;
  - Dump trucks enter the SW Pit via associated haul road (from the Oparure Pit processing area);
  - Limestone rock loaded at pit floor;
  - Filled dump trucks deliver rock to processing area;
  - Up to eight mobile machines (excavators, loaders, and trucks) including a water cart will be used on-site during site development, as noted in Section 4.2 above;
  - Up to 10 additional mobile machines (excavators, loaders, and trucks) including up to two water trucks will be used on site during operation, as noted in Section 4.3 above; and
  - Upon completion of initial site development, it is anticipated that site development and operations will occur concurrently.
- Material handling will be:
  - Topsoil used on rehabilitated areas or stockpiled;
  - Overburden will be used in previously quarried areas for rehabilitation or stockpiled on the northern side of the SW Pit haul road; and
  - Excavated material will be delivered to the processing area.

- Various mitigation measures are planned for the operation of the proposed quarry including:
  - Focussed watering for dust suppression when the distance between operations with the potential to create dust and nearby sensitive receptors is below an effective buffer distance of 250 m;
  - Maintaining current dust mitigation practices as used in the existing Oparure pit and quarry;
  - The use of water carts for targeted suppression of dust;
  - A 20 kmph vehicle speed limit is frequently used in quarries. However for the Graymont quarry due to the distance between the SW pit and processing area, a permanent speed limit of 20 km/hr is not practical, nor is one currently used for the Oparure pit. Graymont use other mitigation measures as a first line of dust reduction actions. However, as a Tier 2 (if and when needed) dust mitigation measure, Graymont will implement a speed limit for any vehicles travelling on unsealed surfaces within 250 metres of an external cadastral boundary of 20 kilometres per hour when the dust plume is approaching the site boundary; ; and,
  - The existing water management system will remain in place to allow recycling of much of the water used for dust suppression and reduce the likelihood of water shortage during times of low rainfall.

The IAQM guidelines break down site activities into seven categories and offer guidance parameters for determination of whether activities in each category are likely to be classified as 'Small', 'Medium', or 'Large' RSEs. These categories are assessed with regards to the proposed pit activities below:

- **Site preparation/restoration:** the anticipated working area of > 10 hectares is classified as 'Large'. The possibility for approximately seven heavy plant units operating simultaneously on development would be classified as 'Medium' but this risk is mitigated through the operation of a water cart for wetting of haul routes and active areas close to downwind boundaries during pit land disturbance operations. Overall, this category has a '**Large**' RSE classification due to the potential working area being greater than 10 hectares.
- **Mineral extraction**: a disturbed area of up to 60 hectares is anticipated and drilling and blasting is proposed to occur at approximately 7 – 10 day intervals. Once every 7 – 10 days is considered infrequent use of a high energy extraction method, therefore mineral extraction can be categorised as a '**Medium**' RSE.

- **Materials handling:** it is proposed to ensure that sufficient water is available for dust suppression of working areas within a buffer distance of 250 m between potential dust disturbing activities and the closest property identified as a potentially sensitive receptor during high-risk conditions (strong dry winds towards the receptor). Only SR01 is within 250 m of the boundary of the proposed working area but is still separated from the proposed boundary by 146 m. A distance of over 100 m from a site boundary is classified as a 'Small' RSE so targeting dust mitigation up to a separation distance of 250 m is considered to mitigate the potential for elevated dust. This category has been conservatively classified overall as '**Small**'.
- **On-site transportation**: 100 – 250 daily vehicle movements on unpaved surfaces is considered a 'Medium' RSE. However, the dust potential of the haul road has been lowered through the use of up to two water carts to wet the roads to reduce the risk of dust events. The AQMP also recommends limiting speed on unsealed surfaces to 20 km/hr when traveling within 250 m of the site boundary and when vehicle generated dust plumes approach the boundary of the site. These mitigation measures are considered to reduce the overall RSE for this category to '**Small**'.
- **Mineral processing:** the fixed processing area is not included as a part of this assessment as it is within the existing consented Oparure Pit operation. Processing of material from the SW Pit will use the existing fixed plant processing area and the mobile crushing and screening plant that is currently operating in the Oparure Pit. The overall processing rate of this consented operation is not anticipated to significantly change. The operation of the mobile crusher and screen is associated with a 'Medium' RSE due to its mobility. Basic good practice mitigation will be used when operating the mobile crusher and screen including locating it at maximum practical distance from the site boundary, reducing or ceasing operation during high dust risk conditions, using the crushing plant and screen within its design capacity and maintaining the plant to a good standard. Conservatively, this category has been classified overall as a '**Medium**' RSE.
- **Stockpiles/exposed surfaces:** The total area of proposed stockpiles of topsoil and/or overburden within the SW Pit and associated haul road area will be less than 2.5 ha. This is associated with a 'Small' RSE. Transfer of material to stockpiles is considered high risk, due to its daily frequency, but has a low risk dust potential, thereby resulting in a 'Medium' RSE. The proposed stockpile duration of over 1 year is considered a 'Large' RSE, but there are mitigation measures including grassing/hydroseeding of stockpiles that address the risks of stockpiling included in the proposed activities. Due to mitigation measures, this category has been classified overall as a '**Medium**' RSE.

- **Off-site transportation:** off-site transportation from the processing area will be along the paved access road to Oparure Road. This activity is covered under the existing consent for the Oparure Pit so has not been allocated an RSE within this assessment.

The highest RSE is the '**Large**' classification identified for the site preparation / restoration category. Combining the 'Ineffective' pathway and 'Large' RSE values using Table 6 gives an overall Dust Impact Risk of 'Low Risk' for the SW pit activities on both of the sensitive receptors considered in this assessment.

Table 6: Estimation of Dust Impact Risk

		Residual Source Emissions		
		Small	**Medium**	**Large**
Pathway Effectiveness	**Highly Effective Pathway**	Low Risk	Medium Risk	High Risk
	Moderately Effective Pathway	Negligible Risk	Low Risk	Medium Risk
	Ineffective Pathway	Negligible Risk	Negligible Risk	**Low Risk**

Notes:

1. *Table as provided in IAQM (2016) – Table A3-5.*

7.4 Duration

The duration of potential dust events is determined by the duration of the quarrying activities coinciding with the duration of strong, dry wind events when the dust emissions may be elevated.

