Appendix G – Air Quality Assessment

Air Quality Assessment of the Tweed Sand Plant Expansion

Prepared for:

Hanson Construction Materials Pty Ltd

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Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Ground Floor, 16 Marie Street | PO Box 2217
Milton, Brisbane, Queensland, 4064, Australia

www.katestone.global
admin@katestone.com.au
Ph +61 7 3369 3699

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Prepared by:	Sarah-Jane Donnelly and Andrew Vernon
Reviewed by:	Simon Welchman
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Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
µm	microns
°C	degrees Celsius
g/m^2/month	grams per square meter per month
km	kilometre
ha	hectare
m	metre
m/s	metres per second
m^2	square metres
tpa	tonnes per annum
Nomenclature	**Definition**
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
TSP	total suspended particles
Abbreviations	**Definition**
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AQIA	Air Quality Impact Assessment
BoM	Bureau of Meteorology
DA	Development Application
DES	Queensland Department of Environment and Science
DPIE	NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPL	Environmental Protection Licence
Hanson	Hanson Construction Materials Pty Ltd
NSW	New South Wales
NSW EPA	New South Wales Environmental Protection Authority
POEO Act	*Protection of the Environment (Operations) Act 1997*
TAPM	The Air Pollution Model

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) has been commissioned by Hanson Construction Materials Pty Ltd (Hanson) to prepare an Air Quality Impact Assessment (AQIA) to support an expansion of its existing Tweed Sand Plant located at Altona Road, Cudgen, in northern New South Wales (NSW).

The proposed expansion includes an increase in the approved sand production rate from 500,000 tonnes per annum (tpa) up to 950,000 tpa. The total area for the Tweed Sand Plant site would increase from 77 hectares (ha) to approximately 236 ha.

This AQIA has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) as they relate to air quality including:

- A detailed assessment of potential construction and operational impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10},
- Considers dust and other emissions generated from dredging, processing, operational activities and transportation of products.
- Discusses reasonable and feasible mitigation measures to minimise dust and emissions.
- Provides monitoring and management measures.

The AQIA has used a dispersion modelling approach conducted in accordance with the EPA's Approved Methods. A site-specific meteorological data file for 2019 has been generated using the TAPM and CALMET meteorological models and local meteorological measurements. The meteorological modelling has accounted for local terrain and land use features of the region.

Dust (as TSP, PM_{10}, $PM_{2.5}$ and deposition rate) from the proposed Tweed Sand Plant expansion operations has been considered in the AQIA. The CALPUFF dispersion model has been used to predict ground-level concentrations of dust as a result of two stages of the development of the proposed Tweed Sand Plant expansion, Phase 1-6 and Phase 7-11. A cumulative assessment that includes addition of ambient backgrounds has been conducted. The results of the dispersion modelling have been assessed against the relevant impact assessment criteria in NSW.

The results of the AQIA show the following:

TSP

- Annual average ground-level concentrations of TSP are predicted to comply with the relevant impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and with background levels for both stages of the development.

PM_{10}

- Maximum 24-hour average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both stages of the development.

- For the cumulative assessment of 24-hour average concentrations of PM_{10}, a level 2 (contemporaneous) assessment was conducted, which shows the following:
  - For Phase 1-6, the Tweed Sand Plant is predicted to contribute to between one and three additional days that exceed the impact assessment criterion at sensitive receptors R5 – R15, which are to the immediate southeast of the existing washplant.
  - Of these receptors, R11 is the closest to the Tweed Sand Plant (300m) and predicted the greatest number of additional exceedances of the 24-hour average impact assessment criterion for PM_{10} (3). The maximum contribution of Tweed Sand Plant to an exceedance at R11 is 12% compared to background.
  - For Phase 7-11, the Tweed Sand Plant is predicted to contribute one additional day that exceeds the impact assessment criterion at sensitive receptors R9 – R12, which are to the immediate southeast of the site boundary.
  - Of these receptors, R11 is the closest to the site and the maximum contribution of Tweed Sand Plant to an exceedance at R11 is 8% compared to background.
- The Approved Methods requires that a proponent demonstrate that a proposed development does not result in additional exceedances of the impact assessment criteria at sensitive receptors. Hanson will ensure compliance with the air quality criterion is achieved in practice through a proactive and reactive management strategy, whereby, watering will be increased and/or certain operations will cease during periods of elevated dust risk. Key features of this strategy will be managed using the proposed dust monitoring program and weather forecasts.
- Annual average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both stages of the development.

$PM_{2.5}$

- Maximum 24-hour average ground-level concentrations of $PM_{2.5}$ are predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both stages of the development.
- A level 2 (contemporaneous) assessment 24-hour average concentrations of $PM_{2.5}$ was conducted, which shows that the Tweed Sand Plant is predicted to result in no additional days that exceed the impact assessment criterion for both stages of the development.
- Annual average ground-level concentrations of $PM_{2.5}$ were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both stages of the development.

Dust deposition

- Annual average dust deposition rates are predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background levels for both stages of the development.

Monitoring and mitigation

Overall, the contribution of the proposed Tweed Sand Plant expansion to air pollutant levels in the region is low compared to background. On a small number of occasions there is potential for Tweed Sand Plant operations combined with background to result in elevated concentrations of PM_{10}. On these occasions, the contribution of

Tweed Sand Plant is small (less than 12%) and background air quality dominates. Accordingly, Hanson proposes to implement a proactive and reactive strategy that includes real time PM_{10} monitoring and ongoing use of weather forecasts to ensure that Hanson can effectively manage operations, through increased watering or ceasing operations, during times of elevated dust risk, which will ensure that no additional exceedances occur due to the expansion.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) has been commissioned by Hanson Construction Materials Pty Ltd (Hanson) to prepare an Air Quality Impact Assessment (AQIA) to support an expansion of its existing Tweed Sand Plant located at Altona Road, Cudgen, in northern New South Wales (NSW).

Hanson operates under an existing Notice of Modification to DA 152-6-2005 issued by the New South Wales Department of Planning, Industry & Environment (DPIE) on 20 August 2018 that allows for extraction and screening of material up to 500,000 tonnes per annum (tpa). Hanson also holds an Environment Protection Licence (EPL) number 11453 issued under the *Protection of the Environment Operations Act 1997*.

The current approved sand extraction site includes the following lots: 22DP1082435, 23DP1077509 and 494DP720450 with a total area of 77 hectares (ha). The proposed expansion includes an increase in the sand production rate up to a maximum of 950,000 tpa. The sand extraction area will also be extended to Lot 1 DP1250570, Lot 2 DP1192506, Lot 3 DP1243752, Lot 51 DP1166990 and Lot 50 DP1056966. The total area of the expanded Tweed Sand Plant would be approximately 236 ha.

This report details an AQIA of the proposed Tweed Sand Plant expansion for inclusion in the Environmental Impact Statement (EIS) required to be submitted to the DPIE under Section 4.12(8) of the *Environmental Planning and Assessment Act 1979* and *Schedule 2 of the Environmental Planning and Assessment Regulation 2000*.

In December 2019, the Planning Secretary's Environmental Assessment Requirements were issued for the preparation of the EIS for the proposed development. In relation to air quality, the SEARs state:

- *"A detailed assessment of potential construction and operational impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy.*
- *Dust and other emissions generated from blasting, processing, operational activities and transportation of products.*
- *Reasonable and feasible mitigation measures to minimise dust and emissions.*
- *Monitoring and management measures, in particular, real-time air quality monitoring."*

The SEARs identify the following Environmental Planning Instruments, Policies, Guidelines and Plans that are relevant to the EIS for the proposed development:

- Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (DPIE)
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA)
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (EPA)
- Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for inclusion into the 'Approved Methods for the Sampling and Analysis of Air Pollutants in NSW, Australia' (EPA)
- National Greenhouse Accounts Factors (Commonwealth).

This AQIA has been prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (*Approved Methods*)* (EPA, 2017) and aims to quantify the potential impact of the expansion on air quality in the local area.

The scope of works of the AQIA is as follows:

- Describe baseline conditions, including:
    - Nearest existing and likely future sensitive receptors
    - Activities in the region
    - Ambient air quality levels in the area, based on publicly available information
    - Local meteorological patterns.
- Summarise legislative requirements and guidelines relevant to air quality impacts from the expansion, including the following:
    - *Protection of the Environment Operations Act 1997*
    - Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
    - Voluntary Land Acquisition and Mitigation Policy.
- Estimate emissions for operations of the expanded Tweed Sand Plant.
- Develop a site-specific meteorological file suitable for use in a dispersion model using on-site observations and the TAPM and CALMET meteorological models.
- Conduct dispersion modelling to make predictions of ground-level concentrations of air pollutants in the surrounding region. Predicted concentrations will be assessed against the relevant criteria.
- Provide recommendations for appropriate mitigation measures and monitoring requirements.

2. PROJECT DESCRIPTION

2.1 Existing Operations

Tweed Sand Plant is located off Altona Road in Cudgen, northern NSW. The site consists of the following lots: 22DP1082435, 23DP1077509 and 494DP720450, with a total area of approximately 77 ha of which some 46 ha is the approved extraction area.

Sand extraction has been conducted at the site since 1983 with Hanson taking over operation in 2007. A single dredge unit is linked to an onshore wash plant via a floating flow line. Sand is processed through the wash plant, stockpiled and then loaded via a front-end loader into highway trucks. No blasting is conducted at Tweed Sand Plant. Typical operations include the following steps:

- Material is dredged from the lake and sent via a pipeline to the onshore wash plant located within the sand processing area.
- Dredged material is washed and screened and sand product is stored in stockpiles.
- Sand stockpile maintenance is carried out using a front-end loader.
- Reject fines are piped back to the lake in the form of a slurry.
- Product trucks enter the site off Altona Road and travel down the unsealed site road to the sand processing area.
- Trucks are loaded with sand directly from the stockpiles using a front-end loader.
- Laden trucks pass through a weighbridge then travel along the eastern side of the site road back to Altona Road passing through a shakedown grid at the site entrance.
- Laden trucks then follow the standard haul route of Altona Road onto Crescent Street then Tweed Coast Road to proceed either north or south bound on the Pacific Highway.

Hours of operation are between 7am and 5pm Monday to Friday and between 7am to 4 pm (or 12 pm for sand product delivery) on Saturday. Tweed Sand Plant is closed on Sunday and Public Holidays.

Existing dust control measures include fixed sprinklers that are used to wet down site haul roads when required. The extracted materials are wet and remain wet until they reach the stockpiles. The stockpiled material may partially dry depending on its residence time.

The existing Tweed Sand Plant is shown in Figure 1 along with the expansion area.

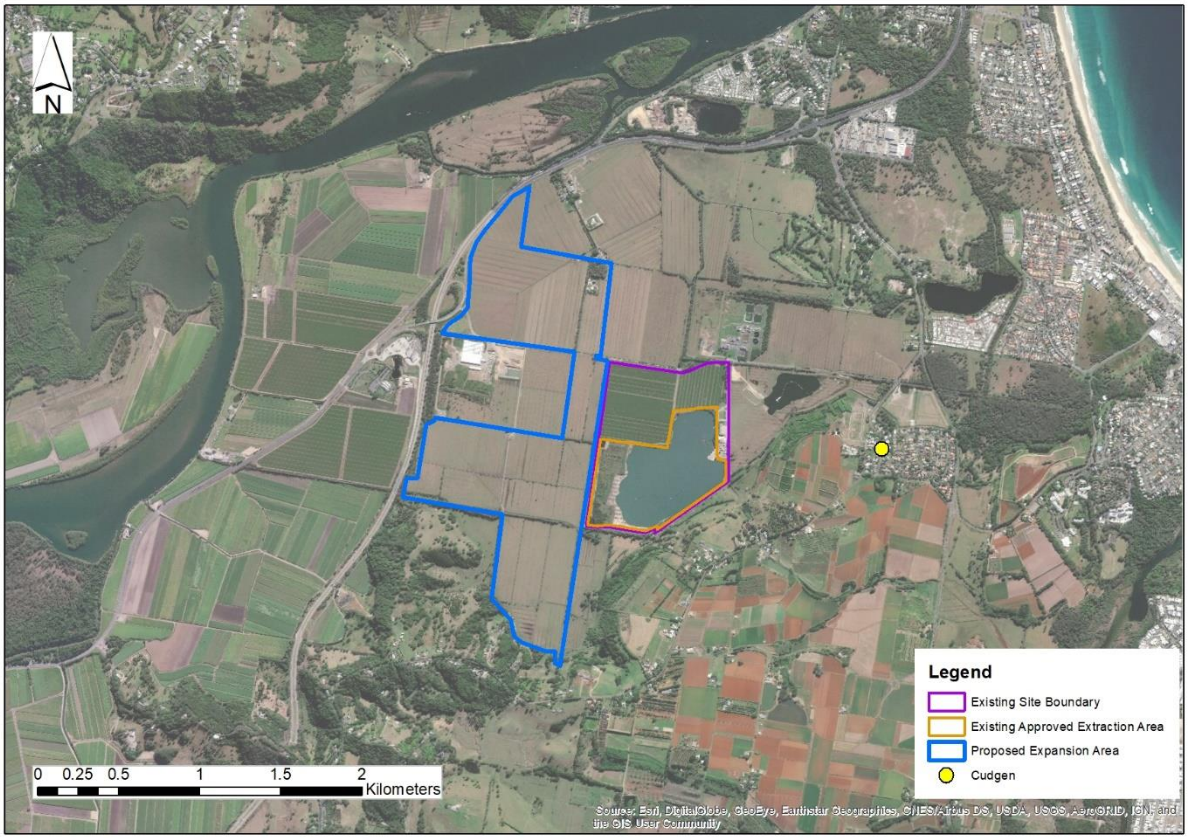

Figure 1 **Tweed Sand Plant Location Map**

2.2 Expansion Project

Hanson proposes to expand the operations of the Tweed Sand Plant to meet expected product demand. The proposed phases of the Tweed Sand Plant expansion are shown in Figure 2 and Figure 3 and include the following:

- An increase in the maximum sand production rate from 500,000 tpa to 950,000 tpa.
- An increase in the sand extraction area, increasing the overall site area to approximately 236 ha.
- Sand extraction via a suitable dredge unit and pipeline to an onshore wash plant.
- Onshore wash plant will have suitable capacity to meet market demand and utilise the existing location for washing, screening and stockpiling (Phase 1-6).
- Wash plant will be relocated in the future (Phase 7 onwards) to a more central location on the expanded site.
- Loading of the product will be via front-end loader into highway trucks.
- Initially, the existing access route via Altona Road will be utilised until the new sealed internal haul road and connection to the Tweed Valley Way south bound offramp on the western side of site, is constructed.
- The expanded facility will operate 24-hours per day, seven days per week.
- The Tweed Sand Plant extraction areas will be progressively rehabilitated.

Figure 2 **Proposed Tweed Sand Plant Expansion Phase 1-7**

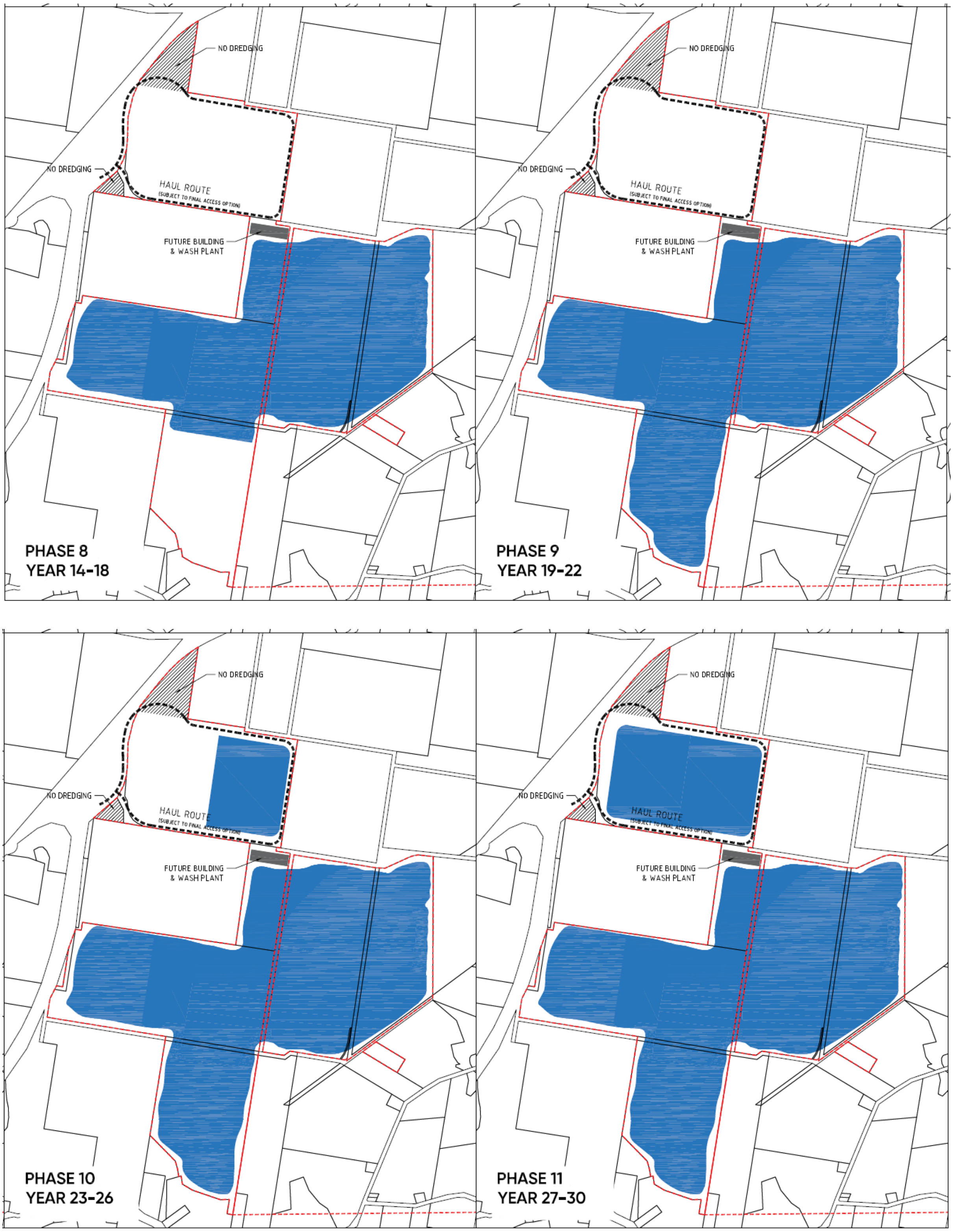

Figure 3 **Proposed Tweed Sand Plant Expansion Phase 8-11**

3. ASSESSMENT METHODOLOGY

This AQIA aims to quantify the potential impact of the proposed expansion of the Tweed Sand Plant on air quality using site representative data and design information. The following sections provide an overview of the methodology of the AQIA, which has been conducted to address the SEARs in accordance with the legislative requirements of the NSW Government, including the Approved Methods.

