Intended for
**Audalia Resource Limited**

Date
**2 June 2020**

# AUDALIA RESOURCES LIMITED MEDCALF PROJECT
# HAUL ROAD DUST DEPOSITION STUDY

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# AUDALIA RESOURCES LIMITED MEDCALF PROJECT HAUL ROAD DUST DEPOSITION STUDY

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# 1. INTRODUCTION

## 1.1 Background

Audalia Resources Limited (Audalia) is proposing to develop the Medcalf Project, a vanadium, titanium and iron project located approximately 470 km south east of Perth near Lake Johnston, Western Australia. The proposal includes the development of four open mine pits, beneficiation plant, tailings storage facility, waste rehabilitation stockpile (to be removed post-mining operations), evaporation ponds, process water facility, private haul road, concentrate transfer area and associated infrastructure such as laydown areas, borrow and gravel pits, borefield, workshops and accommodation camp.

Mining will be by conventional load and haul, with ore delivered to the run of mine (ROM) pad. The ROM ore will be processed onsite at a beneficiation plant, incorporating a comminution circuit (including both crushing and milling processes) and a magnetic separation circuit, upgrading the ROM ore to a primary concentrate. Based on the proposed mining rate of approximately 1.5 million tonnes per annum (Mtpa), approximately 1.2 Mtpa of concentrate will be produced from the beneficiation plant. The primary concentrate is to be transported along a 74 km private haul road from the mine to a dedicated road train transfer area adjacent to the Coolgardie-Esperance Highway (Figure 1). The primary concentrate will be stockpiled at this transfer area, and then loaded onto highway-approved road trains for the remainder of the journey to the Esperance Port.

Audalia has requested that Ramboll Australia Pty Ltd (Ramboll) undertake air dispersion modelling of fugitive dust emissions associated with the haulage of concentrate from the mine site to the road train transfer area, adjacent to the Coolgardie-Esperance Highway; and the transfer of concentrate from the haul trucks to the road trains (including stockpiling, reclaiming and truck loading).

## 1.2 Purpose of this Report

This report presents the assessment of the potential dust deposition rates associated with fugitive particulate emissions from the haulage of concentrate to the road train transfer area; and the transfer of concentrate from the haul trucks to the road trains. The approach, methodology and results of the air dispersion modelling are detailed as well as the predicted impacts.

Two concentrate transport scenarios have been considered in this assessment:

- **Scenario 1:** Concentrate transferred by road train from the mine site to the transfer yard near the highway, stockpiled, then loaded to road trains; and
- **Scenario 2:** Concentrate transferred by slurry pipeline from the mine site to the transfer yard near the highway, dewatered in a mobile unit, stockpiled, then loaded to road trains.