Figure 7 shows the annual frequency and duration of high-risk wind conditions (an average hourly wind speed above 5 m/s blowing from the proposed site areas towards the sensitive receptors on dry days). The frequency of events rapidly declines with increasing duration. Theoretical exposure to an event greater than 6 hours in duration is predicted to occur twice per year for SR02. SR01 is not predicted to be exposed to any dry wind events greater than 3 hours in duration and SR02 is not predicted to be exposed to any wind events greater than 9 hours in duration.

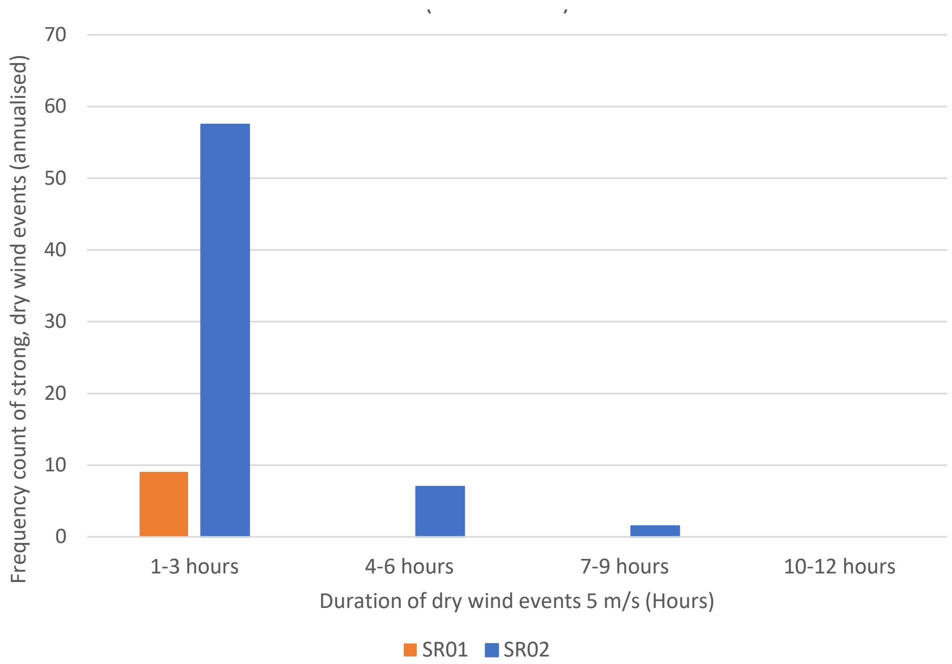

Figure 7: Annual frequency and duration of high-risk wind conditions blowing from the proposed operations towards sensitive receptors

7.5 Offensiveness

There are two main dust types from the SW Pit; stripped overburden soil stockpiles, and the extracted limestone.

The dust from the stripped overburden is light brown in colour, is inert in nature, and would only potentially cause a nuisance effect if it settles on surfaces. This is considered to be of low offensiveness, and consistent with dust expected in a rural environment.

Dust from the extracted rock is predominantly limestone, which is light in colour and of low visual offensiveness.

7.6 Location (Sensitivity of Receiving Environment)

The sensitive receptors in the receiving environment are discussed in Section 3.0. The surrounding area, other than Oparure Pit, is used for rural activities and is zoned as Rural within the proposed Waitomo District Plan.

The receiving environment will have background dust sources associated with rural activities, and the overall environment would be classified as having low sensitivity to dust. Despite this, SR01 and SR02 are rural dwellings that can be expected to have moderate to high sensitivity to dust nuisance impacts.

In the future, there is potential for additional dwellings or community facilities to be developed on the land surrounding the SW Pit site. Land that is not owned by Graymont within 250 m of the site boundary[7] is on the northern, western, and southern boundaries and any future development is expected to be low density due to the rural nature of the surrounding area. Prevailing winds blow from the west and southwest (i.e. towards the east and northeast). Due to the infrequency of winds towards potential future developments, there is potential for only minor adverse effects off-site for the closest possible developments. If sensitive future developments do occur within 250 m of the site boundary, use of targeted mitigation as described in the AQMP for the existing receptor SR01 will be adopted to reduce any potential impact from dust discharges to less than minor adverse effects. Due to the infrequent nature of winds towards potential future developments, any increase in water demand is anticipated to be within the water constraints of current site operations.

7.7 Cumulative Dust Impacts

There is a potential risk of a cumulative dust impact from the combined emissions of the Oparure Pit and its processing area, and the SW Pit.

Together, the long operating history of the Oparure Quarry without complaints, and the dust assessment written to support the reconsenting of the Oparure Pit indicate that the Oparure Pit is operated without causing any significant adverse dust impact on the receiving environment adjacent to the pit or on any of the identified sensitive receptors.

The extraction and processing rates of limestone from the quarry will not increase with the development of the SW Pit. However, the development of the SW Pit will initially increase the total area of quarry being worked. Therefore, in the development stage of the SW Pit there is a risk of a cumulative dust impact from the two pits. The two pits are located around 400 m apart at the closest point. Dust travel distances (IAQM 2016) indicate that impacts of dust are limited to an area within 250 m of the source. Therefore, the dust discharged from the SW Pit will have settled out of the air before it is able to add to the dust plume from the Oparure Pit.

There is an area between the two pits, through which the haul road runs, that is likely to experience increased dust deposition with the development of the SW Pit. The dust mitigation measures implemented at both pits and on the connecting haul road will reduce this cumulative impact of dust emissions. This land is owned by Graymont and is not considered highly sensitive to the deposition of dust.

[7] Distance based upon proposed separation distance within which to target application of water for dust suppression during high-risk conditions. For more details, see Section 9.1.

For the previous WRC consent application for the larger Pakeho Pit, in the WRC notification report they did not consider SRO2 as a potentially affected party. Since that WRC process ended, as part of the FTA processes Graymont has approached SR01 and SR02 and gained written approval from the owners of these two properties. Beyond the sign off from the two closest sensitive receptors PDP consider that any measurable cumulative impact of dust from the development and operations of the Oparure and SW Pits will be limited to a low sensitivity on-site area located between the pits. Given the pit separation and the distance of the pits to the site boundary, any off-site cumulative effects will be negligible.

7.8 Overall Finding of Dust Amenity Assessment

Table 7 provides a summary of the assessment of the FIDOL factors for the potentially sensitive receptors within 500 metres of the boundary of the SW Pit.