3.1 Legislative requirements

The regulation of air pollution in NSW is provided for under the *Protection of the Environment Operations Act 1997* (POEO Act), which is underpinned by a number of regulatory instruments that address air quality. A summary of the relevant instruments is provided in Section 4.

3.2 Surrounding environment

The location of Tweed Sand Plant and its surrounding environment is described in terms of climate, land use, terrain, meteorology, existing air quality and location of sensitive receptors in Section 5.

Ambient air quality background levels have been determined from data collected at nearby air quality monitoring stations (as described in Section 5.4).

3.3 Emission inventory

Certain activities at the Tweed Sand Plant can generate emissions of dust. The type and magnitude of dust emitted will depend on the rate and intensity of each activity, the properties of the materials and the application of emission control measures.

Dust emissions from the expanded Tweed Sand Plant were calculated using published emission factors based on the USEPA - AP42, Fifth Edition, Volume 1: Stationary Point and Area Sources (USEPA, 2006a; USEPA, 2006b; USEPA, 2004a; USEPA, 2004b). The emission factors were used along with operating information, dust control measures and site layout information provided by Hanson to calculate emission rates representative of the expansion.

The results of the emission calculations and the proposed emission controls are presented in Section 6.

3.4 Site specific meteorology

A site representative three-dimensional meteorological windfield was developed using the TAPM and CALMET meteorological models, in accordance with Level 2 requirements stipulated in the Approved Methods. The 2019 calendar year was selected for meteorological modelling as this is a representative year based on an analysis of data from the Bureau of Meteorology's (BoM) monitoring station at Coolangatta, 10km north of Tweed Sand Plant.

A summary of the site-specific meteorology is detailed in Section 7. The configuration of TAPM and CALMET is detailed in Appendix A.

3.5 Air quality assessment

Dispersion modelling of the Tweed Sand Plant expansion operations were conducted using CALPUFF to predict ground-level concentrations of dust (as TSP, PM_{10} and $PM_{2.5}$) and deposition rate across a 40km by 40km model domain centred on the plant and at discrete locations representative of the nearest sensitive receptors.

Dispersion modelled was conducted for two scenarios that represent different stages of development of the Tweed Sand Plant expansion, namely: Phase 1 to 6 and Phase 7 to 11. Phase 1-6 is an assessment of the expanded operational rate at the existing processing plant location. Phase 7-11 is an assessment of the expanded operational rate at the new central location of the processing plant.

CALPUFF dispersion model configuration is detailed in Appendix A.

3.5.1 Cumulative impacts

Cumulative concentrations of air pollutants have been assessed by adding the air pollutant concentrations associated with the Tweed Sand Plant expansion with an ambient background concentration.

The assessment of cumulative ground-level concentrations of PM_{10} and $PM_{2.5}$ has been conducted using the Level 2 assessment methodology outlined in the Approved Methods, that is, the hourly average background concentration is added to the hourly dispersion model prediction for the modelled calendar year of 2019 (contemporaneous assessment).

3.5.2 Presentation of results

Dispersion model predictions have been presented as ground-level concentrations across the model domain (contour plots) and at locations indicative of sensitive receptors. The cumulative assessment results have been presented at the locations indicative of sensitive receptors (Section 8).

The predicted ground-level concentrations have been assessed by comparison with the relevant impact assessment criteria that are contained in the Approved Methods.

3.6 Limitations and uncertainty

A limitation of this study is that it relies on the accuracy of a number of data sets that feed into the dispersion model. These data sets have been sourced from reputable sources, including:

- Meteorological monitoring observations from the Bureau of Meteorology
- Air quality monitoring observations from DES sites
- Synoptic and surface information datasets from CSIRO
- Land-use from aerial imagery
- Emissions factors for estimating dust emissions for sand plant operations.

It is important to note that numerical models are based on an approximation of governing equations and will inherently be associated with some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included. There may be physical processes that are not explicitly accounted for in the model and, in general, these approximations tend to lead to an over prediction of air pollutant levels.

4. LEGISLATIVE FRAMEWORK FOR AIR QUALITY

4.1 *Protection of the Environment Operations Act 1997*

Environmental protection from the effects of industrial emissions is primarily administered under the *Protection of the Environment Operations Act 1997* (POEO Act). The POEO Act provides a framework for the:

- Development of Protection of the Environment Policies
- Licensing and imposition of licence conditions by EPA in relation to activities that are defined under Schedule 1 of the POEO Act
- Development of regulations and guidelines that promulgate impact assessment criteria and emission standards for industry
- Definition of offences and penalties in relation to air pollution under Sections 124-129
- Provision of a mechanism for public participation in the environmental assessment of activities that may be licensed by EPA, in conjunction with the Environmental Planning and Assessment Act 1979 (EP&A Act)

The management of air pollution in NSW is dealt with in *Part 5.4 (sectio*ns 124-135) of the POEO Act. This includes the general requirement that non-residential premises do not cause air pollution by failing to operate or maintain plant, carry out work or deal with materials in a proper and efficient manner (sections 124-126).

Section 128 of the POEO Act requires each premises to comply with any air emission standards prescribed by applicable regulations; where standards are not prescribed for a particular air impurity, all practical means must be taken to prevent or minimise air pollution.

4.2 Environmental Protection License

An EPL permits the holder of the licence to undertake an activity that is included in Schedule 1 of the POEO Act. The EPL specifies the intensity of the activity that can be undertaken and the conditions that must be met whilst the activity is undertaken with respect to regulating the activity's potential environmental impact.

Hanson operates Tweed Sand Plant under EPL 11453 which includes the following in relation to air quality:

> *"O3.1 Activities occurring in or on the premises must be carried out in a manner that will minimise the generation, or emission from the premises, of wind-blown or traffic generated dust.*
>
> *O3.2 Trucks entering and leaving the premises that are carrying loads must be covered at all times, except during loading and unloading."*

4.3 Development Approval

The Tweed Sand Plant DA 152-6-2005 was issued by DPIE on 20 August 2018. Air quality conditions are detailed in Schedule 3, Conditions 4, 5 and 6, and reproduced below:

> ***Air Quality***
>
> ***Air Quality Impact Assessment Criteria***
>
> *4. The Applicant must ensure that particulate matter emissions generated by the development do not cause exceedances of the criteria in Table 3 at any residence on privately-owned land.*

Table3: Air quality criteria

Pollutant	Averaging Period	Criterion	
Particulate matter < 10 µm (PM_{10})	Annual	[a,c] 25 µg/m³	
	24-hour	[b] 50 µg/m³	
Particulate matter < 2.5 µm ($PM_{2.5}$)	Annual	[a,c] 8 µg/m³	
	24-hour	[b] 25 µg/m³	
Total suspended particulates (TSP)	Annual	[a,c] 90 µg/m³	
Deposited dust [d]	Annual	[b] 2 g/m²/month	[a] 4 g/m²/month

Notes:

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).

[c] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary).

[d] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3590.10.1:2003 Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method.

Operating Conditions

5. The Applicant must:

a) Implement best management practice to minimise the dust emissions of the development, including routinely watering haul roads being used by heavy vehicles and equipment;

b) Regularly assess meteorological and air quality monitoring data to guide the day-to-day planning of operations and implementation of air quality mitigation measures to ensure compliance with the relevant conditions of the consent;

c) Minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Note c to Table 3 above);

d) Monitor and report on compliance with the relevant air quality conditions in the consent; and

e) Minimise surface disturbance of the site, other than as permitted under this consent, to the satisfaction of the Secretary.

Air Quality Management Plan

6. The Applicant must prepare an Air Quality Management Plan for the development to the satisfaction of the Secretary. This plan must:

a) Be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Secretary;

b) Be prepared in consultation with the EPA

c) Be submitted to the Secretary within three months of the determination of Modification 1;

d) Describe the measures to be implemented to ensure:

i. compliance with the air quality criteria and operating conditions of this consent;

ii. *best practice management is being employed; and*

iii. *the air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events;*

e) *describe the air quality management system in detail; and*

f) *include an air quality monitoring program that:*

i. *is capable of evaluating the performance of the development against the air quality criteria;*

ii. *adequately supports the air quality management system; and*

iii. *includes a protocol for determining any exceedances of the air quality criteria*

The Applicant must implement the Air Quality Management Plan as approved from time to time by the Secretary.

The Tweed Sand Plant Air Quality Management Plan (Katestone, 2019) was approved by the Secretary in 2019 and documents the abovementioned requirements.

4.4 Assessment requirements

Air quality impact assessments of new activities or amendments to existing activities are carried out in accordance with the Approved Methods, which lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources.

The purpose of an air quality impact assessment is to demonstrate that the proposed project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) and minimises risks to human health and the environment to the greatest extent practicable.

This air quality assessment has been conducted in accordance with the Approved Methods. Impact assessment criteria detailed in the Approved Methods that are relevant to the assessment are reproduced in Table 1. It is noted that these assessment criteria match the DA Conditions for Air Quality.

Table 1 Impact assessment criteria (Approved Methods)

Pollutant	Averaging Period	Impact Assessment Criteria (µg/m³)
TSP	Annual	90
PM_{10}	24-hour	50
	Annual	25
$PM_{2.5}$	24-hour	25
	Annual	8
Dust deposition rate (total insoluble solids)	Annual	2 g/m²/month (Project only)
	Annual	4 g/m²/month (Cumulative)

5. EXISTING ENVIRONMENT

5.1 Climate

A summary of climate statistics from the closest Bureau of Meteorology (BoM) weather station to Tweed Sand Plant, Coolangatta Airport (10km south), is provided in Table 2.

The northern NSW region is classed as having a subtropical climate with warm summers and no distinct dry season. This is shown in the Coolangatta Airport data (1999-2020) with December to February being the warmest months with a mean maximum temperature of 27-29°C.

Rainfall occurs all year round and averages 1,500 mm per year and 155 rain days. Whilst the number of rain days is fairly consistent throughout the year, rainfall is more frequent and heavier in summer and spring compared to winter.

Table 2 Climate statistics from BoM Coolangatta Airport (1999 -2020)

Climate Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	28.5	28.3	27.4	25.5	23.2	21.1	20.7	21.6	23.4	24.6	26	27.4	24.8
Mean minimum temperature (°C)	21	20.9	19.8	17	13.9	11.4	10.2	10.4	13.3	15.9	18.1	19.7	16
Mean daily solar exposure MJ/(m*m)	24	21	19	16	13	12	13	16	20	22	24	24	19
Mean rainfall (mm)	160	185	186	158	130	137	71	57	39	89	118	145	1480
Mean number of days of rain	14	16	18	16	15	13	10	8	8	10	12	14	155

5.2 Local land use and terrain

Tweed Sand Plant is approximately 3 km west of the Pacific coastline and 2.5 km southeast of the Tweed River. The land use in the area is primarily agricultural land for cropping and grazing as well as the small township of Cudgen and Kingscliff.

The terrain in the immediate north and northwest is relatively flat and is part of the Tweed River floodplain. To the immediate east, south and southwest are small rolling hills that form part of the Tweed Valley. Further afield, the area has a distinct geography due to the Pacific Ocean to the east, the Tweed Valley (river and floodplain) to the north and the hinterland of the Great Diving Range to the southwest to northwest, including Mount Warning and Springbrook Mountain.

A topographic map of the elevations used in the Tweed Sand Plant dispersion model is shown in Figure 4.

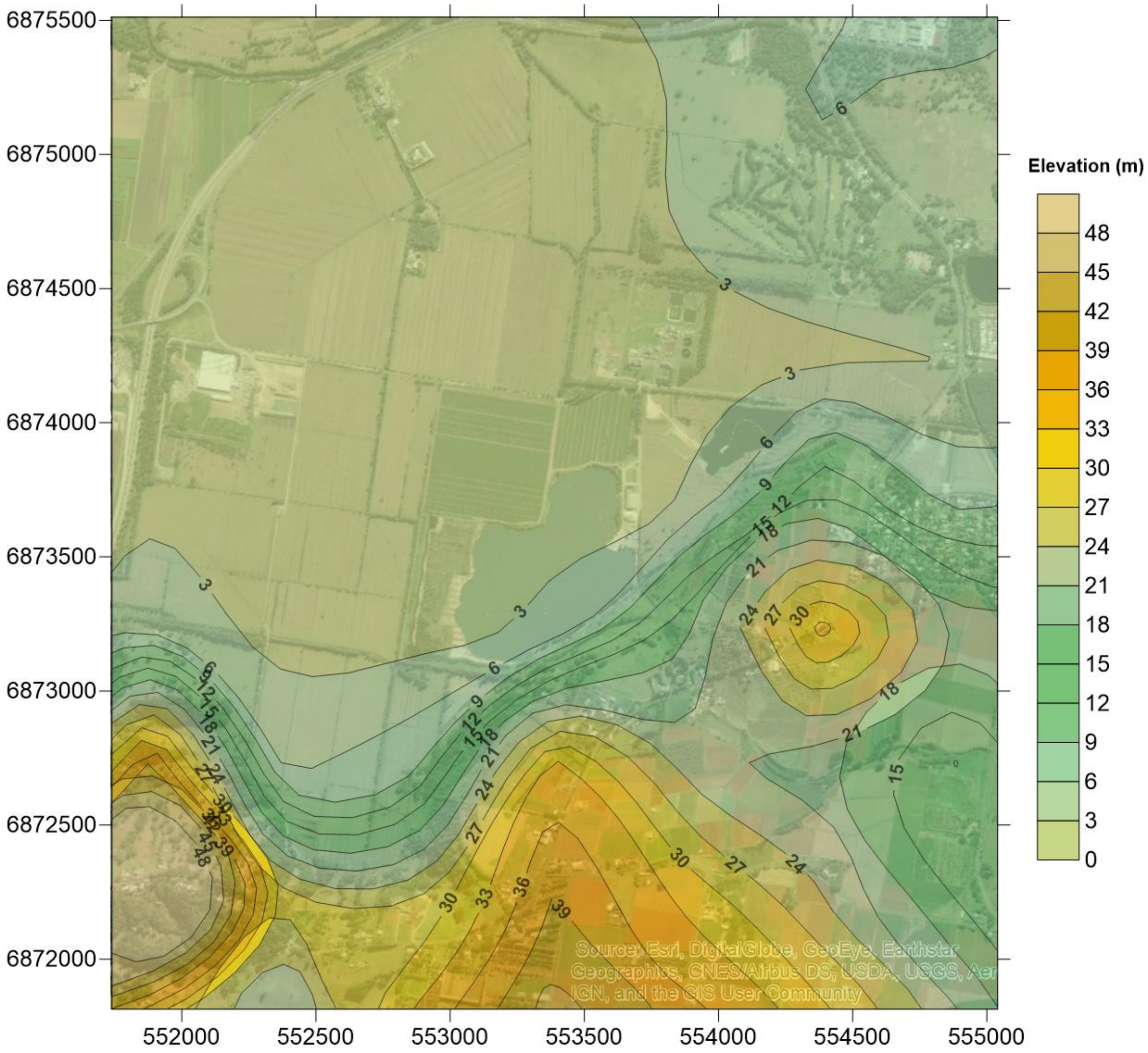

Figure 4 **Elevation (m) across the Tweed Sand Plant air quality assessment model domain**

5.3 Sensitive Receptors

In the vicinity of Tweed Sand Plant, are a number of sensitive receptors as shown in Figure 5. These include:

- Rural residential properties located between 500 m to 1.3km to the northwest and northeast of the existing Tweed Sand Plant (R1, R2 and R3). It is noted that residential property R1 is currently within the final expansion area proposed by Hanson.
- Cudgen township located 700 metres to the east (R4).
- Rural residential properties on Cudgen Road, located between 300 m to 1.5 km to the southeast, south and southwest of Tweed Sand Plant (R5 – R21).

Whilst not considered as receptors in this assessment there are also the residential areas of Kingscliff (2.5 km east) and Chinderah (2 km north). Commercial and industrial locations in proximity to the Tweed Sand Plant include the Tweed River wastewater treatment plant (WWTP) located immediately north of the existing site, the Cudgen Lake Sand Plant located 300m east, the Australian Bay Lobster Producers located 700m west of the existing site boundary and the M1 Chinderah Service Station, 1.1km west of existing site boundary.

A map of Tweed Sand Plant sensitive receptors considered in this assessment (green labels) are shown in Figure 5.

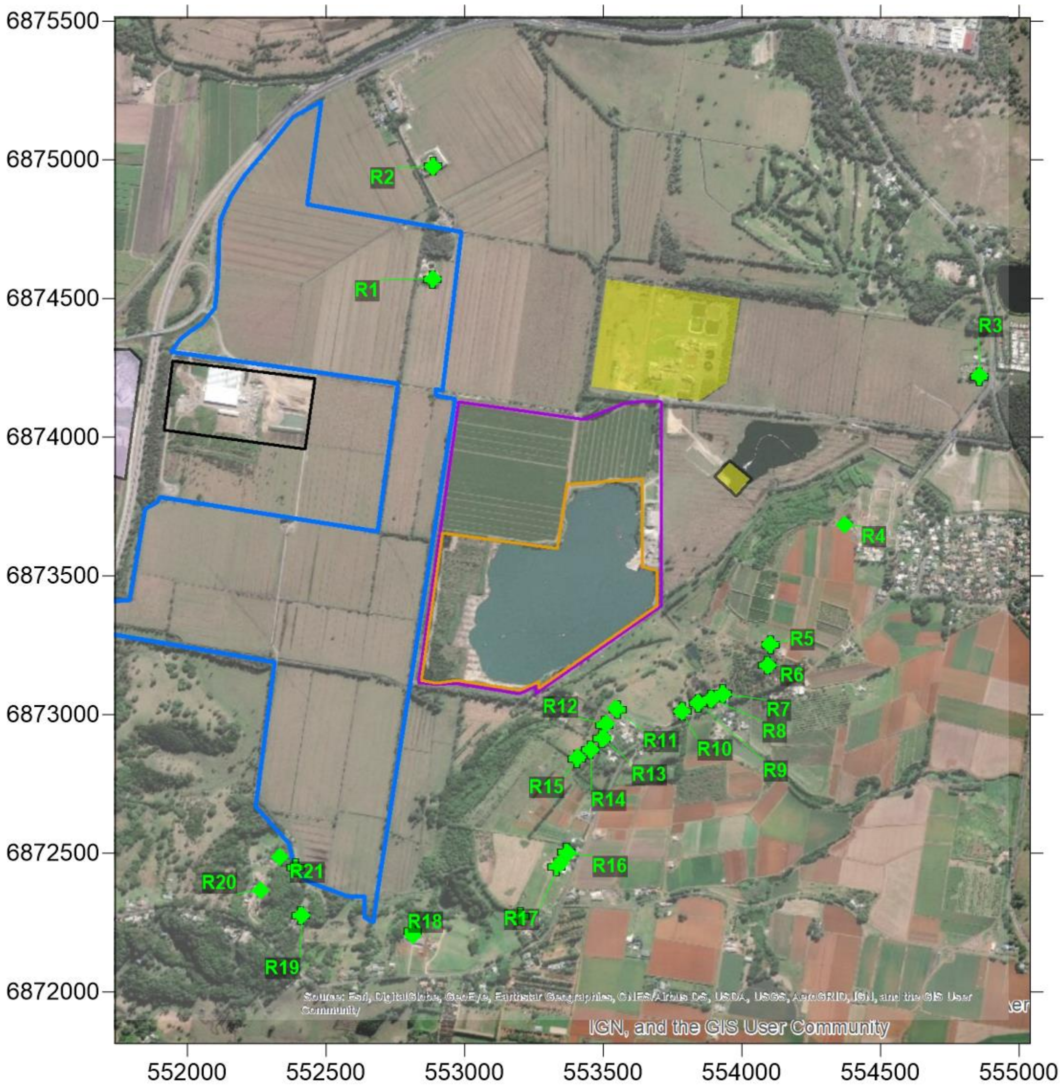

Figure 5 Map of sensitive receptors considered in this AQIA

5.4 Existing air quality

5.4.1 Existing sources of emissions

The existing environment in the Cudgen area is influenced by climatic conditions of the region and local natural and anthropogenic activities. Emission sources of dust (particulate matter) are mainly diffuse sources such as road transport (motor vehicles), intensive agriculture (sugar cane farming) and Tweed Sand Plant.