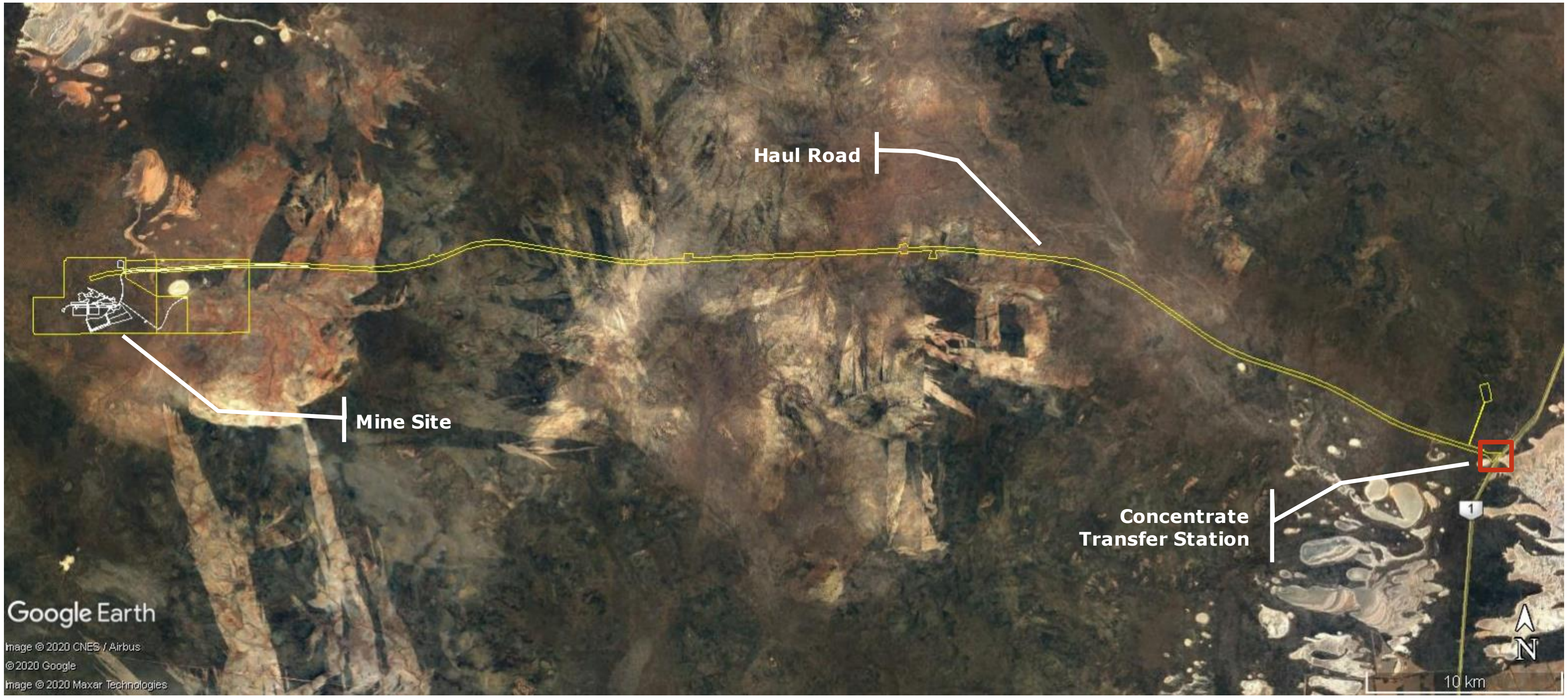



**Figure 1: Medcalf Project Proposed Mine Site and Haul Road Development Envelope**

# 2. BACKGROUND INFORMATION

## 2.1 Operational Overview

The proposed Medcalf Project involves shallow (above the groundwater table) open pit mining for four separate open pits; the Vesuvius, Fuji, Pinatubo and Egmont deposits. The combined ore tonnage inventory is for 19.1 Million tonnes (Mt), with a waste/ore strip ratio of 0.15. The mine schedule indicates a pit life of 13 years and maximum annual ore production of 1.6 Mtpa. Mining will be by conventional load and haul, with ore delivered to the ROM pad. The ROM ore will be processed onsite at a beneficiation plant, incorporating a comminution circuit (including both crushing and milling processes) and a magnetic separation circuit, upgrading the ROM ore to a primary concentrate. The primary concentrate is dewatered by thickening and filtration, with the filter cake stacked and prepared for transport.

Based on an average mining rate of 1.5 Mtpa, approximately 1.2 Mtpa of concentrate will be produced from the beneficiation plant. The primary concentrate is proposed to be hauled by road trains along a 74 km private haul road from the mine to a dedicated road train transfer area adjacent to the Coolgardie-Esperance Highway. The primary concentrate will be stockpiled at this transfer area, and then loaded onto highway-approved road trains for the remainder of the journey to the Esperance Port (Figure 2).