Table 7: Assessment summary of the FIDOL factors

Factor	Discussion	Risk Assessment
Frequency	SR01 and SR02 are downwind of the pit operations under weather conditions with the potential for dust effects very infrequently at less than 1% of the time.	Very low
Intensity	The pathway effectiveness method concludes that the pathway is ineffective and even with a large residual source emission, the risk is assessed as low.	Low
Duration	The duration of isolated events when wind conditions could give rise to dust travelling in the direction of sensitive receptors is short at up to 3 hours for receptor SR01 and 9 hours for SR02.	Very low
Offensiveness	The light colour character of the dust from soil and limestone has low offensiveness from deposition.	Low
Location	The environment is rural and generally considered of low sensitivity. The nearest sensitive receptor is 146 m from the SW Pit, with only one other receptor at more than 400 m distance, which will not be affected by deposited dust given this level of separation.	Low

Further, using the IAQM Source-Pathway-Receptor framework, Table 8 combines the 'Low Risk' Dust Impact Risk value derived from the frequency and intensity assessment with the 'High' receptor sensitivity classification to assess the magnitude of dust effects rated as a '**Slight Adverse Effect**' for SR01.

SR02 is at a distance of more than 400 m from the potential source so is outside the area for which a detailed assessment is recommended under the IAQM framework and will not be impacted by dust deposition effects at this distance. It is therefore concluded that the amenity impact at SR02 is negligible.

Table 8: Descriptors for Magnitude of Dust Effects (IAQM, 2016)

		Receptor Sensitivity		
		Low	**Medium**	**High**
Dust Impact Risk	High Risk	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Effect
	Medium Risk	Negligible Effect	Slight Adverse Effect	Moderate Adverse Effect
	Low Risk	Negligible Effect	Negligible Effect	**Slight Adverse Effect**
	Negligible Risk	Negligible Effect	Negligible Effect	**Negligible Effect**

Any measurable cumulative impact of dust from the development and operations of the Oparure and SW Pits will be limited to a low sensitivity area located between the pits. Given the pit separation and the distance of the pits to the site boundary, any off-site cumulative effects will be negligible.

Beyond SR01 and SR02, the FIDOL/S-P-R assessment clearly indicates that dust impacts over the rest of the receiving environment surrounding the SW Pit will be negligible. The measurements of inhalable and respirable and results from the dust and RCS Workspace Exposure Standards demonstrate that on-site concentrations of contaminants are not of any health impact concern. This risk further reduces for receptors off site and further from the dust sources.

8.0 Assessment of Effects - Health Effect of Dust

As detailed in Section 5.2 the potential human health impacts are driven primarily by the smaller size fraction of particulate (PM_{10} and smaller). Given the sources and type of dust which will be discharged from the SW Pit, PDP consider the human health impact from the discharge of dust from the development and operation of the pit likely to be less than minor because:

- PM_{10} and particularly $PM_{2.5}$ is not a significant component of the dust generated from quarry activities, and therefore dust emitted from the SW Pit is not generally in the inhalable fraction;
- Given low background PM_{10} concentrations of the rural environment, with the small contribution to PM_{10} from quarry activities, total cumulative concentrations of PM_{10} will be maintained well below the NESAQ criteria of 50 mg/m^3 as a 24-hour average and the AAQG criteria of 20 µg/m^3 as an annual average;
- Low toxicity of the soil and limestone dust particles (including low levels of respirable crystalline silica (RCS));
- Suppression of dust also suppresses PM_{10};
- Low number of, and large separation distance between, residential properties and the quarry;
- Low concentrations of PM_{10} experienced at the sensitive receptors located in relatively close proximity to the site boundary; and
- Lack of health impacts on the workers on the quarry site from relatively high exposure to dust.

Where no local data exist, background air quality can be categorised using the background air quality maps published by Waka Kotahi NZ Transport Agency.[8] For rural areas outside of Te Kūiti the assessed background PM_{10} is 20.1 µg/m^3 as a 24-hour average.

To help understand the potential level of PM_{10} concentrations from quarrying activities, PDP has reviewed the monitoring commissioned by Environment Canterbury in 2017 around the Yaldhurst quarry area.[9] In this study monitoring for PM_{10} was undertaken at 10 locations at a variety of different distances around the Yaldhurst quarries (Mote, 2018). The Yaldhurst study measured PM_{10} and RCS concentrations to assess the dust nuisance and the potential risk to public health. Yaldhurst represents a large area (230 ha) containing multiple quarries and a range of processing activities at a scale approximately six times larger than the SW Pit (39 ha).

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[8] NZTA. (2022). *Background Air Quality: Marokopa Census Area Unit.*
[9] Mote Ltd. (19/06/2018). *Yaldhurst Air Quality Monitoring – Summary Report: 22 December – 21 April 2018.*

While this PM_{10} data is from a different location, it is a high quality and comprehensive data set collected from a quarrying area that is larger than the SW Pit. This data set provides robust information to inform a conservative (worst case) a health impact assessment for the SW Pit.

Monitoring of PM_{10} at distances downwind of the Yaldhurst quarries showed that at around 160 m downwind of the nearest boundary the PM_{10} concentrations were estimated to have increased on average by approximately 4 µg/m³ as a 24-hour average. PDP estimates that the worst case cumulative (SW Pit activities plus background including the existing Oparure Quarry and processing activities and other rural activities) the 24-hour PM_{10} concentration at the closest sensitive receptor (SR01) will be much lower than the relevant NESAQ ambient air quality standard.

The IAQM (2016) collated a significant body of PM_{10} monitoring data from sites located within 1 km of quarries. Figure 8 shows average mineral site PM_{10} increment as a function of distance from the quarry. Figure 9 shows average mineral site PM_{10} increment as a function of distance from the quarry by mineral type.