The Cape Byron Power Station at Condong Sugar Mill is the only significant point source of air pollutants in the region. It is located 12 km southwest of Tweed Sand Plant on the Tweed River.

There are no ambient air quality or meteorological monitoring stations located in the Cudgen area. Variations in dusts levels can be expected during cane production and harvesting, after long periods without rainfall and during short-term events such as bushfires and dust storms.

5.4.2 Existing ambient air quality

5.4.2.1 Site monitoring

Tweed Sand Plant undertakes dust deposition monitoring on a monthly basis at four locations, namely: northern boundary, eastern boundary, southern boundary and south-western boundary, as shown in Figure 6.

The dust deposition monitoring is conducted in accordance with the relevant Australian Standard AS/NZS 3580.10.1.

A summary of the monitoring undertaken between 2015 and 2019 is shown in Figure 7 and Table 3. The data shows that dust deposition rate are below the relevant impact assessment criterion of 4 g/m²/month at all four sites.

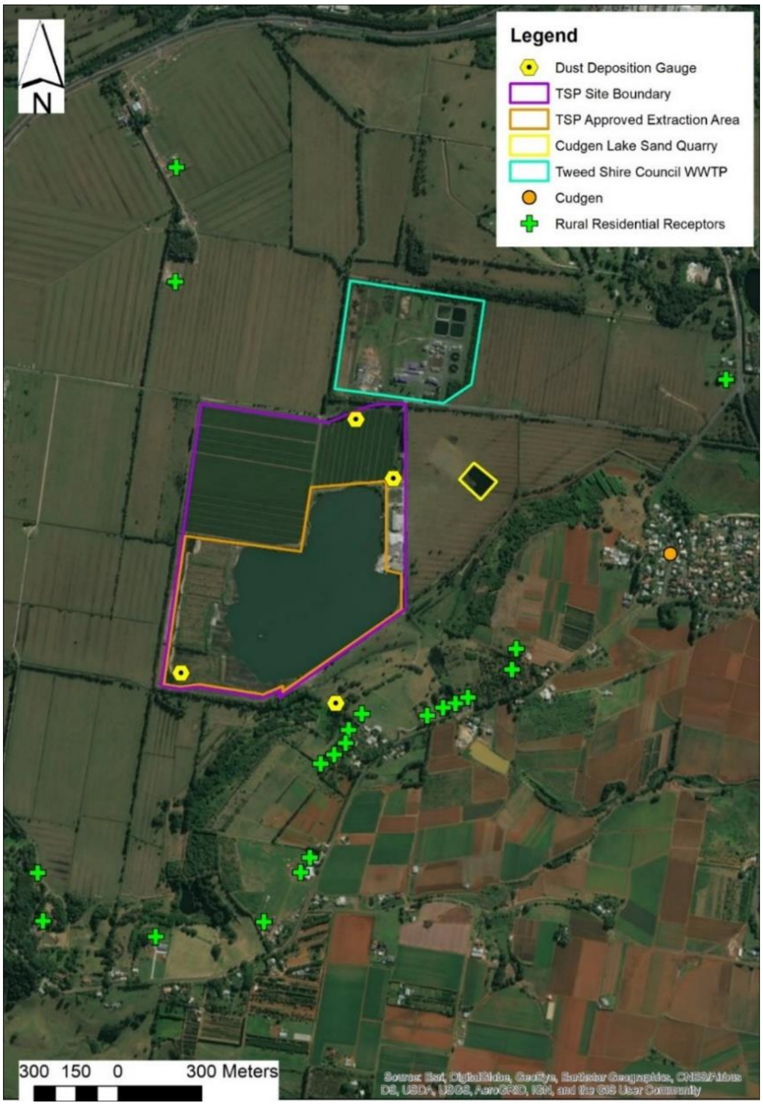

Figure 6 Tweed Sand Plant dust deposition monitoring locations

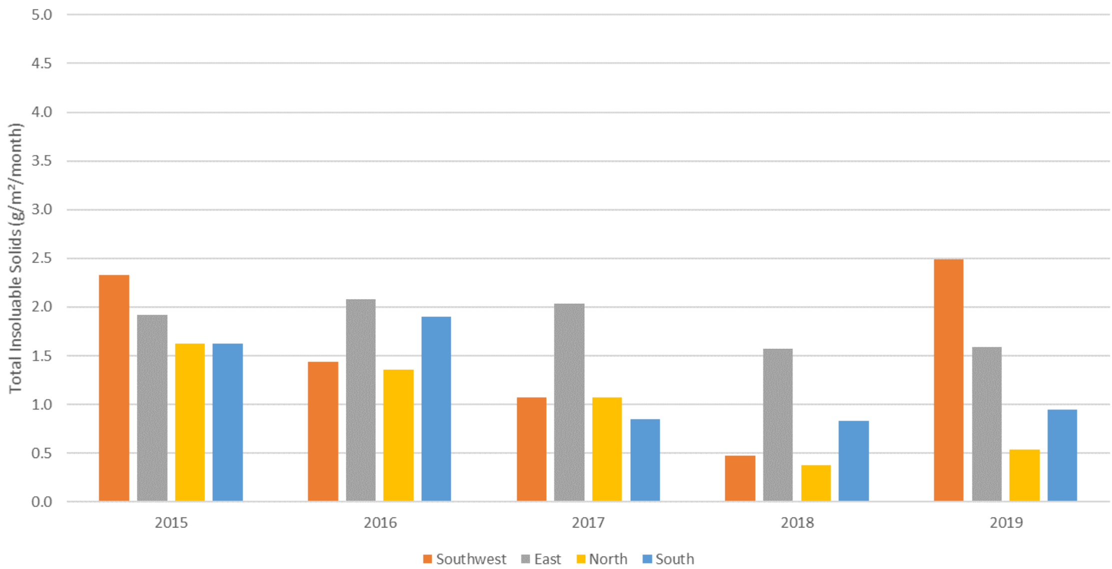

Figure 7 Dust deposition rates at Tweed Sand Plant monitoring sites between 2015 - 2019

Table 3 **Dust deposition rates at Tweed Sand Plant monitoring sites between 2015 - 2019**

Year	Southwest	East	North	South
2015	2.3	1.9	1.6	1.6
2016	1.4	2.1	1.4	1.9
2017	1.1	2.0	1.1	0.9
2018	0.5	1.6	0.4	0.8
2019	2.5	1.6	0.5	1.0
Criterion	*4 g/m²/month*			

5.4.2.2 DES monitoring

There is no monitoring of TSP, PM_{10} or $PM_{2.5}$ conduct in the vicinity of Tweed Sand Plant. The closest continuous air monitoring stations to Tweed Sand Plant that measures these air pollutants is operated by Queensland Department of Environment and Science (DES) and located at Springwood, Queensland, 80km to the north. The site measures PM_{10} and $PM_{2.5}$.

The NSW Office of Environment and Heritage (OEH) does operate a monitoring station at Lismore (70km to the south) that measures TSP, PM_{10} or $PM_{2.5}$, however, this is an emergency station that was established in 2019 to monitor bushfire events. In 2019, the Lismore station operated for 10% of the year.

Whilst the Springwood site is some distance away and located in suburban Brisbane, it is located in close proximity to the Pacific Highway and a similar distance away as the Tweed Sand Plant is. It also has a long-term continuous dataset. Accordingly, with a lack of any other suitable data, the DES Springwood site has been selected to derive the ambient background air quality levels for the assessment.

Concentrations of PM_{10} and $PM_{2.5}$ from the DES Springwood station from 2015 to 2019 is summarised in Table 4. The data shows the following:

- The maximum 24-hour average concentration of PM_{10} in each year varies from 30 µg/m³ to 195 µg/m³.
- The 90th percentile 24-hour average concentration of PM_{10} varies year on year between 17 µg/m³ and 31 µg/m³.
- There have been 16 days when the 24-hour average concentration of PM_{10} exceeded the impact assessment criterion of 50 µg/m³ over the five years, the majority of which occurred in 2019 when 13 exceedances occurred due predominantly to bush fires. During 2018, there were two exceedances and in 2015, there was one exceedance.
- Annual average concentrations of PM_{10} range from 11-17 µg/m³, which is consistently below the impact assessment criterion of 25 µg/m³.
- The maximum 24-hour average concentration of $PM_{2.5}$ in each year varies from 12 µg/m³ to 102 µg/m³.
- There have been thirteen days when the 24-hour average concentration of $PM_{2.5}$ exceeded the impact assessment criterion of 25 µg/m³ over the 5 years, which all occurred in 2019 due predominantly to bush fires.

- Annual average concentrations of $PM_{2.5}$ range in each year from 4-7 µg/m³, which is consistently below the impact assessment criterion of 8 µg/m³.

Table 4 Monitoring Data at Springwood for 2015 to 2019

Year	PM_{10}				$PM_{2.5}$		
	Maximum 24-hour average	**90th percentile 24-hour average**	**Number of exceedances**	**Annual average**	**Maximum 24-hour average**	**Number of exceedances**	**Annual average**
2015	56.1	17.6	1	12.5	12.6	0	4.6
2016	30.6	18.7	0	12.4	20.1	0	5.7
2017	34.4	19.1	0	11.6	23.9	0	5.4
2018	126.2	20.0	2	13.1	24.7	0	5.9
2019	193.5	30.2	13	16.9	101.1	13	6.7
Criteria	**50**	**-**	**0**	**25**	**25**	**0**	**8**

5.4.3 Background levels for the cumulative assessment

The cumulative assessment of the Tweed Sand Plant includes the addition of ambient background concentrations derived from the above data. The dispersion modelling has considered the 2019 calendar year and, therefore, background concentration for the relevant pollutants for 2019 have been used. For dust deposition, the highest value from the four sites in 2019 has been used.

Data for TSP has been estimated based on the PM_{10} data and assuming a typical PM_{10}/TSP ratio of 50%.

6. EMISSIONS TO THE ATMOSPHERE

6.1 Overview

Certain activities at Tweed Sand Plant will generate emissions of dust. The type and magnitude of dust emitted from Tweed Sand Plant will vary depending upon the rate and intensity of each activity, the properties of the materials and the application of emission control measures.

The sand that is extracted by dredging operation is relatively wet and the potential for generation of dust is extremely low during extraction, screening and stockpiling. Notwithstanding this, the activities occurring at Tweed Sand Plant that may give rise to emissions of dust are:

- Dredge operation (wet material so very minimal dust generation)
- Material handling
  - Wash plant operation – screening material
  - Stacking product in stockpiles
  - Reclaiming product from stockpiles
  - Loading product into trucks
  - Product stockpile maintenance (front-end loader operation)
- Removing topsoil from future sand dredging area (bulldozer operation)
- Wind erosion of exposed ground and product stockpiles
- Wheel generated dust from vehicle movements on unsealed site roads.

6.2 Methodology to estimate dust emissions

Dust emissions associated with the proposed Tweed Sand Plant expansion have been calculated using published emission factors based on the USEPA - AP42, Fifth Edition, Volume 1: Stationary Point and Area Sources (USEPA, 2006a; USEPA, 2006b; USEPA, 2004a; USEPA, 2004b). The emission factors were used along with operating information (such as dust control measures) and site layout information provided by Hanson to calculate emission rates representative of the proposed expansion.

Dust emissions have been split into three areas, namely:

- Sand Processing (includes material screening and handling/vehicle loading within the processing area)
- Wind Erosion (stockpiles and exposed ground)
- Wheel Generated Dust.

Dust controls used at Tweed Sand Plant, as detailed in the next section, have been included in estimating the site emissions.

6.3 Dust Control Measures

The following dust control measures are currently in use at Tweed Sand Plant:

- Material handling:

  - Wash plant structure is protected by side walls
  - Material drop heights are minimised.
- Wind erosion of exposed ground and product stockpiles:
  - Water sprinklers are used on product stockpiles and exposed ground
  - Frequency of use is linked to weather conditions and activity rates
  - The area of exposed ground and stockpiles is minimised as far as practical
  - Vegetation screen around the wash plant and stockpile area is maintained.
- Wheel generated dust from vehicle movements on unsealed site roads:
  - Remote control water sprinklers are used on the site haul roads.
  - Application of water to site haul roads linked to vehicle movements, with more frequent application to occur during high vehicle movement periods, as and when required.
  - A shaker grid at the site exit prevents any track out of dust onto public roads
  - Site vehicle speed limit set to 30 kph
  - Minimisation of site vehicle movements through fleet optimisation and haulage planning.
- All trucks leaving the site are covered.

6.4 Dust Emissions Inventory

The dust emission inventory for the proposed Tweed Sand Plant expansion is presented in Table 4. The inventory has been based on the proposed extraction and screening of the maximum limit of 950,000 tpa, considered to be a worst-case scenario for dust generation.

The inventory shows that wheel generated dust accounts for 69% of TSP emissions, 56% of PM_{10} emissions and 47% of $PM_{2.5}$ emissions.

Table 5 Dust emission inventory for the Tweed Sand Plant expansion project

Source	Emission (tonnes per annum)		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Sand processing	8.0	3.8	0.4
Wind erosion	5.4	2.7	0.4
Wheel generated dust	29.3	8.3	0.8
Total	**42.6**	**14.8**	**1.7**

The dispersion modelling has been conducted for two scenarios that represent distinct stages of the development with the processing plant being relocated towards the centre of the site in Phase 7 to 11. In the initial stage of the expansion (Phase 1 to 6), the processing plant is in its current location in the southeast corner of the site. Dust emissions are unchanged across the two scenarios.

7. METEOROLOGY

7.1 Overview

The following sections describe the local meteorology of the Tweed area, focusing on parameters that are important for dispersion of air pollutants generated by the Tweed Sand Plant activities: namely, wind speed, wind direction, atmospheric stability and boundary layer mixing height.

Local meteorological data has been generated for the year 2019 by the coupled The Air Pollution Model (TAPM)/CALMET meteorological models at the location of the Tweed Sand Plant and used in the dispersion model assessment. The detailed meteorological model configuration is described in Appendix A.

7.2 Wind speed and wind direction

Wind speed and wind direction are important parameters for the transport and dispersion of air pollutants from the point of emission. The predicted annual, seasonal and diurnal distribution of winds predicted by TAPM/CALMET at Tweed Sand Plant are presented in Figure 8, Figure 9 and Figure 10, respectively. The analysis of the wind speed at the site shows that winds are predominantly light to moderate, up to 3 to 6 m/s. Winds are predominantly from the southeast, southwest and north to north-northeast.

Seasonal trends show the stronger northerlies tend to occur more often through spring and summer. The lighter winds from the southwest and southeast tend to occur during the autumn and winter months. Winds at the facility are strongest during the day, particularly during the afternoon period from midday to 6pm, while the lightest winds occur during the early morning from midnight to 6am.