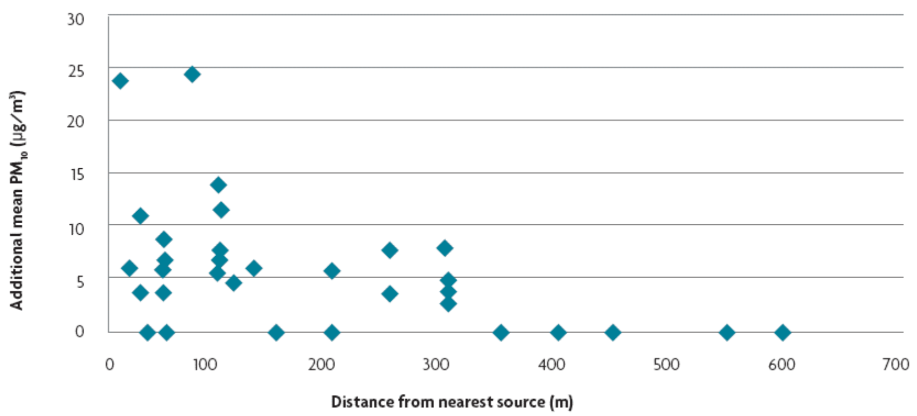

Figure 8: Mineral site PM_{10} increment as a function of distance from the quarry (IAQM 2016)

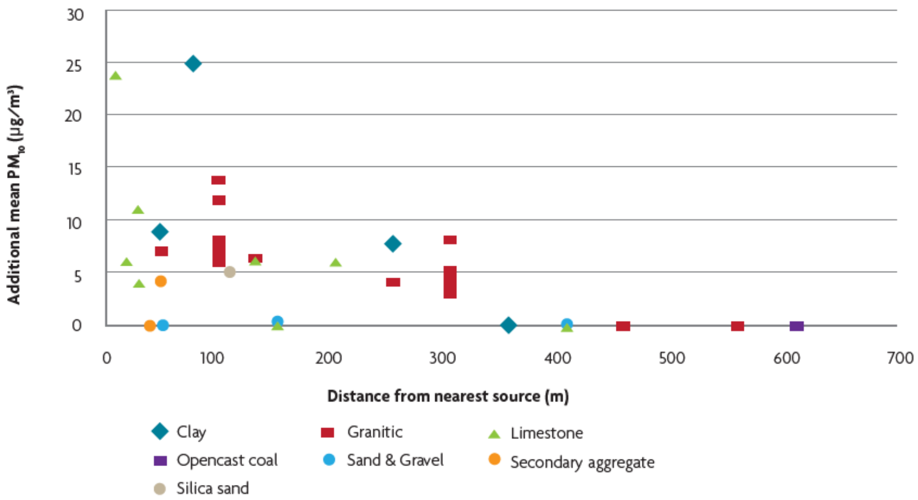

Figure 9: Mineral site PM_{10} increment as a function of distance from the quarry by mineral type (IAQM 2016)

Figure 8 shows that at a distance of 200 m downwind of a quarry the average PM_{10} increment measured by IAQM was approximately 5 µg/m^3. This compares well with the Yaldhurst quarries study.

Given the increase of PM_{10} concentrations monitored at Yaldhurst and as analysed by IAQM (2016), at the approximate distance of SR01, the low frequency and duration of wind blowing towards SR01, the relative scales of the quarry areas, and likely background concentrations, PDP concludes that the NESAQ for PM_{10} will not be exceeded as a result of the SW Pit development or operation. PDP further concludes that concentrations of PM_{10} (and consequently $PM_{2.5}$) will be maintained well below the relevant standards and guidelines in the vicinity of the site.

RCS was not found in air at concentrations of concern for human health in the vicinity of the Yaldhurst quarries. We expect that this will also be the case for the SW pit given the considerably smaller scale of the operations compared to Yaldhurst and the negligible quartz content of limestone (predominantly calcium carbonate) compared to the aggregate material being extracted and processed at the Yaldhurst quarries.

Graymont has an ongoing programme to measure worker exposures to hazardous air substances. This work is undertaken by Paragon Health and Safety Limited. The two most recent monitoring cycles were untaken in January 2022[10] and in April 2024[11]. The assessments considered worker exposures to inhalable and respirable

[10] Assessment of Worker Exposures to Noise and Hazardous Substances – Oparure Quarry. Paragon Health and Safety Limited. 18 February 2022. Report number LP05-21.
[11] Assessment of Worker Exposures to Noise and Hazardous Substances – Oparure Quarry. Paragon Health and Safety Limited. 2 April 2024. Report number LP02-24.

dust from routine operations. The dust measurements taken for the assessment demonstrated that workplace dust concentrations were sufficiently below the relevant Workplace Exposure Standard to conclude that the risk of respiratory irritation is low for most people. RCS was not detected in any of the samples.

In summary, PDP concludes there are negligible health risks from airborne dust discharged from the SW Pit for any sensitive receptors beyond the site boundary.

9.0 Mitigation of Dust Emissions

The assessment of dust impacts found that only one receptor, SR01 has the potential to be slightly adversely affected by nuisance dust impacts. Due to the separation and location of SR01 and with the additional mitigation measures proposed by Graymont the actual risk of dust impacts is considered to be negligible, and dust was assessed as a less than minor adverse effect.

The main management and mitigation measures for dust control used during the development and operation of the pit will be detailed by the AQMP and include good management of quarry operations and wind monitoring to determine the times when water suppression will be implemented.

9.1 Water Suppression

Although a separation distance of 500 m was used for identification of potential sensitive receptors for detailed assessment to align with EPA Victoria Guidelines (2013), experience in New Zealand is that there are limited effects of dust discharges on receptors beyond a distance of 250 m. This is backed up by IAQM (2016) which indicates that nuisance dust will generally travel up to 250 m from the source before returning to the surface. The targeted application of water for dust suppression proposed by Graymont and detailed in the AQMP prioritises water application to sources of potential dust discharges within 250 m of the site boundary when winds are blowing towards the site boundary. This targeted approach will maximise the reduction of nuisance dust and ensure the most efficient use of water for dust suppression.

9.1.1 Volume of water available on site

The existing operation in the Oparure Pit operates an on-site water management system which allows use of recycled water for dust suppression. Surface flows from the processing plant comprising runoff from rainfall and water from truck wash and wheel wash areas are directed through sediment traps to an on-site stormwater collection pond. The pond ('water storage lagoon') was constructed in 1997 with a capacity of 5,680 m^3 and an approximate depth of 3.5 m. Water is pumped from this pond to the water management system for re-distribution around the site to be used for dust suppression on haul roads and access roads, truck washdown and wheel wash. The current consented allowance for water use from the stormwater collection pond is 200 m^3 per day (m^3/day).

Stormwater pond water take records for the period October 2023 to December 2025 confirm that the maximum water take for dust suppression from current Oparure quarry operations has been 152 m³/day. The average stormwater pond water take over that period is 36 m³/day.

Graymont also has a consent to take 100 m³/day of groundwater from an on-site bore which is used for potable water and for the scrubbing/cooling of exhaust gasses from the lime kiln within the processing plant.