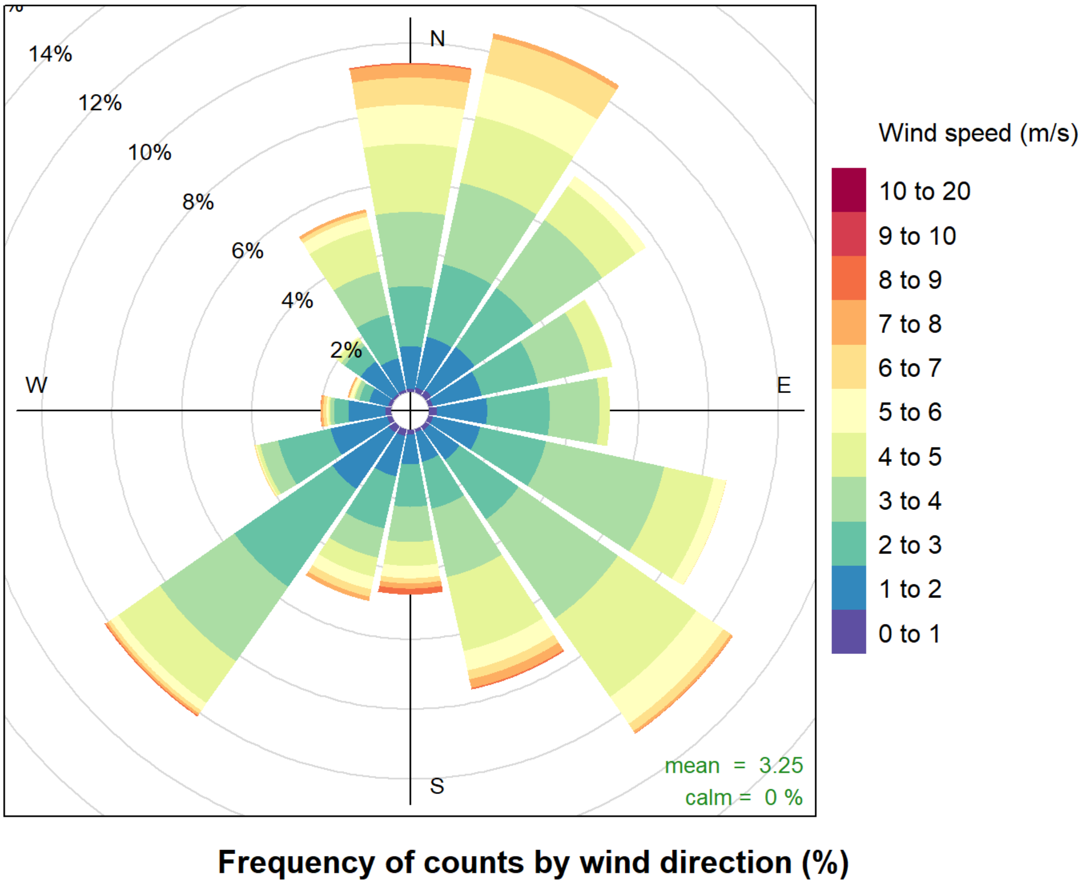

Figure 8 **Annual distribution of the TAPM/CALMET generated winds at Tweed Sand Plant**

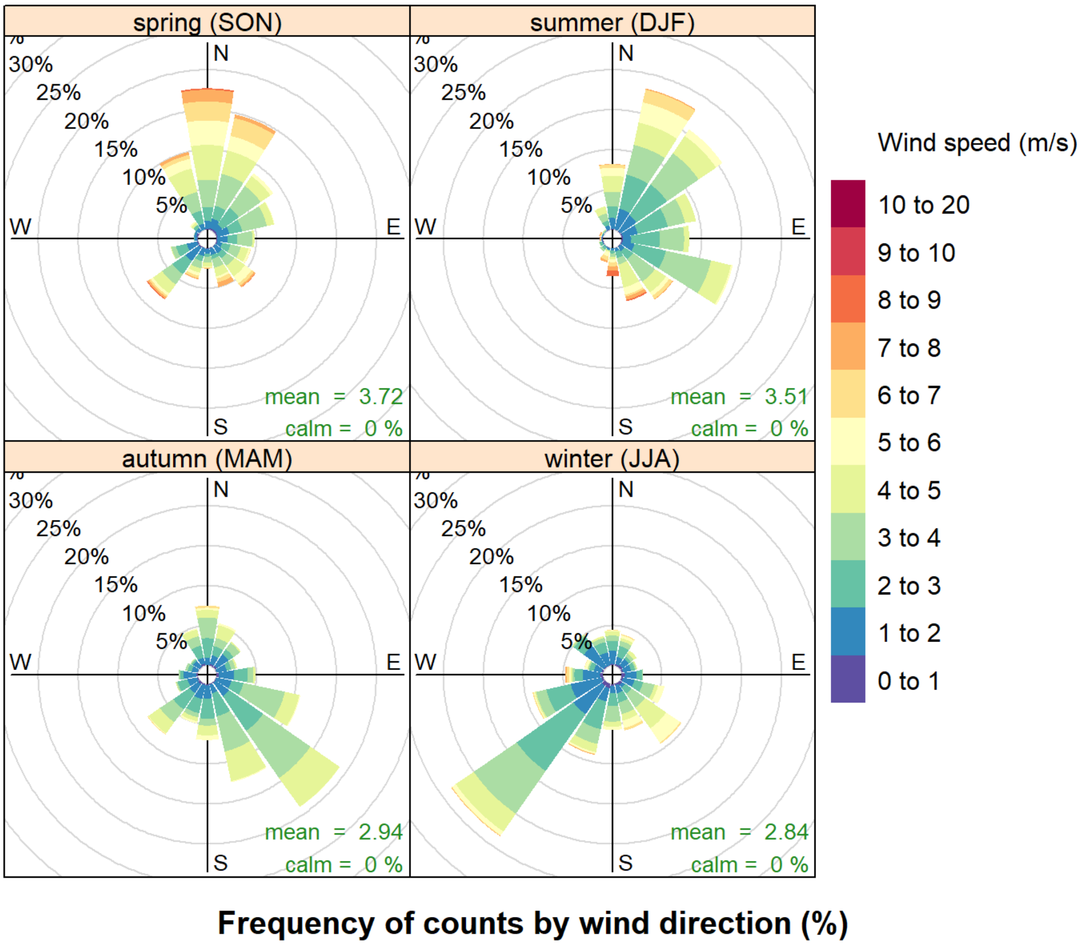

Figure 9 **Seasonal distribution of the TAPM/CALMET generated winds at Tweed Sand Plant**

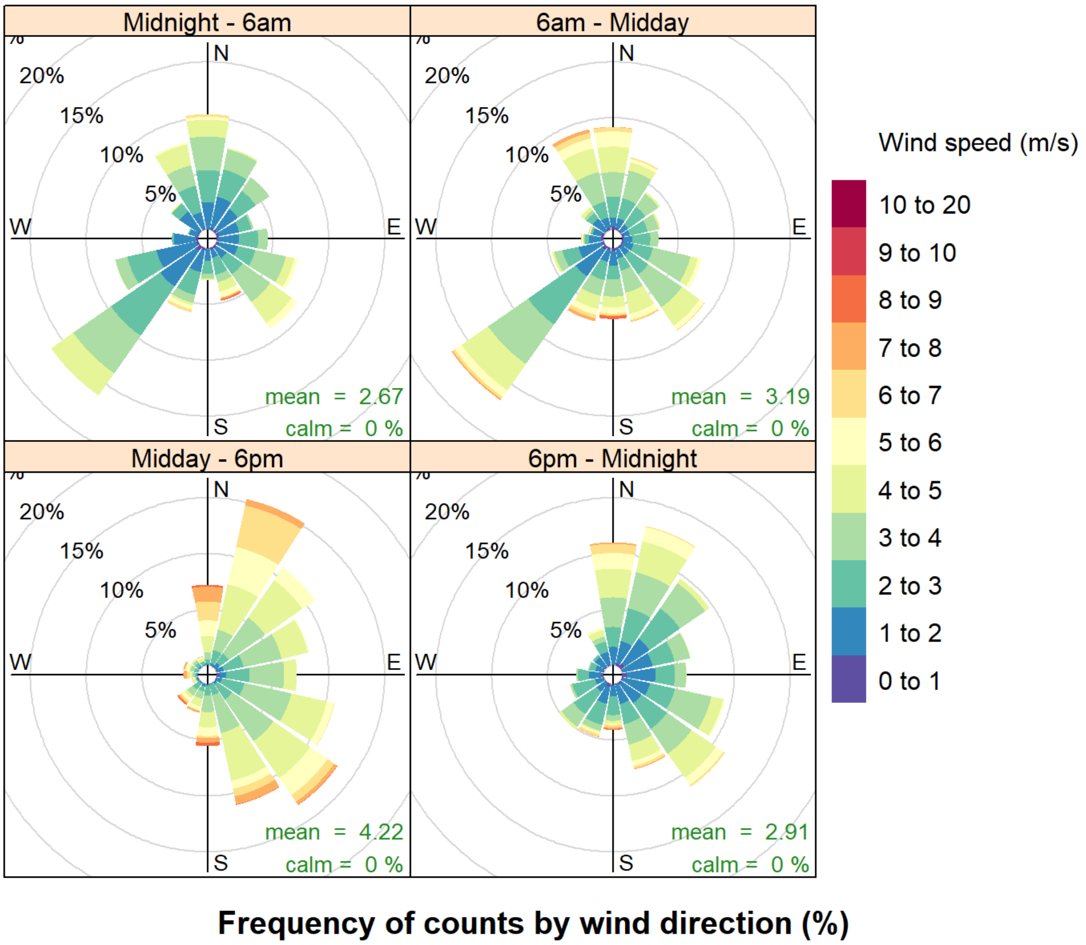

Figure 10 Diurnal distribution of the TAPM/CALMET generated winds at Tweed Sand Plant

7.3 Atmospheric stability

Stability refers to the vertical movement of the atmosphere and is therefore an important factor in the dispersion and transport of pollutants within the boundary layer. Atmospheric stability is classified under the Pasquil-Gifford scheme and ranges from Class A, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to Class F which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Classes A-C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground.

Turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for neutral conditions (Class D), which are most frequent at the facility, are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface, such as terrain features and building structures. During the night, the atmospheric conditions are generally neutral or stable (Class D, E and F) with cloud cover reducing solar heating and enhancing stability.

Stability class is calculated by CALMET across the model domain. Figure 11 shows the distribution of stability class predicted at the facility by hour of day.

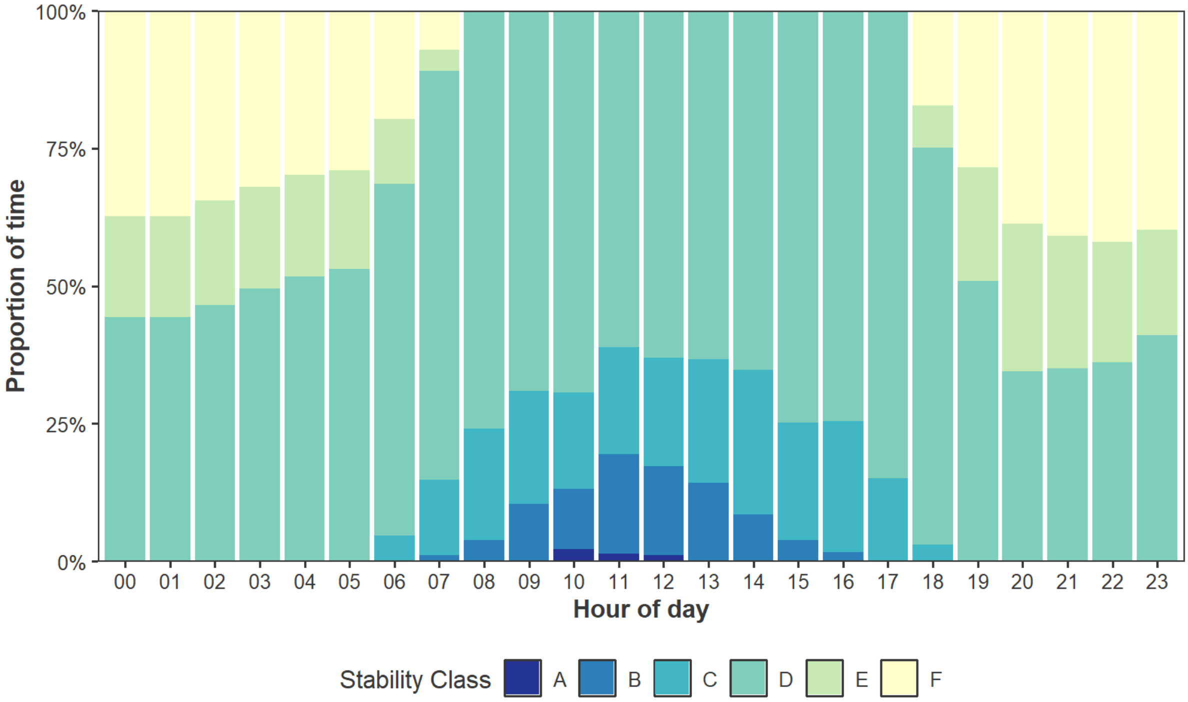

Figure 11 Proportion of stability class predicted at Tweed Sand Plant by hour of day

7.4 Mixing Height

The mixing height refers to the height above ground within which air pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and pollutant dispersion is limited to within this layer. During the day, solar radiation heats the air at ground level and causes the mixing height to rise. This results in the better dispersion as pollutants can travel further before reaching the ground, and lower ground-level concentrations typically occur. The air above the mixing height during the day is generally cooler. The growth of the mixing height is dependent on how well the air can mix with the cooler upper level air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions, the air will be well mixed, resulting in a high mixing height.

Mixing height information has been extracted from the TAPM/CALMET dataset at the location of Tweed Sand Plant and is presented in Figure 12. The data shows that the mixing height develops at around 7am, increases to a peak at 2pm before descending rapidly between 4 and 6pm.

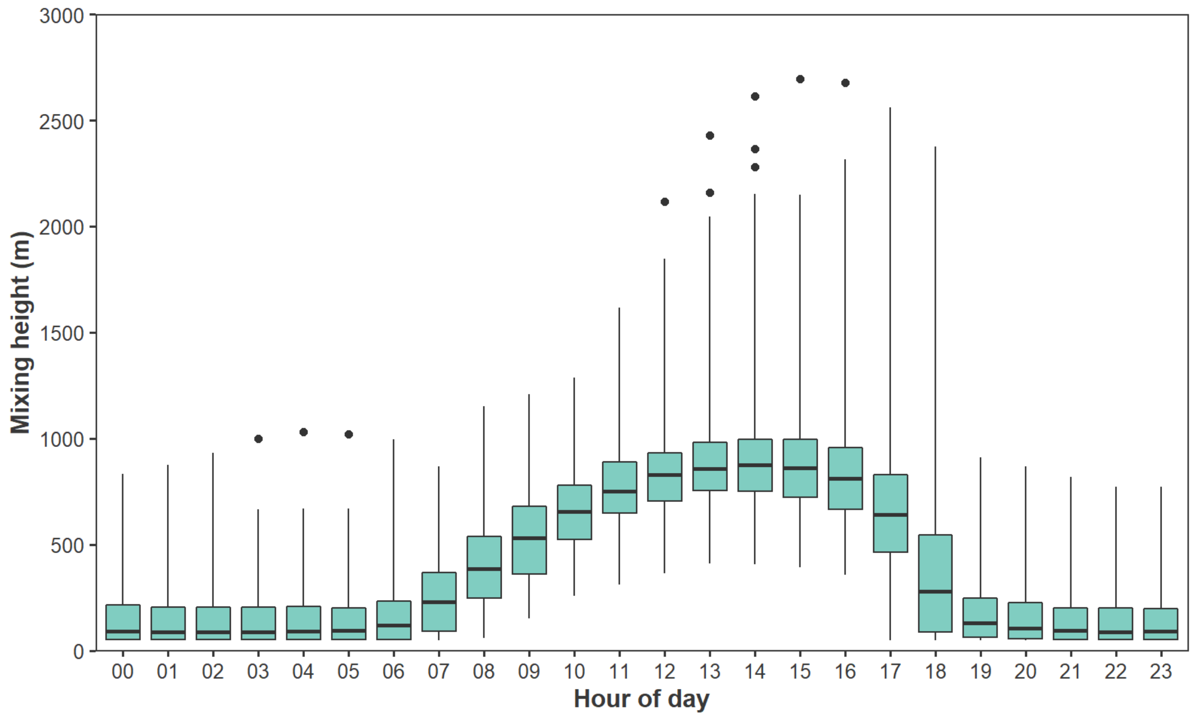

Figure 12 **Box and whisker plot of mixing height data extracted from CALMET at Tweed Sand Plant by hour of day**

8. AIR QUALITY IMPACT ASSESSMENT

8.1 Overview

The results of the dispersion modelling assessment are presented in the following sub-sections. Modelling results have been presented as ground-level concentrations or dust deposition rates at sensitive receptors as well as contours across the modelling domain.

Results for the two stages of operation have been presented: Phase 1 to 6 and Phase 7 to 11.

Background dust levels have been added to the incremental model predictions in order to obtain an estimate of the potential cumulative impacts of the Project. Results have been assessed by comparing the predicted concentrations and dust deposition rates with the relevant impact assessment criteria.

When considering the results, it is important to note the 24-hour average dispersion modelling results are based on the concentration of each pollutant predicted at the receptors over the one-year period and thus represent a peak-impact scenario. The contour plots are constructed such that the highest value is obtained and stored from each point in the modelled domain. As these values may occur at different times at different grid points, these figures do not represent a single snapshot of conditions at any given time.

8.2 PM_{10}

Table 6 and Table 7 provide the predicted maximum 24-hour and annual average ground-level concentrations of PM_{10} at the sensitive receptors in isolation (i.e. without the background) and with background levels applied for Phase 1-6 and Phase 7-11, respectively.

Plate 1 and Plate 2 show the predicted maximum 24-hour and annual average ground-level concentrations of PM_{10} for the Tweed Sand Plant in isolation (i.e. without the background) for Phase 1-6.

Plate 3 and Plate 4 show the predicted maximum 24-hour and annual average ground-level concentrations of PM_{10} for the Tweed Sand Plant Phase 7-11 operations in isolation (i.e. without the background) for Phase 7-11.

The results show the following:

- Maximum 24-hour average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both Phase 1-6 and Phase 7-11 operations.
- For the cumulative assessment of 24-hour average concentrations of PM_{10}, a level 2 (contemporaneous) assessment was conducted, which shows the following:
    - For Phase 1-6, the Tweed Sand Plant is predicted to contribute to between one and three additional days that exceed the impact assessment criterion at sensitive receptors R5 – R15, which are to the immediate southeast of the existing washplant.
    - Of these receptors, R11 is the closest to the Tweed Sand Plant (300m) and predicted the greatest number of additional exceedances of the 24-hour average impact assessment criterion for PM_{10} (3). The maximum contribution of Tweed Sand Plant to an exceedance at R11 is 12% compared to background (as discussed in Section 6.2.1).
    - For Phase 7-11, the Tweed Sand Plant is predicted to contribute one additional day that exceeds the impact assessment criterion at sensitive receptors R9 – R12, which are to the immediate southeast of the site boundary.

    - Of these receptors, R11 is the closest to the site. The maximum contribution of Tweed Sand Plant to an exceedance at R11 is 8% compared to background (as discussed in Section 6.2.2).

- The Approved Methods requires that a proponent demonstrate that a proposed development does not result in additional exceedances of the impact assessment criteria at sensitive receptors. Hanson will ensure compliance with the air quality is achieved in practice through a proactive and reactive management strategy, whereby, watering will be increased and/or certain operations will cease during periods of elevated dust risk. Key features of this strategy will be managed using the proposed dust monitoring program and weather forecasts.

- Annual average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both stages of the development.