Water take data from Oparure bore show that, on average, Graymont use 42 m^3/day of this 100 m^3/day consented take. This means, on average, 58 m^3/day would be available to supplement the consented 200 m^3/day water take from the Oparure stormwater pond. The 58 m^3 bore water combined with the 200 m^3 stormwater take brings the total volume of water available for dust suppression to 258 m^3/day.

In October 2021 Graymont installed and are now operating a water metering system on the outlet from the water storage lagoon. This system allows Graymont to accurately quantify and better manage the volume of water used for dust suppression. Figure 10 shows Graymont's water use data for their Oparure Quarry water storage lagoon from October 2023 to December 2025 based on average pump flow and hours of operation.

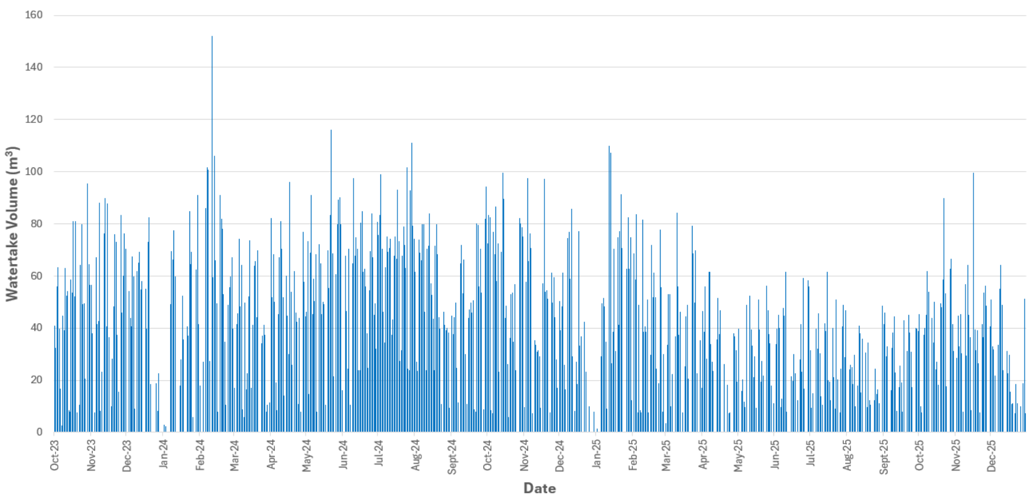

Figure 10: Water use data for Oparure Quarry from October 2023 to December 2025

Figure 10 indicates an overall average of approximately 36 m³/day of water pumped to the water management system from the pond and a maximum daily take of 152 m³/day. This is less than the consented take of 200 m³/day so there is potential for pump rates to be increased within the current allocation.

When the SW Pit is fully developed and before the Oparure Pit is fully backfilled and remediated, the total exposed area of the combined SW and Oparure pits could be slightly larger than the exposed area of the current Oparure Pit. The larger exposed area suggests there may be an increased water demand for dust suppression. However, in reality the production rate of the site will remain similar and the progressive quarrying and filling operation is not likely to greater increase the total exposed area. Combining these factors means that the actual water demand for dust suppression is highly unlikely to increase from current levels and shall remain well within the available combined water take capacity.

Since Graymont took over the operation of the Oparure Quarry in 2015, the site has never had a dust complaint. This demonstrates that using the current control measures, the available water volume is sufficient to ensure that any off-site impacts are not offensive or objectionable.

Graymont will manage water shortage risk by monitoring water levels in the stormwater collection pond. If the volume of water in the pond dips below 2,000 m^3 the water taken from the pond for dust suppression will be carefully managed and water sourced for dust suppression will be supplemented by the ground water take. This management strategy will reduce demand on the pond water and extend the period over which the pond can supply water. Between the pond and bore water sources, Graymont has a secure supply of water for dust suppression.

The on-site meteorological monitoring systems will further enable staff to identify high and low risk dust conditions and manage water used for dust suppression in a “smart” way. Saving dust suppression water during low dust risk periods will allow for an increased volume being available during high-risk dust periods. Using on site meteorological data to manage dust risk will lead to a more efficient use of water available, especially during summer months if the water level in the lagoon is below 2,000 m^3.

Given the maximum realistic travel distance of dust from the quarry is 250 m beyond the source, in the unlikely circumstances that water for dust suppression was limited, with quarry management targeting high risk areas an appropriate level of control could be achieved with a lower volume of water than is currently needed.

In summary, given the volume of the pond, the backup bore water supply, and the improved water monitoring and management practices, it is concluded that the volume of water available on the site is adequate to control dust discharges from the operation of both the Oparure and SW Pits.

9.1.2 Proposed approach for dust suppression water use

It is proposed that dust suppression water will be applied according to a prioritisation schedule (as detailed in Table 9) to ensure that sufficient water remains available for top priority weather conditions and areas. This schedule will ensure that dust suppression watering is prioritised to manage dust sources with the potential to impact neighbouring sensitive receptors and to ensure worker safety. The priority dust sources for water suppression are summarised in Table 9 below and is covered in more detail in the AQMP for the proposed site. Figure 11 provides a map showing the Oparure Pit and SW Pit priority areas for dust suppression water. Triggers for dust suppression will be linked to high wind speeds occurring during dry days, with staff being alerted to high-risk conditions through the on-site meteorological monitoring described in Section 9.2. The highest priority dust sources are active haul roads and the processing area.

Table 9: Priority Dust Sources for Water Suppression

Water Priority	Type of Source
1	Active Haul Roads (red and blue lines)
2	Processing area (light blue box)
3	Product stockpile area (light green shape)
4	Overburden haul road example (yellow line)
5	Working Area

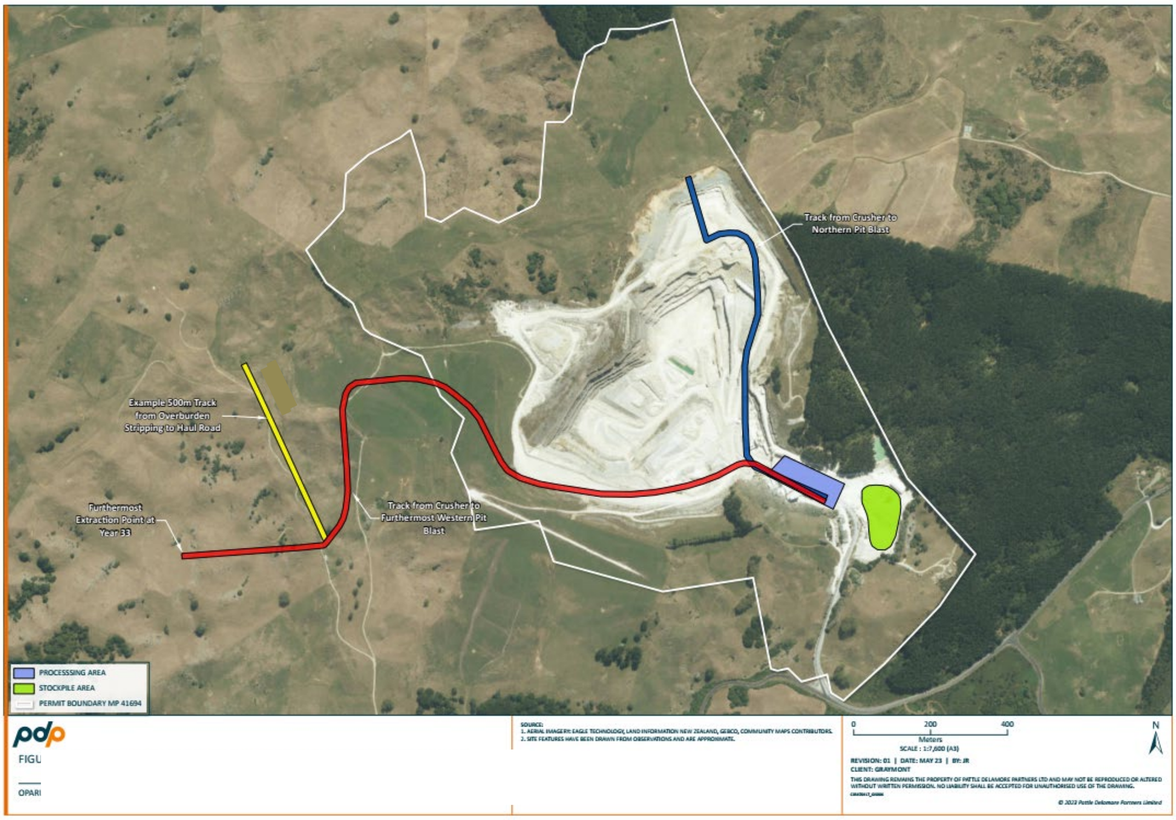

Figure 11: Oparure Pit and SW Pit priority areas for dust suppression water

Table 10 shows the area covered by priority dust sources in the Oparure Pit and SW Pit.

Table 10: Areas for priority dust sources in the Oparure Pit and SW Pit		
Pit	**Dust Source**	**Approximate Area (ha)**
Oparure	Active haul Road- Track from crusher to northern pit blast (approx. 14.4 m wide x 1.2 km long)	1.7
	Processing area (PLS/aglime area)	1.3
	Product stockpile area	1.3
	Total area	**4.3**
SW	Active haul Road - Track crusher to furthermost blast face. (approx. 14.4 m wide x 2 km long)	2.9
	Processing area (PLS/aglime area)	1.3
	Product stockpile area	1.3
	Overburden haul road - Example track overburden stripping to main haul road (14.4 m wide x 400 m long)	0.5
	Total area	**6.0**

For the Oparure Pit, the maximum water demand for dust suppression is 152 m^3/day or 35 m^3/day/ha. This measured water take (and dust suppression application volume) has been demonstrated as sufficient to ensure there have been no dust complaints nor visible dust plumes extending beyond the boundary of the Oparure Pit. This consent compliance record indicates the same dust suppression water application rate will be appropriate for the SW Pit.

The maximum actual water use for dust suppression in the Oparure Pit and the maximum estimated water use for dust suppression in the SW Pit is shown in Table 11. Table 11 also shows maximum estimated water use for dust suppression for a third operational scenario where the Oparure Pit and SW Pit are operated for half a day each. Finally, Table 11 compares the water demand with the water available and presents the daily volume of surplus water.

Table 11: Water demand for dust suppression in the Oparure Pit and SW Pit

Pit	Water use rate (m^3/ha/day)	Priority Area (ha)	Water demand (m^3/day)	Water available (m^3/day)	Water surplus (m^3/day)
Oparure	36	4.3	155	258	103
SW		6.0	215	258	43
Oparure and SW		5.4	194	258	64

The information presented in Table 11 demonstrates there is sufficient headroom within the consented water take (stormwater + groundwater) to provide adequate dust suppression water for the SW Pit and the combined pit operating scenarios.

9.2 Meteorological Monitoring

The Oparure Pit monitors on-site wind speed, wind direction and rainfall. The location of the meteorological site has been selected to provide data that is, as far as practical, representative for the whole site including the SW Pit (See 3.3).

The risk of dust discharges increases during dry days, with high wind speeds blowing in the direction of sensitive receptors. The monitoring and communication of meteorological conditions to on-site staff will be used to enhance the proactive control of dust emissions. The meteorological site telemeters data in real-time and has an inbuilt alert system which sends text and e-mail messages to the relevant Graymont staff. The alert system will be set up to provide warnings when high risk dust conditions occur and enable additional dust mitigation measures to be put in place as required. The dust risk warning system and mitigation processes are detailed in the AQMP.

9.3 Dust Monitoring

On-site dust monitoring is not proposed as part of the SW Pit expansion because of the relatively low sensitivity of the receiving environment and buffer distances between dust sources and sensitive receptors. However, the wind speed and direction alert system described in Section 9.2 and in the AQMP is considered to provide sufficient risk assessment of off-site dust effects. Real-time dust monitoring will not provide any significant benefit to either the risk assessment process or to the control of dust from the SW Pit. However, in accordance with good practice for dust management it is recommended that regular visual dust monitoring is undertaken and recorded and these processes are detailed in the AQMP.

9.4 Air Quality Management Plan

The AQMP includes details on the two-tier approach that will be used for mitigation of on-site dust during the development and operation of the SW Pit. Before being implemented the AQMP will be submitted to the WRC for review and certification.

An AQMP is a generally accepted good practice approach to implementing dust mitigation measures at quarry sites. The AQMP describes how Graymont will provide effective dust mitigation using their available water supply through a combination of real-time wind monitoring and targeted water suppression in response to high-risk weather conditions.