Table 6 Predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} at discrete receptors for the Tweed Sand Plant Expansion Project Phase 1-6

Receptor	PM_{10} (µg/m³)					
	24-hour average				Annual average	
	Plant	Plant -Days > 50	Background Days >50	Plant + Background Additional Days > 50	Plant	Plant + Background
R1	10.1	0	13	0	0.7	17.0
R2	7.0			0	0.4	16.7
R3	6.3			0	0.4	16.7
R4	21.2			0	0.8	17.1
R5	29.9			1	1.1	17.4
R6	33.8			1	1.1	17.4
R7	26.4			1	1.3	17.6
R8	27.3			2	1.4	17.7
R9	27.7			2	1.5	17.8
R10	25.8			2	1.5	17.8
R11	36.3			3	2.0	18.2
R12	31.1			2	1.8	18.0
R13	28.4			2	1.6	17.9
R14	22.8			2	1.5	17.7
R15	20.5			1	1.4	17.6
R16	14.1			0	0.8	17.1
R17	12.5			0	0.7	17.0
R18	7.6			0	0.5	16.8
R19	9.3			0	0.4	16.7
R20	7.1			0	0.4	16.7
R21	7.6			0	0.4	16.7
Criteria	**50**	**-**	**-**	**-**	**25**	

Table 7 Predicted maximum 24-hour average and annual average ground-level concentrations of PM_{10} at discrete receptors for the Tweed Sand Plant Expansion Project Phase 7-11

Receptor	PM_{10} (µg/m³)					
	24-hour average				Annual average	
	Plant	Plant -Days > 50	Background Days >50	Plant + Background Additional Days > 50	Plant	Plant + Background
R1	16.3			0	1.1	17.9
R2	12.3			0	0.5	17.4
R3	3.2			0	0.1	17.0
R4	6.8			0	0.2	17.1
R5	10.6			0	0.2	17.1
R6	8.6			0	0.2	17.1
R7	9.9			0	0.3	17.2
R8	9.7			0	0.3	17.2
R9	12.0			1	0.3	17.2
R10	15.5			1	0.3	17.2
R11	12.1	0	13	1	0.5	17.3
R12	8.1			1	0.4	17.3
R13	8.0			0	0.4	17.3
R14	8.8			0	0.4	17.3
R15	9.8			0	0.4	17.3
R16	7.0			0	0.3	17.2
R17	5.7			0	0.3	17.2
R18	5.2			0	0.3	17.2
R19	8.4			0	0.4	17.3
R20	7.3			0	0.4	17.3
R21	8.1			0	0.5	17.3
Criteria	**50**	**-**	**-**	**-**	**25**	

8.2.1 Source Contribution Analysis

PM_{10} source contribution analysis has been conducted at R11 for Phase 1-6 and Phase 7-11 operations, as shown in Figure 13 and Figure 14, respectively.

The analysis shows the following:

- For Phase 1-6, the contribution of the Tweed Sand Plant to the three additional exceedances is 8%, 12% and 1%, respectively.
- For Phase 7-11, the contribution of the Tweed Sand Plant to the one additional exceedance is 8%.
- The Approved Methods requires that a proponent demonstrate that a proposed development does not result in additional exceedances of the impact assessment criteria at sensitive receptors. Accordingly, additional dust emissions mitigation will need to be implemented at times of elevated background levels of PM_{10}. Additional mitigation could include increase application of water or ceasing of plant operations.
- To assist when additional mitigation is required, a PM_{10} monitor will be established to the southeast of the site to ensure that elevated PM_{10} levels do not occur or are adequately managed to ensure no additional exceedances of the 24-hour average criterion. This monitoring is discussed in more detailed in Section 9.

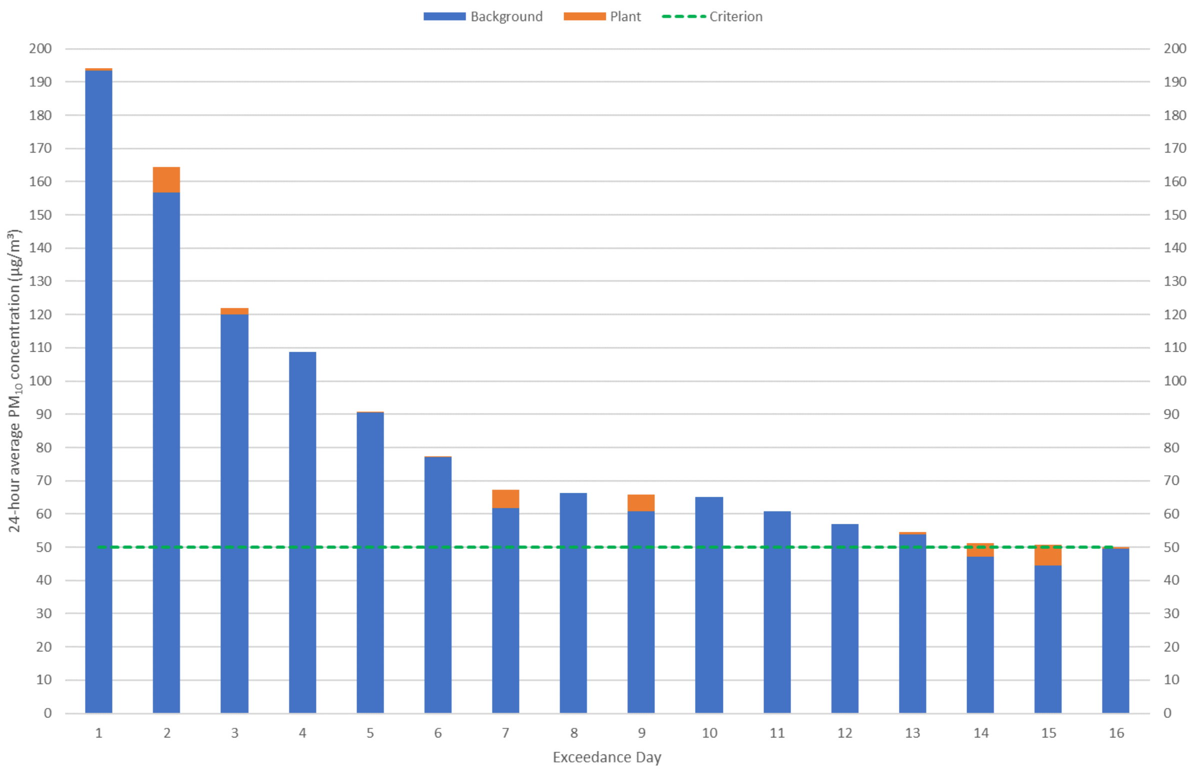

Figure 13 Source contribution of 24-hour average PM_{10} criterion exceedances at R11 for Tweed Sand Plant Phase 1-6

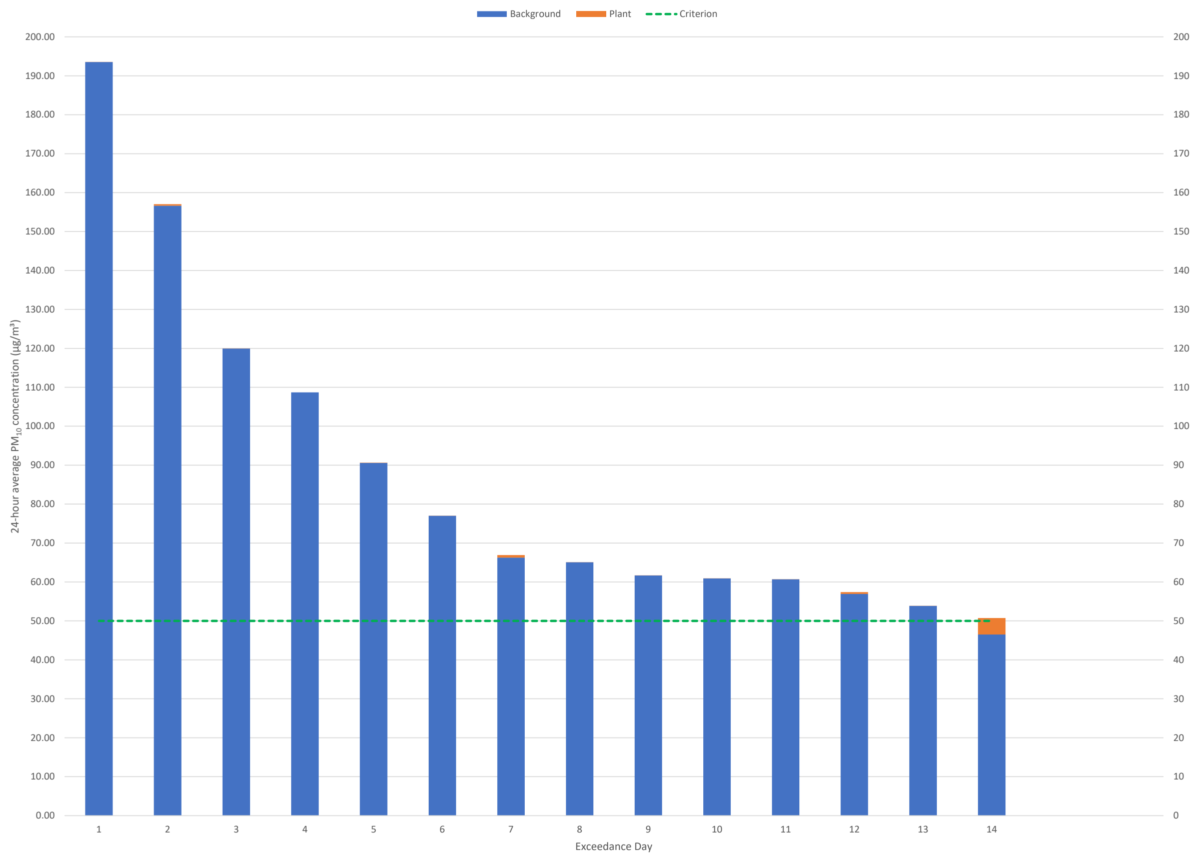

Figure 14 **Source contribution of 24-hour average PM_{10} criterion exceedances at R11 for Tweed Sand Plant Phase 7-11 operations**

8.3 $PM_{2.5}$

Table 8 and Table 9 provides the predicted maximum 24-hour and annual average ground-level concentrations of $PM_{2.5}$ at the sensitive receptors in isolation (i.e. without the background) and with background levels applied for Phase1-6 and Phase 7-11, respectively.

Plate 5 and Plate 6 show the predicted maximum 24-hour and annual average ground-level concentrations of $PM_{2.5}$ for the Tweed Sand Plant in isolation (i.e. without the background) for Phase 1-6.

Plate 7and Plate 8 show the predicted maximum 24-hour and annual average ground-level concentrations of $PM_{2.5}$ for the Tweed Sand Plant in isolation (i.e. without the background) for Phase 7-11.

The results show the following:

- Maximum 24-hour average ground-level concentrations of $PM_{2.5}$ are predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both Phase 1-6 and Phase 7-11 operations.
- A level 2 (contemporaneous) assessment 24-hour average concentrations of $PM_{2.5}$ was conducted, which shows that the Tweed Sand Plant is predicted to result in no additional days that exceed the impact assessment criterion for both Phase 1-6 and Phase 7-11 operations.
- Annual average ground-level concentrations of $PM_{2.5}$ were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both Phase 1-6 and Phase 7-11 operations.

Table 8 Predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ at discrete receptors for the Tweed Sand Plant Expansion Project Phase 1-6

Receptor	$PM_{2.5}$ (µg/m³)					
	24-hour average				Annual average	
	Plant	Plant -Days > 25	Background Days >25	Plant + Background Additional Days > 25	Plant	Plant + Background
R1	1.1	0	13	0	0.1	6.8
R2	0.8				0.05	6.7
R3	0.7				0.05	6.7
R4	2.4				0.1	6.8
R5	3.4				0.1	6.8
R6	3.9				0.1	6.8
R7	3.0				0.1	6.8
R8	3.2				0.2	6.9
R9	3.2				0.2	6.9
R10	3.0				0.2	6.9
R11	4.1				0.2	6.9
R12	3.6				0.2	6.9
R13	3.3				0.2	6.9
R14	2.6				0.2	6.9
R15	2.4				0.2	6.9
R16	1.7				0.1	6.8
R17	1.5				0.1	6.8
R18	1.0				0.1	6.8
R19	1.2				0.1	6.7
R20	0.9				0.05	6.7
R21	0.9				0.1	6.7
Criteria	**25**	**-**	**-**	**-**	**8**	

Table 9 **Predicted maximum 24-hour average and annual average ground-level concentrations of $PM_{2.5}$ at discrete receptors for the Tweed Sand Plant Expansion Project Phase 7-11**

Receptor	$PM_{2.5}$ ($\mu g/m^3$)					
	24-hour average				Annual average	
	Plant	Plant -Days > 25	Background Days >25	Plant + Background Additional Days > 25	Plant	Plant + Background
R1	1.7				0.1	6.8
R2	1.4				0.1	6.8
R3	0.5				0.01	6.7
R4	0.8				0.02	6.7
R5	1.3				0.03	6.7
R6	1.0				0.03	6.7
R7	1.2				0.03	6.7
R8	1.2				0.03	6.7
R9	1.4				0.04	6.7
R10	1.9				0.04	6.7
R11	1.4	0	13	0	0.1	6.7
R12	0.9				0.1	6.7
R13	0.9				0.1	6.7
R14	1.0				0.1	6.7
R15	1.2				0.1	6.7
R16	0.9				0.04	6.7
R17	0.7				0.04	6.7
R18	0.6				0.03	6.7
R19	1.1				0.1	6.7
R20	0.9				0.1	6.7
R21	1.0				0.1	6.8
Criteria	**25**	**-**	**-**	**-**	**8**	

8.4 TSP and Dust Deposition

Table 10 and Table 11 provides the predicted annual average ground-level concentrations of TSP and dust deposition rate at the sensitive receptors in isolation (i.e. without the background) and with background levels applied for Phase 1-6 and Phase 7-11, respectively.

Plate 9 and Plate 10 show the predicted ground-level concentrations of TSP and dust deposition rate for the Tweed Sand Plant in isolation (i.e. without the background) for Phase 1-6, respectively.

Plate 11 and Plate 12 show the predicted ground-level concentrations of TSP and dust deposition rate for the Tweed Sand Plant in isolation (i.e. without the background) for Phase 7-11, respectively.

The results show the following:

- TSP:
  - Annual average ground-level concentrations of TSP were predicted to comply with the relevant NSW criterion at the location of the sensitive receptors for the Tweed Sand Plant in isolation and with background levels for both Phase 1-6 and Phase 7-11 operations.
- Dust deposition
  - Annual dust deposition rates were predicted to comply with the relevant criterion at the location of the sensitive receptors for the Tweed Sand Plant in isolation and including background levels Phase 1-6 and Phase 7-11 operations.

Table 10 **Predicted annual average ground-level concentrations of TSP and annual average dust deposition rates at discrete receptors for the Tweed Sand Plant Expansion Project Phase 1-6**

Receptor	TSP (µg/m³)		Dust Deposition (g/m²/month)	
	Annual average		Annual average	
	Plant	Plant + Background	Plant	Plant + Background
R1	1.5	1.5	0.08	2.6
R2	0.8	0.9	0.04	2.9
R3	0.8	0.8	0.03	2.8
R4	1.7	1.7	0.07	3.2
R5	2.3	2.3	0.10	3.4
R6	2.2	2.2	0.09	3.4
R7	2.8	2.8	0.13	3.8
R8	3.0	3.0	0.15	3.9
R9	3.3	3.3	0.17	4.1
R10	3.4	3.4	0.18	4.2
R11	4.3	4.3	0.22	4.6
R12	3.7	3.8	0.19	4.3
R13	3.3	3.3	0.17	4.1
R14	3.0	3.0	0.15	3.9
R15	2.7	2.8	0.13	3.8
R16	1.4	1.4	0.06	3.1
R17	1.3	1.3	0.06	3.1
R18	0.8	0.8	0.03	2.8
R19	0.6	0.7	0.02	2.7
R20	0.6	0.6	0.02	2.7
R21	0.7	0.7	0.02	2.7
Criteria	**90**		**2**	**4**

Table 11 Predicted annual average ground-level concentrations of TSP and annual average dust deposition rates at discrete receptors for the Tweed Sand Plant Expansion Project Phase 7-11

Receptor	TSP (µg/m³)		Dust Deposition (g/m²/month)	
	Annual average		Annual average	
	Plant	Plant + Background	Plant	Plant + Background
R1	2.8	36.5	0.26	2.8
R2	1.1	34.9	0.09	2.6
R3	0.2	33.9	0.01	2.5
R4	0.3	34.0	0.02	2.5
R5	0.3	34.1	0.02	2.5
R6	0.3	34.1	0.02	2.5
R7	0.4	34.2	0.03	2.5
R8	0.4	34.2	0.03	2.5
R9	0.5	34.3	0.03	2.5
R10	0.6	34.3	0.04	2.5
R11	0.8	34.6	0.06	2.6
R12	0.8	34.5	0.06	2.6
R13	0.7	34.5	0.05	2.6
R14	0.7	34.5	0.05	2.6
R15	0.7	34.5	0.06	2.6
R16	0.5	34.3	0.04	2.5
R17	0.5	34.3	0.04	2.5
R18	0.5	34.2	0.04	2.5
R19	0.6	34.4	0.05	2.6
R20	0.7	34.4	0.05	2.6
R21	0.8	34.6	0.06	2.6
Criteria	**90**		**2**	**4**

9. MITIGATION AND MANAGEMENT

9.1 Air quality monitoring

An air quality monitoring program will continue to operate at Tweed Sand Plant to ensure conditions are regularly assessed and relevant air quality criteria are achieved.

Previous approvals stated that by monitoring dust deposition rates and demonstrating compliance with the relevant limits, emissions of TSP, PM_{10} and $PM_{2.5}$ would also be expected to be effectively controlled and, therefore, compliance with the respective limits would likely be achieved.

However, due to the proposed increased production rate, there is a small potential for cumulative 24-hour average concentrations of PM_{10} to exceed the impact assessment criterion and so a PM_{10} monitoring program will be established so that site operations can effectively manage any potential elevated PM_{10} levels.

Accordingly, the air quality monitoring program will include the following:

- Continuation of the existing dust deposition monitoring on a monthly basis at the four locations, namely: northern boundary, eastern boundary, southern boundary and south-western boundary (Figure 6).
- As the Tweed Sand Plant operations expand into the new area, a dust deposition site should be installed to the northwest in proximity to R2 and on the western boundary.
- A continuous PM_{10} monitor, using a light scattering technique, should be installed to the south / southeast of the existing washplant with elevated levels triggering dust management actions. Dust management actions include determining if winds are from the plant to receptors (see meteorological monitoring), increased water application, limiting certain operations and ceasing operations.

Air quality monitoring shall be conducted in accordance with the Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (EPA, 2007).

9.2 Meteorological monitoring

The BoM produces 3-hourly forecasts of weather conditions at Cudgen seven days in advance. The forecasts are updated twice daily at 6am and 6pm and include the following meteorological parameters:

- Rainfall
- Temperature
- UV index
- Significant weather (including thunderstorms)
- Humidity and wind.

Tweed Sand Plant staff will continue to review the BoM 3-hourly forecasts of weather conditions at Cudgen on a daily basis and plan operations accordingly. The potential for sustained strong winds from the plant towards sensitive receptors (northerly to westerly winds) and dry temperatures are the key parameters that will drive dust management actions, coupled with the continuous PM_{10} monitoring data.

10. CONCLUSIONS

This Air Quality Impact Assessment (AQIA) has been prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW and aims to quantify the potential impact of the expansion of Tweed Sand Plant on air quality in the local area.