10.0 Assessment Summary

The main air quality issue associated with the SW Pit is the potential for adverse effects from dust discharges beyond the boundary due to quarrying and material processing operations. Dust can be considered objectionable to the extent that there is an adverse effect from soiling and amenity effects. Finer fractions of particulate matter can cause health effects. New Zealand and Australian guidelines indicate that adverse effects from quarries can potentially be experienced within 250 m, and under EPA Victoria (2024) guidance consideration of effects has been extended out to 500 m from the site due to the use of blasting.

The SW Pit is located in a rural area with a low density of dwellings and is therefore considered a low sensitivity receiving environment. There are only two residential dwellings for which the dust impact must be assessed. These two dwellings are separated by 146 m and 496 m from the SW Pit boundary. Given the FIDOL and S-P-R assessment, and proposed mitigation, the actual risk of dust impacts at these dwellings is assessed as being negligible and the Project is considered unlikely to cause offensive or objectionable dust effects.

Any measurable cumulative impact of inhalable and respirable dust from the development and operations of the Oparure and SW Pits will be limited to a low sensitivity on-site area located between the pits. Given the pit separation and the distance of the pits to the site boundary, any off-site cumulative effects will be negligible.

Beyond the sensitive receptors specifically covered in the assessment, the FIDOL and S-P-R assessment clearly demonstrates that dust amenity and health impacts in the area surrounding the SW Pit will be negligible.

In addition, good practice mitigation measures to control dust will be specified in an Air Quality Management Plan, which will include the use of water to suppress dust when required.

11.0 References

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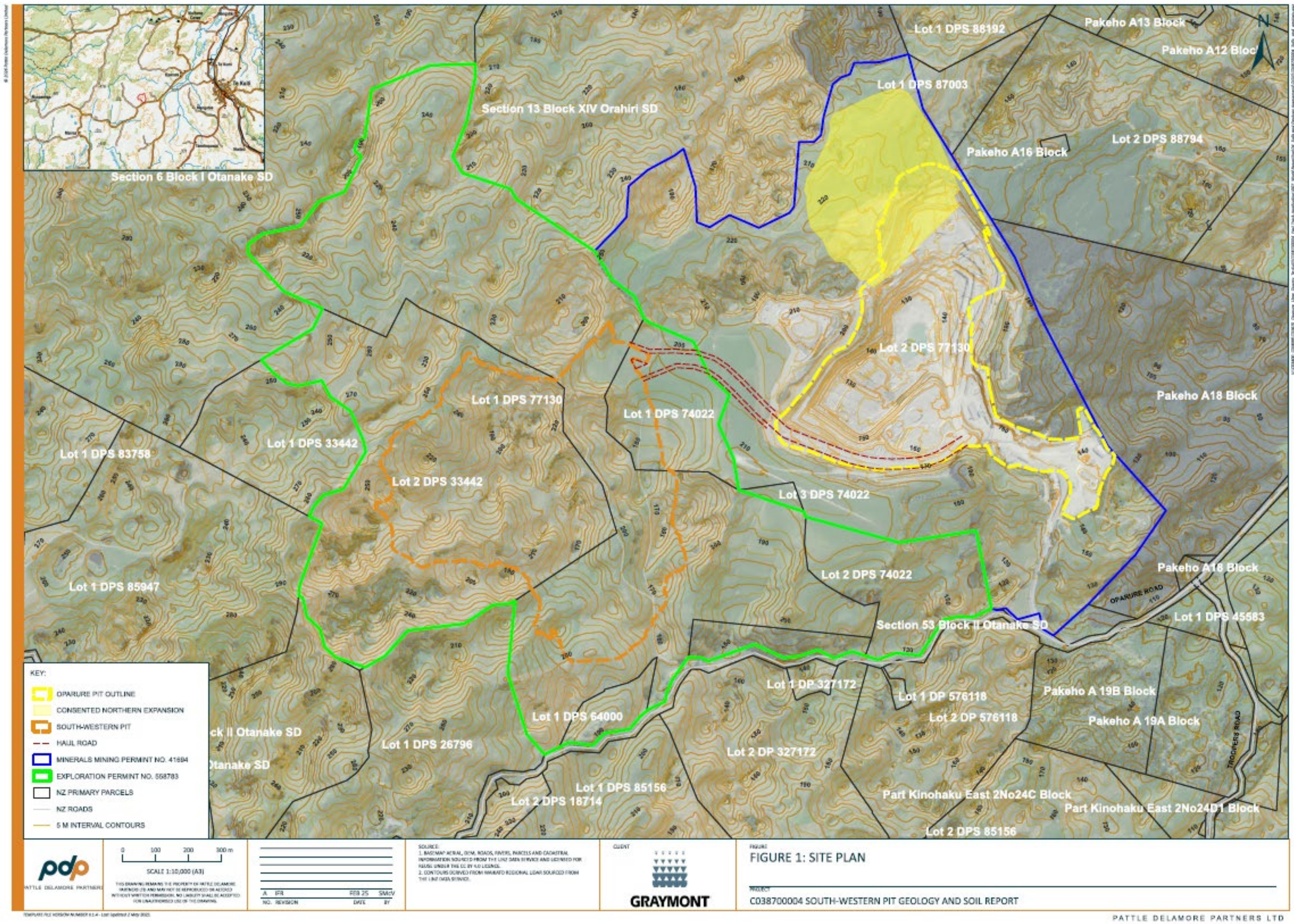
Appendix A: Site Diagram