Dust (as TSP, PM_{10}, $PM_{2.5}$ and deposition rate) from the proposed Tweed Sand Plant expansion operations has been considered in the AQIA. The CALPUFF dispersion model has been used to predict ground-level concentrations of dust as a result of two stages of the development of the proposed Tweed Sand Plant expansion, Phase 1-6 and Phase 7-11. A cumulative assessment that includes addition of ambient backgrounds has been conducted. The results of the dispersion modelling have been assessed against the relevant impact assessment criteria in NSW.

The results of the AQIA show the following:

TSP

- Annual average ground-level concentrations of TSP are predicted to comply with the relevant impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and with background levels for both stages of the development.

PM_{10}

- Maximum 24-hour average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both stages of the development.
- For the cumulative assessment of 24-hour average concentrations of PM_{10}, a level 2 (contemporaneous) assessment was conducted, which shows the following:
    - For Phase 1-6, the Tweed Sand Plant is predicted to contribute to between one and three additional days that exceed the impact assessment criterion at sensitive receptors R5 – R15, which are to the immediate southeast of the existing washplant.
    - Of these receptors, R11 is the closest to the Tweed Sand Plant (300m) and predicted the greatest number of additional exceedances of the 24-hour average impact assessment criterion for PM_{10} (3). The maximum contribution of Tweed Sand Plant to an exceedance at R11 is 12% compared to background.
    - For Phase 7-11, the Tweed Sand Plant is predicted to contribute one additional day that exceeds the impact assessment criterion at sensitive receptors R9 – R12, which are to the immediate southeast of the site boundary.
    - Of these receptors, R11 is the closest to the site. The maximum contribution of Tweed Sand Plant to an exceedance at R11 is 8% compared to background.
- The Approved Methods requires that a proponent demonstrate that a proposed development does not result in additional exceedances of the impact assessment criteria at sensitive receptors. Hanson will ensure compliance with the air quality criterion is achieved in practice through a proactive and reactive management strategy, whereby, watering will be increased and/or certain operations will cease during periods of elevated dust risk. Key features of this strategy will be managed using the proposed dust monitoring program and weather forecasts.
- Annual average ground-level concentrations of PM_{10} were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both stages of the development.

$PM_{2.5}$

- Maximum 24-hour average ground-level concentrations of $PM_{2.5}$ are predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation for both stages of the development.
- A level 2 (contemporaneous) assessment 24-hour average concentrations of $PM_{2.5}$ was conducted, which shows that the Tweed Sand Plant is predicted to result in no additional days that exceed the impact assessment criterion for both stages of the development.
- Annual average ground-level concentrations of $PM_{2.5}$ were predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background for both stages of the development.

Dust deposition

- Annual average dust deposition rates are predicted to comply with the impact assessment criterion at the nearest sensitive receptors for the Tweed Sand Plant in isolation and including background levels for both stages of the development.

Monitoring and mitigation

Overall, the contribution of the proposed Tweed Sand Plant expansion to air pollutant levels in the region is low compared to background. On a small number of occasions there is potential for Tweed Sand Plant operations combined with background to result in elevated concentrations of PM_{10}. On these occasions, the contribution of Tweed Sand Plant is small (less than 12%) and background air quality dominates. Accordingly, Hanson proposes to implement a proactive and reactive strategy that includes real time PM_{10} monitoring and ongoing use of weather forecasts to ensure that Hanson can effectively manage operations, through increased watering or ceasing operations, during times of elevated dust risk, which will ensure that no additional exceedances occur due to the expansion.

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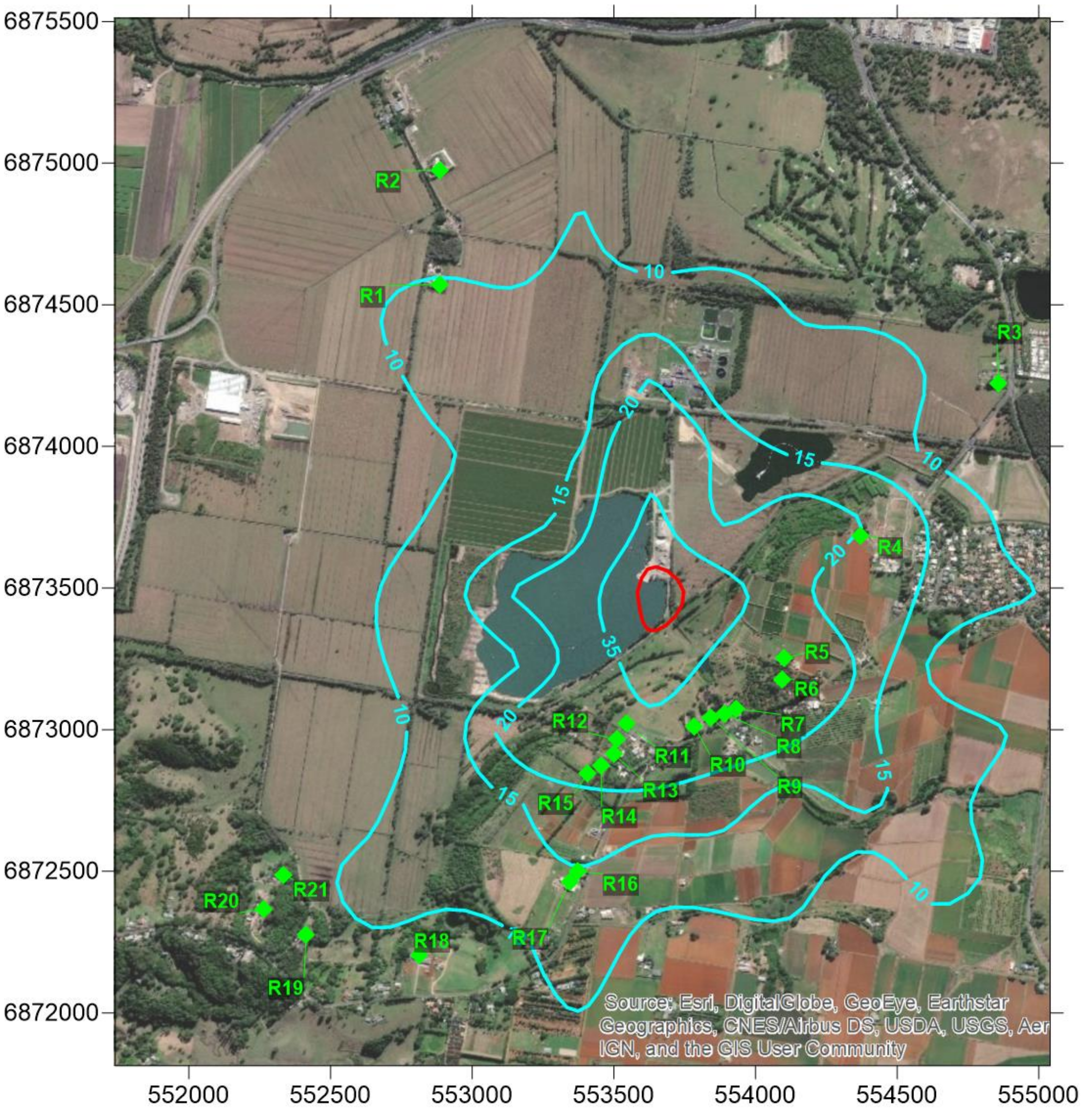

Plate 1	**Phase 1 to 6: Predicted maximum 24-hour average ground-level concentrations of PM_{10} for Tweed Sand Plant**

Location: Tweed Sand Plant	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contour	**Objective:** 50 µg/m³	**Prepared by:** Sarah-Jane Donnelly	**Date:** 2 November 2020

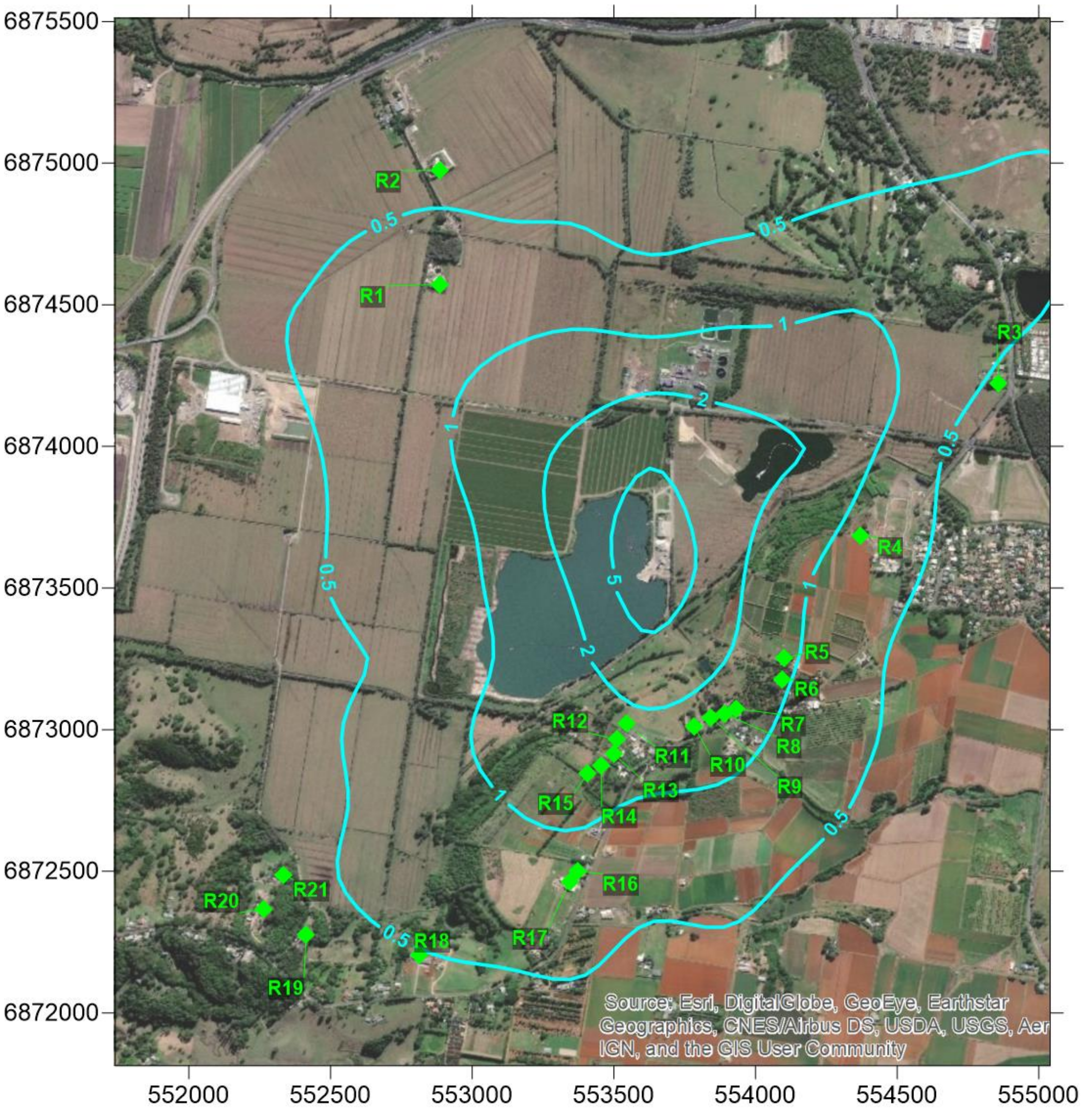

Plate 2	Phase 1 to 6: Predicted annual average ground-level concentrations of PM_{10} for Tweed Sand Plant		
Location: Tweed Sand Plant	**Averaging period:** Annual average	**Data source:** CALPUFF	**Units:** µg/m³
Type: Average contour	**Objective:** 25 µg/m³	**Prepared by:** Sarah-Jane Donnelly	**Date:** 2 November 2020

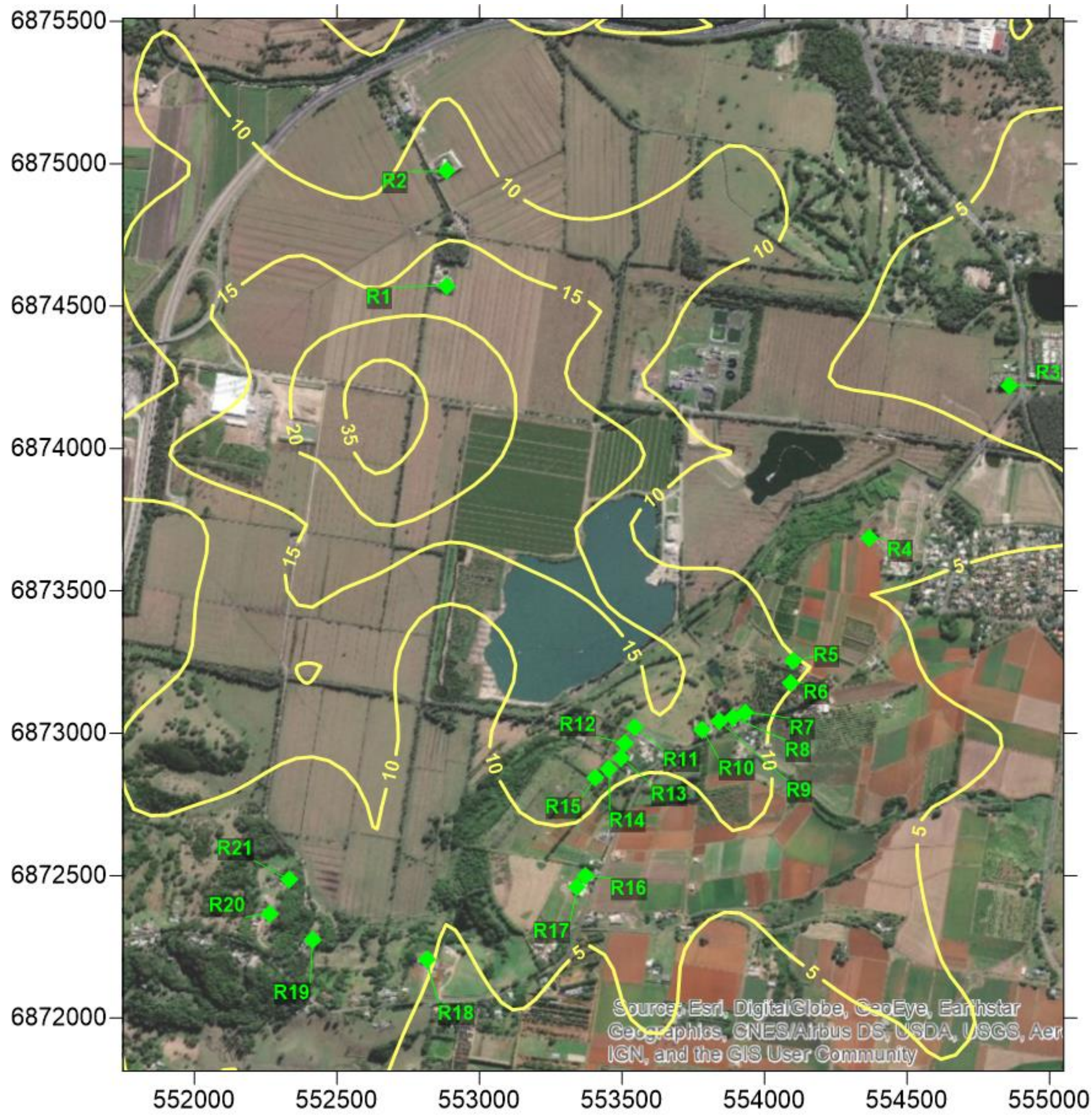

Plate 3	**Phase 7 to 11: Predicted maximum 24-hour average ground-level concentrations of PM_{10} for Tweed Sand Plant**

Location:	**Averaging period:**	**Data source:**	**Units:**
Tweed Sand Plant	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contour	50 µg/m³	Sarah-Jane Donnelly	2 November 2020

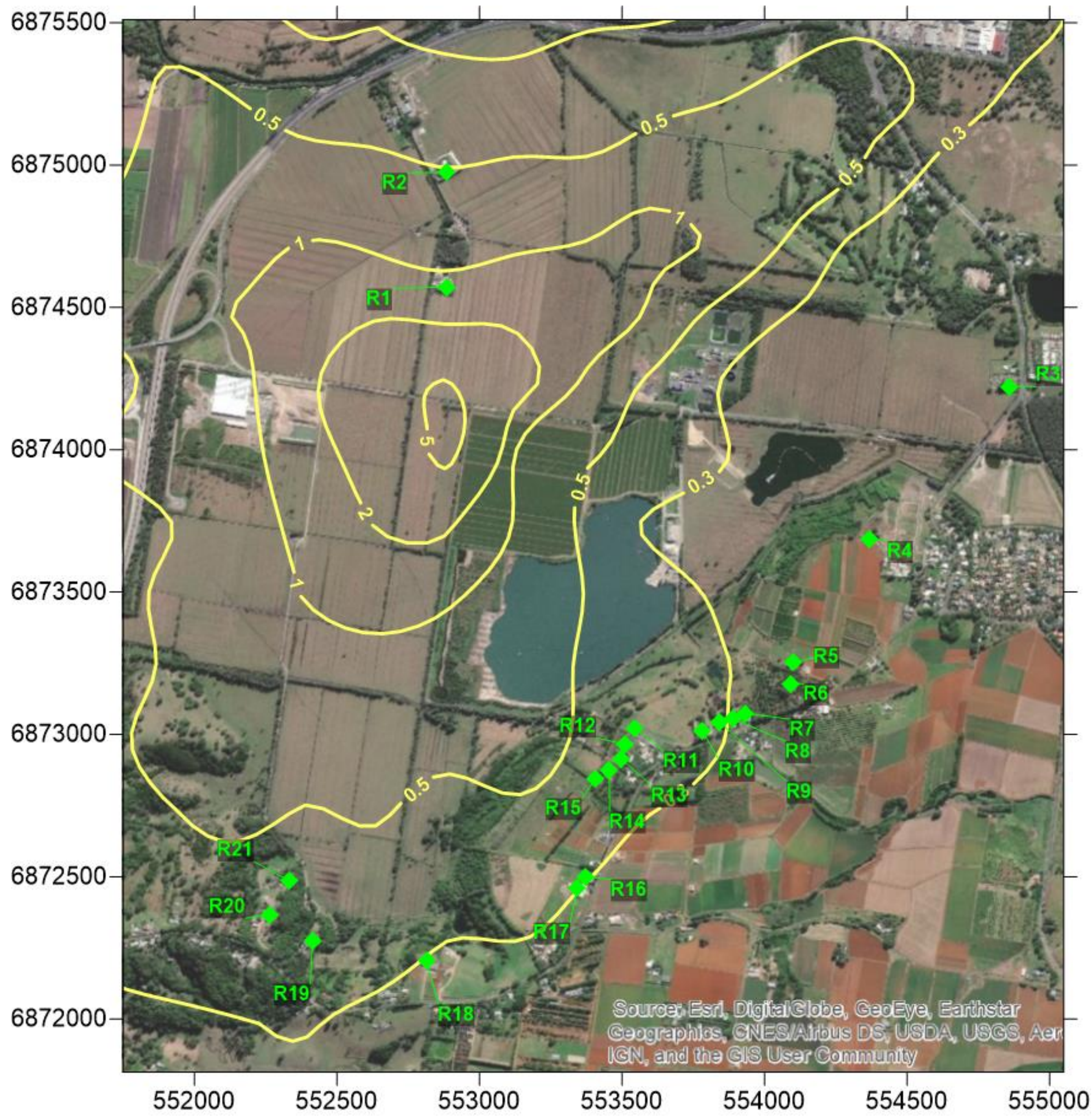

Plate 4	**Phase 7 to 11: Predicted annual average ground-level concentrations of PM_{10} for Tweed Sand Plant**

Location:	**Averaging period:**	**Data source:**	**Units:**
Tweed Sand Plant	Annual average	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contour	25 µg/m³	Sarah-Jane Donnelly	2 November 2020

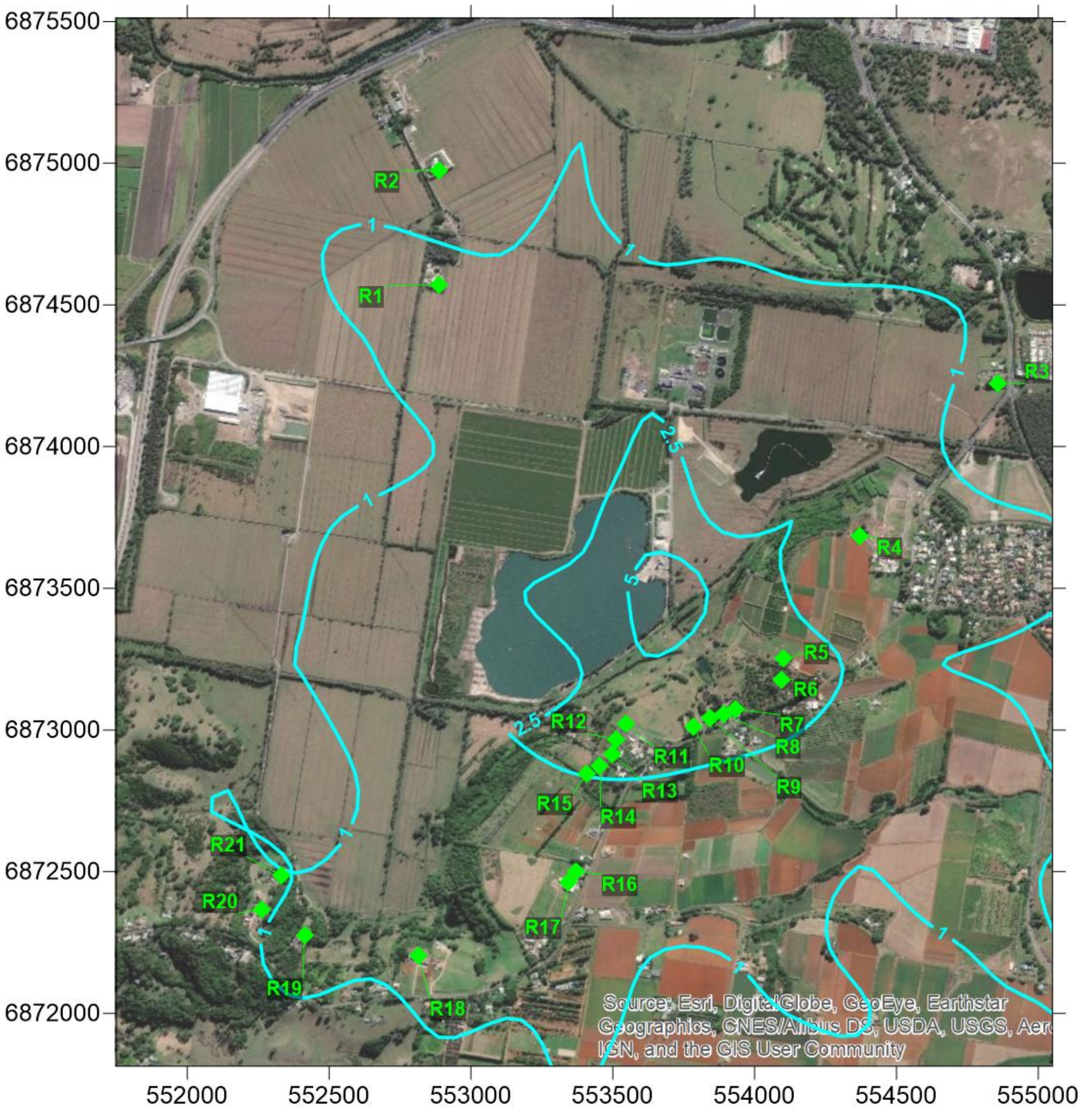

Plate 5	**Phase 1 to 6: Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for Tweed Sand Plant**

Location:	**Averaging period:**	**Data source:**	**Units:**
Tweed Sand Plant	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contour	25 µg/m³	Sarah-Jane	2 November 2020

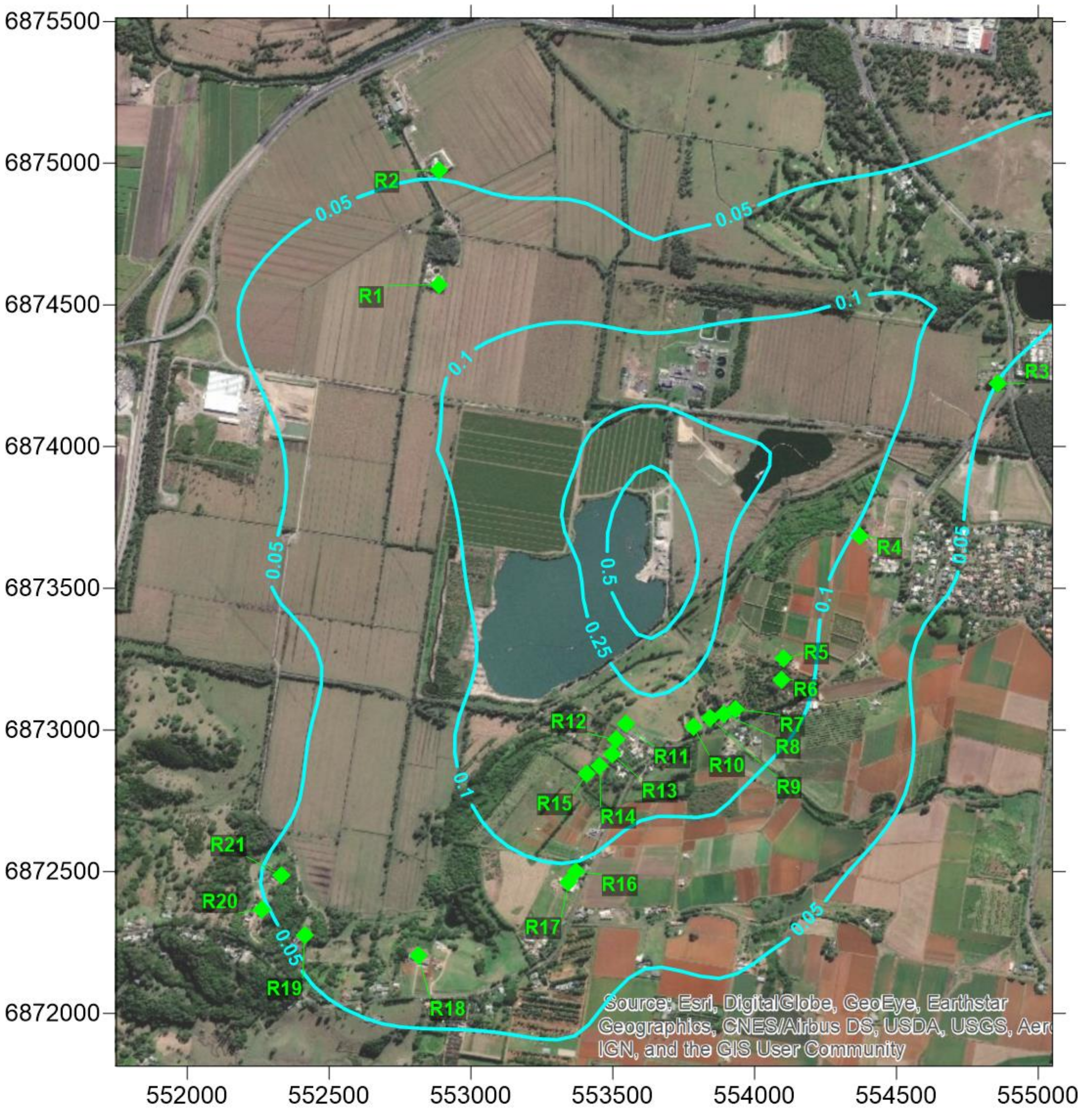

Plate 6	**Phase 1 to 6: Predicted annual average ground-level concentrations of $PM_{2.5}$ for Tweed Sand Plant**

Location: Tweed Sand Plant	**Averaging period:** Annual average	**Data source:** CALPUFF	**Units:** µg/m³
Type: Average contour	**Objective:** 8 µg/m³	**Prepared by:** Sarah-Jane	**Date:** 2 November 2020

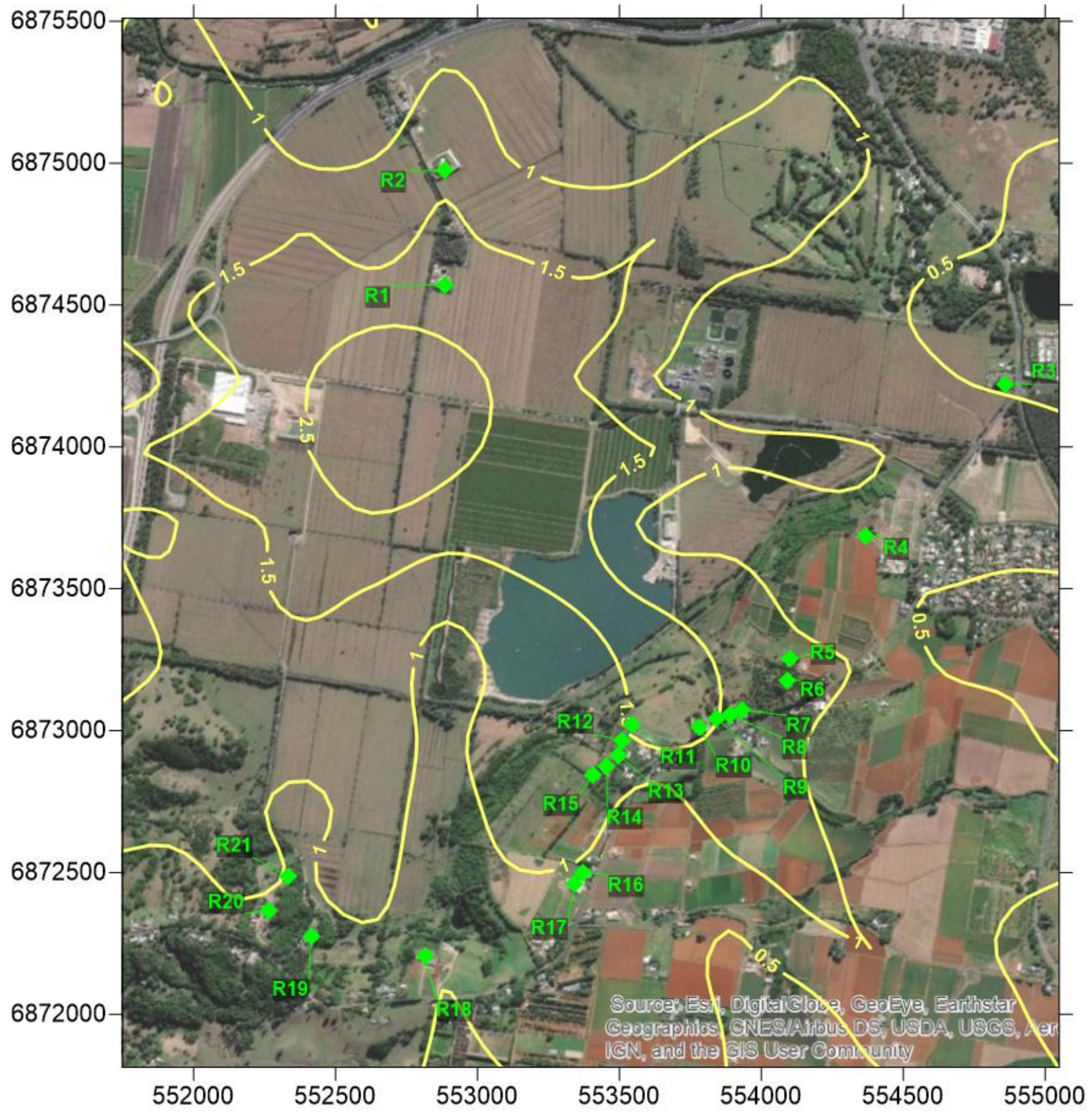

Plate 7 **Phase 7 to 11: Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ for Tweed Sand Plant**

Location:	**Averaging period:**	**Data source:**	**Units:**
Tweed Sand Plant	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contour	25 µg/m³	Sarah-Jane	2 November 2020

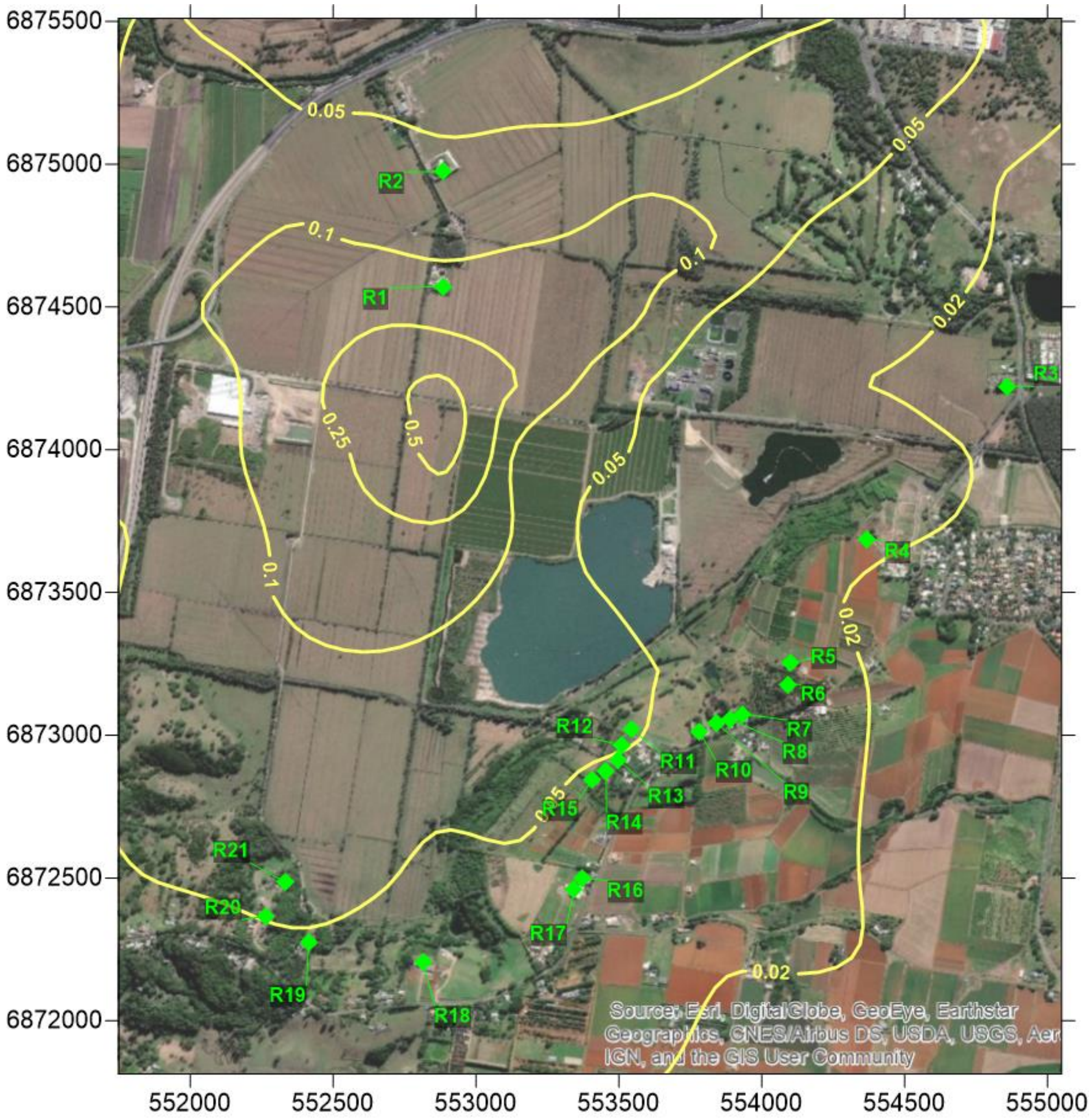

Plate 8	**Phase 7 to 11: Predicted annual average ground-level concentrations of $PM_{2.5}$ for Tweed Sand Plant**

Location:	**Averaging period:**	**Data source:**	**Units:**
Tweed Sand Plant	Annual average	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contour	8 µg/m³	Sarah-Jane	2 November 2020