Appendix B: Te Kūiti EWS Wind Roses
October 2019 – October 2024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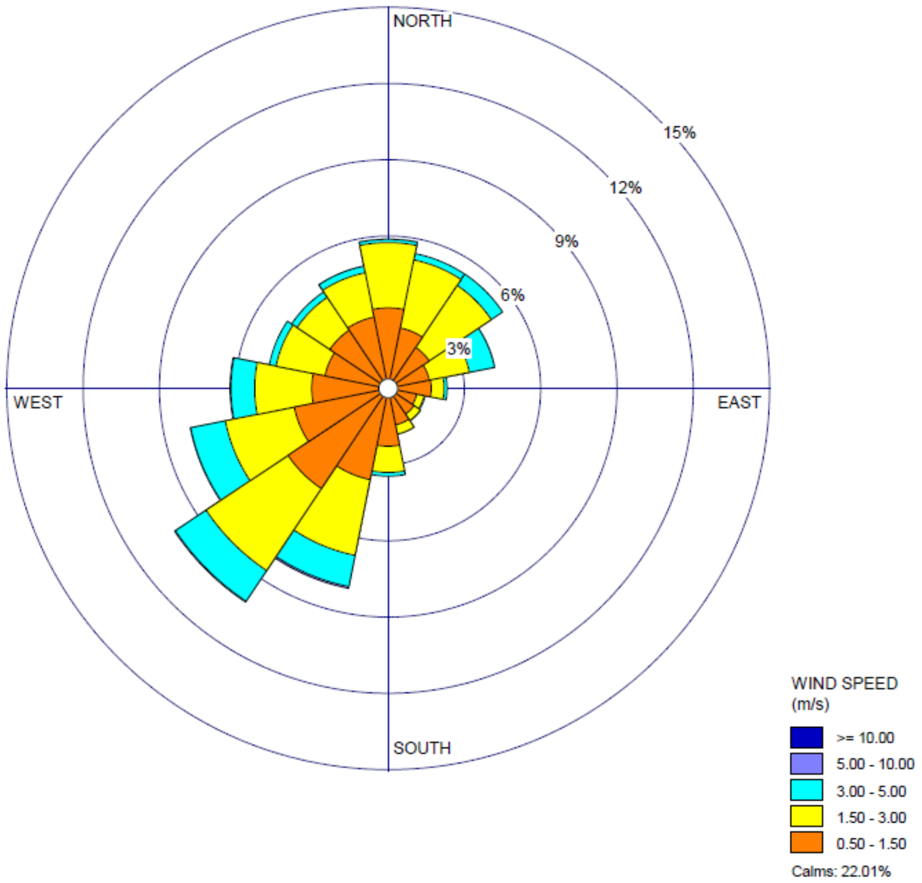
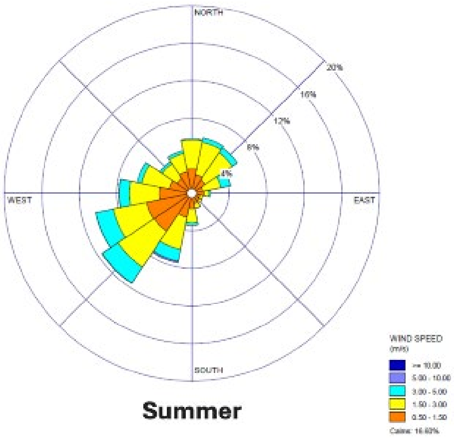
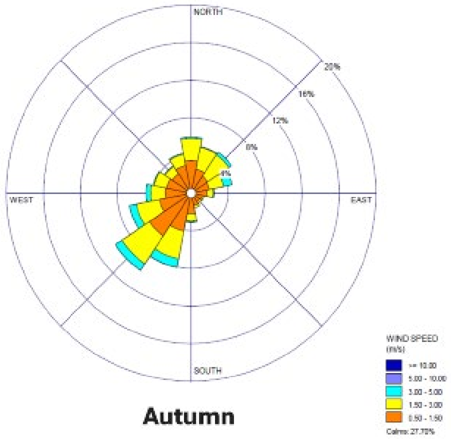
Pakeho A13 Block
Pakeho A12 Block
Lot 1 DPS 87003
Section 13 Block XIV Orahiri SD
Pakeho A16 Block
Lot 2 DPS 88794
Section 6 Block I Otanake SD
Lot 2 DPS 77130
Lot 1 DPS 77130
Lot 1 DPS 74022
Pakeho A18 Block
Lot 1 DPS 33442
Lot 1 DPS 83758
Lot 2 DPS 33442
Lot 3 DPS 74022
Lot 2 DPS 74022
Lot 1 DPS 85947
Pakeho A18 Block
OPARURE ROAD
Lot 1 DPS 45583
Section 53 Block II Otanake SD
Lot 1 DP 327172
Lot 1 DP 576118
Lot 2 DP 576118
Pakeho A 19B Block
Pakeho A 19A Block
Lot 1 DPS 64000
Lot 1 DPS 26796
Lot 2 DP 327172
Lot 1 DPS 85156
Lot 2 DPS 18714
Part Kinohaku East 2No24C Block
Part Kinohaku East 2No24D1 Block
Lot 2 DPS 85156
KEY:
OPARURE PIT OUTLINE
CONSENTED NORTHERN EXPANSION
SOUTH-WESTERN PIT
HAUL ROAD
MINERALS MINING PERMIT NO. 41694
EXPLORATION PERMIT NO. 558783
NZ PRIMARY PARCELS
NZ ROADS
5 M INTERVAL CONTOURS
SCALE 1:10,000 (A3)
GRAYMONT
FIGURE 1: SITE PLAN
C038700004 SOUTH-WESTERN PIT GEOLOGY AND SOIL REPORT
PATTLE DELAMORE PARTNERS LTD

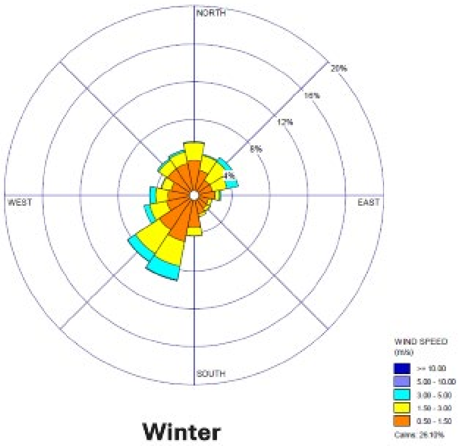

NORTH
SOUTH
EAST
WEST
3%
6%
9%
12%
15%
WIND SPEED
(m/s)
>= 10.00
5.00 - 10.00
3.00 - 5.00
1.50 - 3.00
0.50 - 1.50
Calms: 22.01%



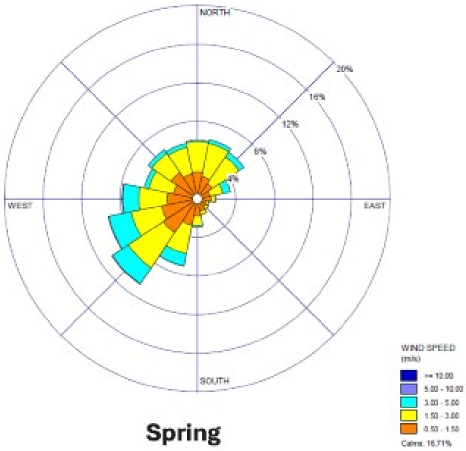
Summer



Autumn



Winter



Spring