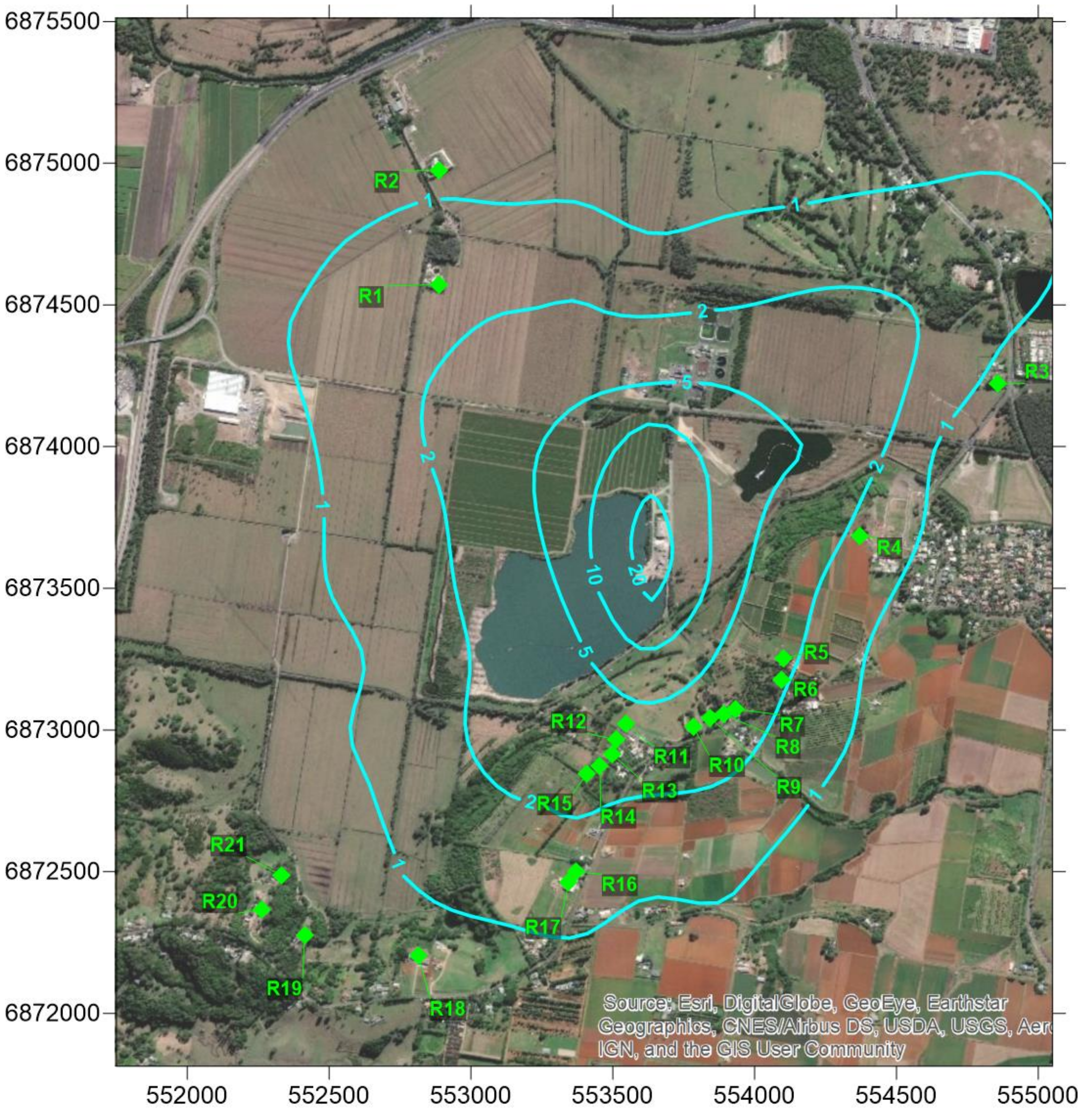

Plate 9	**Phase 1 to 6: Predicted annual average ground-level concentrations of TSP for Tweed Sand Plant, background included**		
Location: Tweed Sand Plant	**Averaging period:** Annual average	**Data source:** CALPUFF	**Units:** µg/m³
Type: Average contour	**Objective:** 90 µg/m³	**Prepared by:** Sarah-Jane	**Date:** 2 November 2020

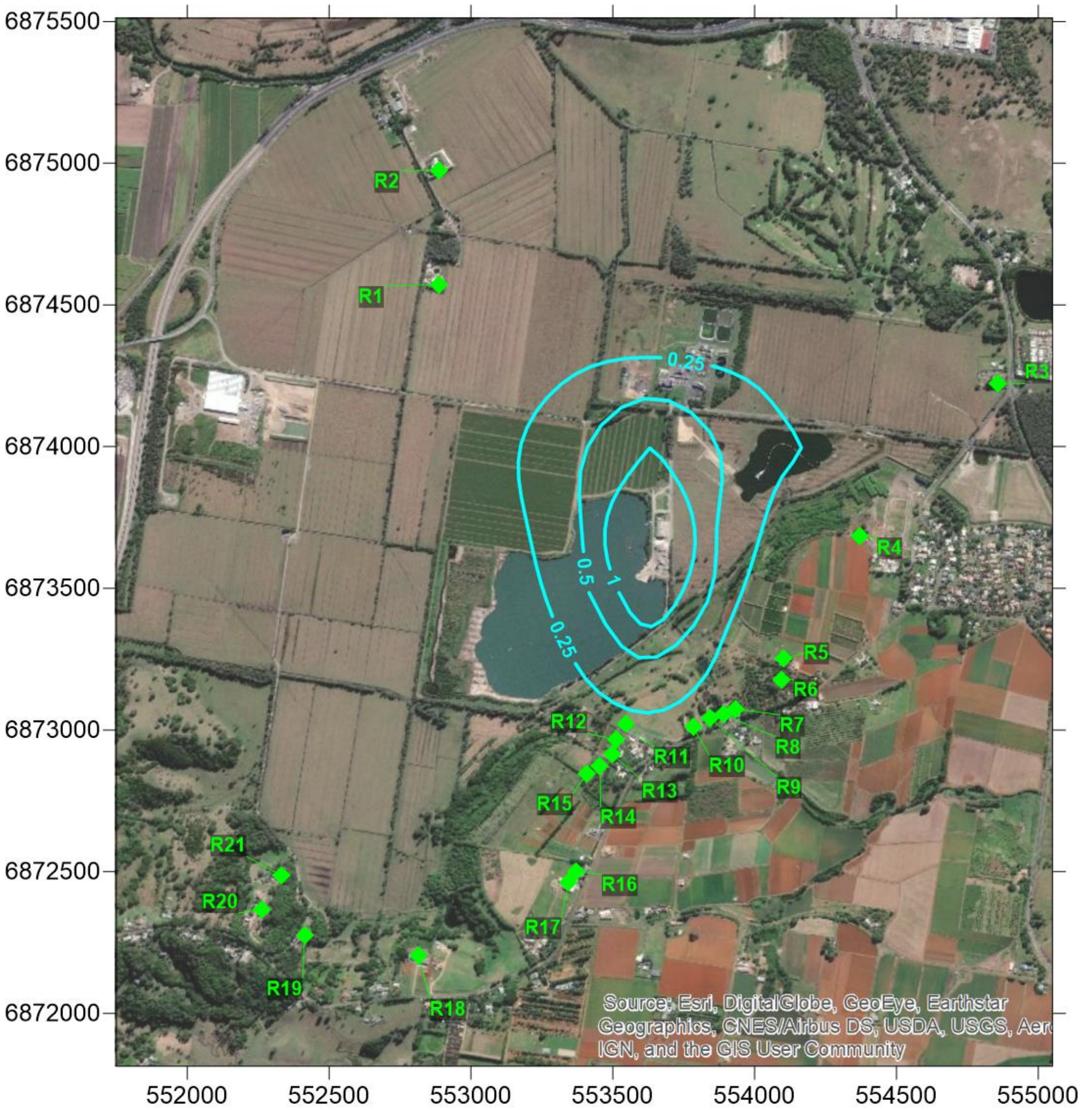

Plate 10	**Phase 1 to 6: Predicted monthly dust deposition for Tweed Sand Plant**		
Location: Tweed Sand Plant	**Averaging period:** Monthly average	**Data source:** CALPUFF	**Units:** g/m²/month
Type: Average contour	**Objective:** 2 g/m²/month	**Prepared by:** Sarah-Jane	**Date:** 2 November 2020

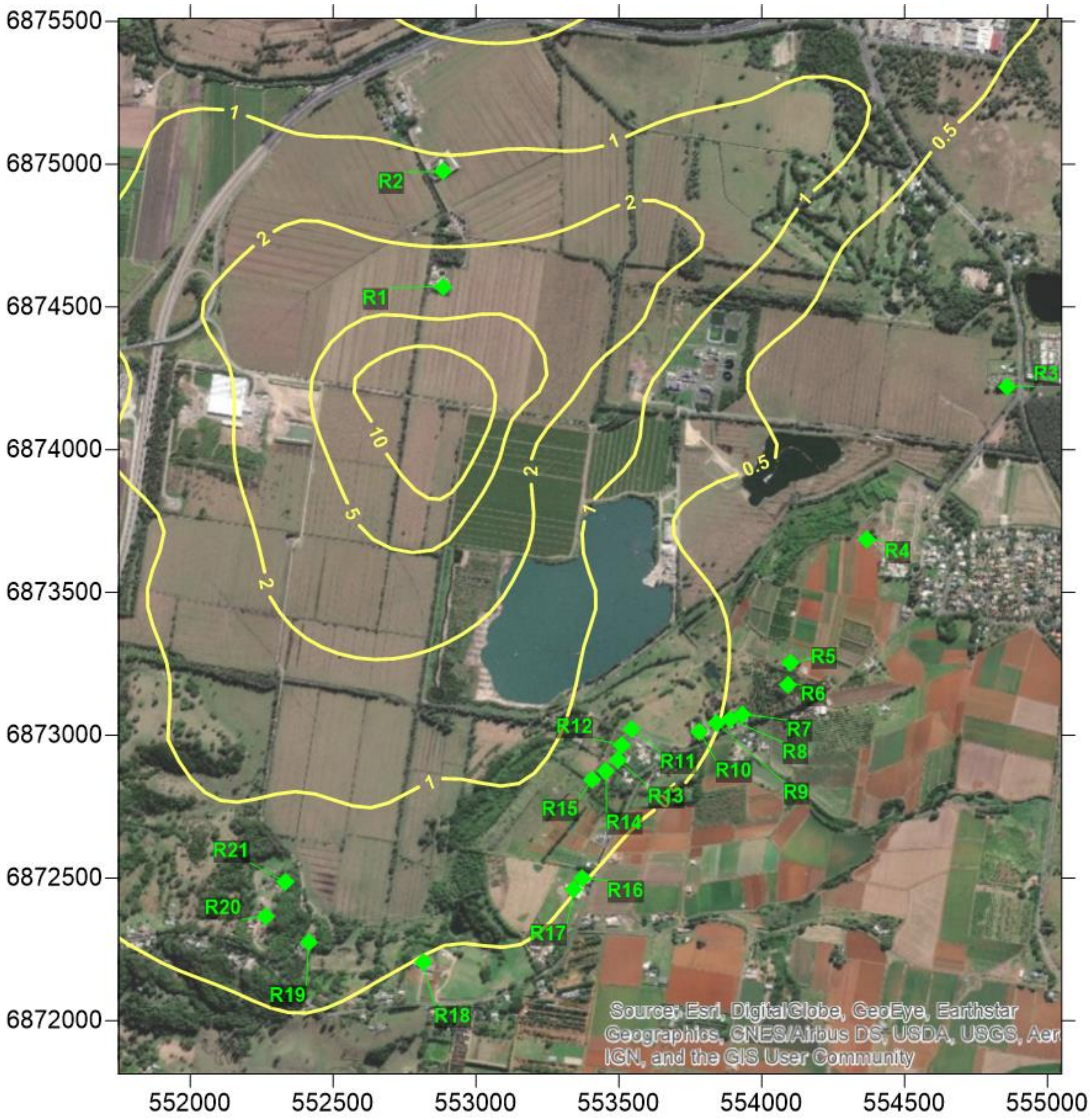

Plate 11	**Phase 7 to 11: Predicted annual average ground-level concentrations of TSP for Tweed Sand Plant, background included**

Location: Tweed Sand Plant	**Averaging period:** Annual average	**Data source:** CALPUFF	**Units:** µg/m³
Type: Average contour	**Objective:** 90 µg/m³	**Prepared by:** Sarah-Jane	**Date:** 2 November 2020

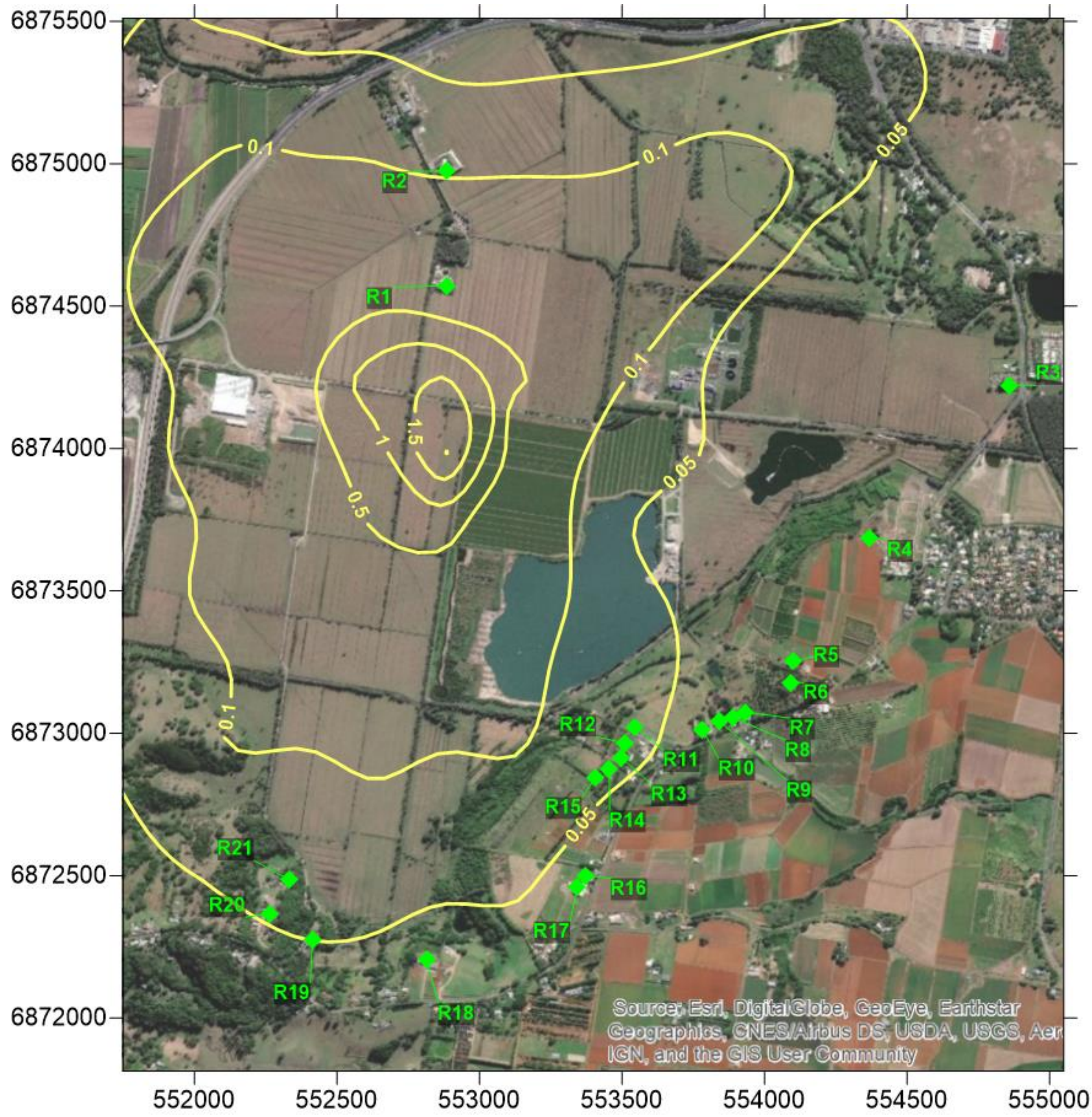

Plate 12 **Phase 7 to 11: Predicted monthly dust deposition for Tweed Sand Plant**

Location:	Averaging period:	Data source:	Units:
Tweed Sand Plant	Monthly average	CALPUFF	g/m²/month
Type:	**Objective:**	**Prepared by:**	**Date:**
Average contour	2 g/m²/month	Sarah-Jane	2 November 2020

APPENDIX A METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

A1 METEOROLOGY

The meteorological data for this study was generated by coupling TAPM, a prognostic mesoscale meteorological model to CALMET, a diagnostic meteorological model.

The coupled TAPM/CALMET modelling system was developed by Katestone to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF. Details of the model configurations are supplied below

A1.1 TAPM meteorology

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.4, was developed by the CSIRO and has been validated by the CSIRO, Katestone Environmental and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO).

TAPM is a prognostic meteorological model that predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the study region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 m to 5 km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

The default land use database for TAPM is based on global land cover data at 30-second grid spacing (approximately 1 km), from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC). A visual comparison of the default geophysical features of the region and imagery provided by Google Earth shows that the default geophysical data are not able to capture distinct terrain and land-use characteristics of the region. In addition to these, geophysical features derived from land cover such as vegetation height, fraction of surface covered by vegetation, and leaf area index will not be substantially represented. These will have an impact on the predicted meteorological conditions.

The land use data for the modelling domain of the two innermost TAPM nests were updated using semi-automated GIS (Geographic Information System) methods. The TAPM land use information was enhanced by overlaying TAPM land-use output map with the most recent aerial images available (Google Earth). Developments and changes to land use were accounted for, and further enhanced on the resultant land use database.

Terrain data were also enhanced from the TAPM default by calculating average elevation over the grid receptor network specified in the domain. The updated information was based on SRTM (Shuttle Radar Topography Mission), a digital elevation model released by NASA (National Aeronautics and Space Administration) on a near-global scale at 90-m resolution.

The TAPM model was configured as follows:

- 41 x 41 grid point domain with an outer grid of 30 kilometres and nested grids of 10 kilometres, 3 kilometres and1 kilometre
- Grid centred on the locality of Tweed Sand Plant (553135, 6874984)
- SRTM DEM terrain data at 90m resolution
- Land cover data updated using imagery to account for recent changes in land use
- Synoptic data used in the simulation for the period of January to December 2019
- 25 vertical grid levels
- 365 days (1 January 2014 to 31 December 2019).

A1.2 CALMET meteorological modelling

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 3km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

CALMET was set up with twelve vertical levels with heights at 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600, 4600 metres at each grid point.

All default options and factors were selected except where noted below.

Key features of CALMET used to generate the wind fields followed NSW CALMET guidance document. Setup includes:

- Domain area of 80 by 80 grid points at 500 metre spacing
- Twelve vertical levels set at 20 m, 80 m, 120 m, 280 m, 320 m, 680 m, 820 m, 1180 m, 1820 m, 2180 m, 3820 m and 4180 m
- 365 days (1 January 2019 to 31 December 2019)
- Kinematic effects turned on
- Slope flow effects turned on
- CALMET version 6.5.

The geophysical data (land use and terrain heights) were generated consistent with the geophysical dataset for TAPM.

A2 CALPUFF DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation.

CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 120 x 120 grids at 250 m spacing,
- 365 days modelled (1 January 2019 to 31 December 2019)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dry deposition calculated only, no chemical transformation
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables.

All other options set to default.