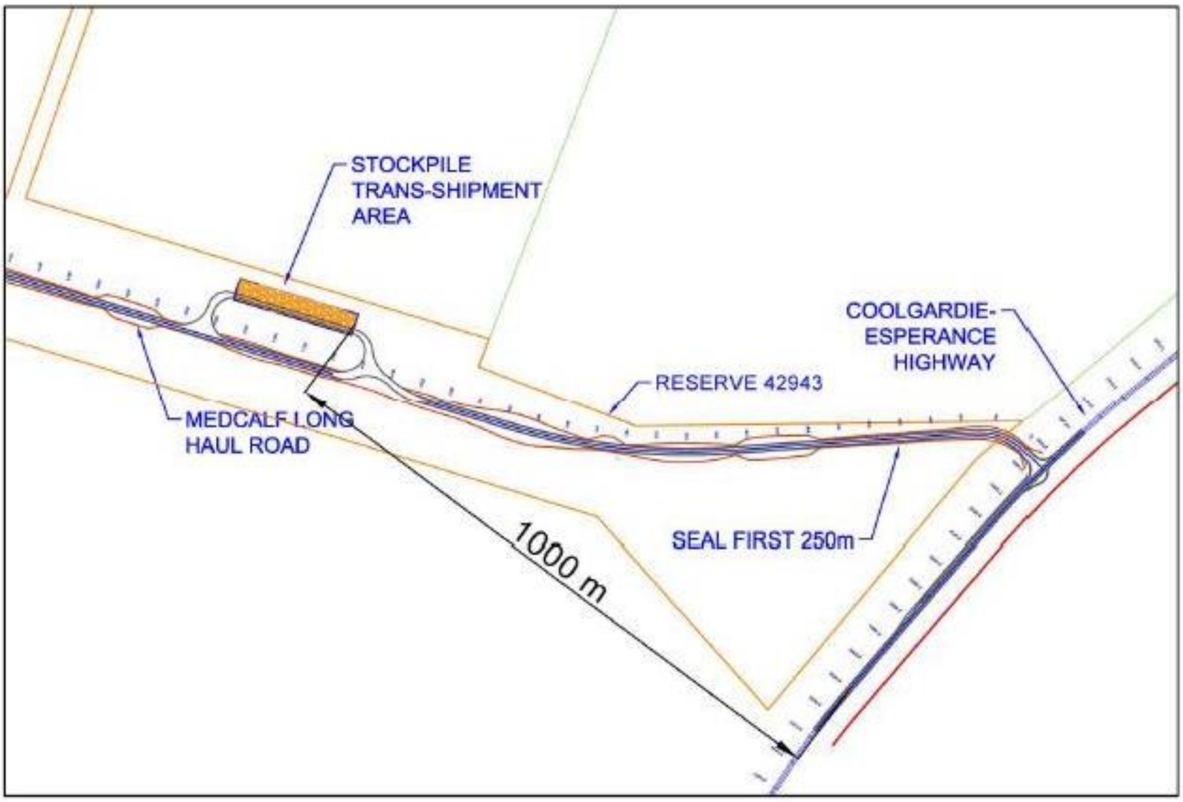



**Figure 2: Medcalf Project Proposed Concentrate Transfer Area Layout**

Source: Roadmiles (2017)

Ramboll understand a second scenario is also under consideration, involving transfer of the concentrate via slurry pipeline from the mine site to the transfer yard near the highway. The concentrate slurry would be dewatered in a mobile unit and stockpiled, before being loaded to road trains. For the purpose of this assessment, it has been assumed the dewatered concentrate would be loaded to trucks via a hopper, stockpiled and subsequently reclaimed and loaded to road train via front end loader.

Mining, processing and haulage operations will occur during day shifts only, nominally between 06:00 and 18:00 hrs.

### 2.2 Regional Climate

The proposed Medcalf Project is located in the Lake Johnston region of WA. The regional climate is characterised as arid to semi-arid, warm Mediterranean. Mean climate data for the Salmon Gums (40 km south of the proposed road-train transfer area) and Norseman (47 km north-east of the proposed road-train transfer area) Bureau of Meteorology (BoM) meteorological monitoring stations were obtained from the BoM. The long-term mean annual rainfall data for the two sites are presented in Figure 3. These data indicate the highest rainfall at the Salmon Gums site tends to occur between May and August; while the highest rainfall at the Norseman site occurs between May and July. The mean annual rainfall for the Salmon Gums[1] site is 341 mm; and for Norseman[2] is 298 mm.

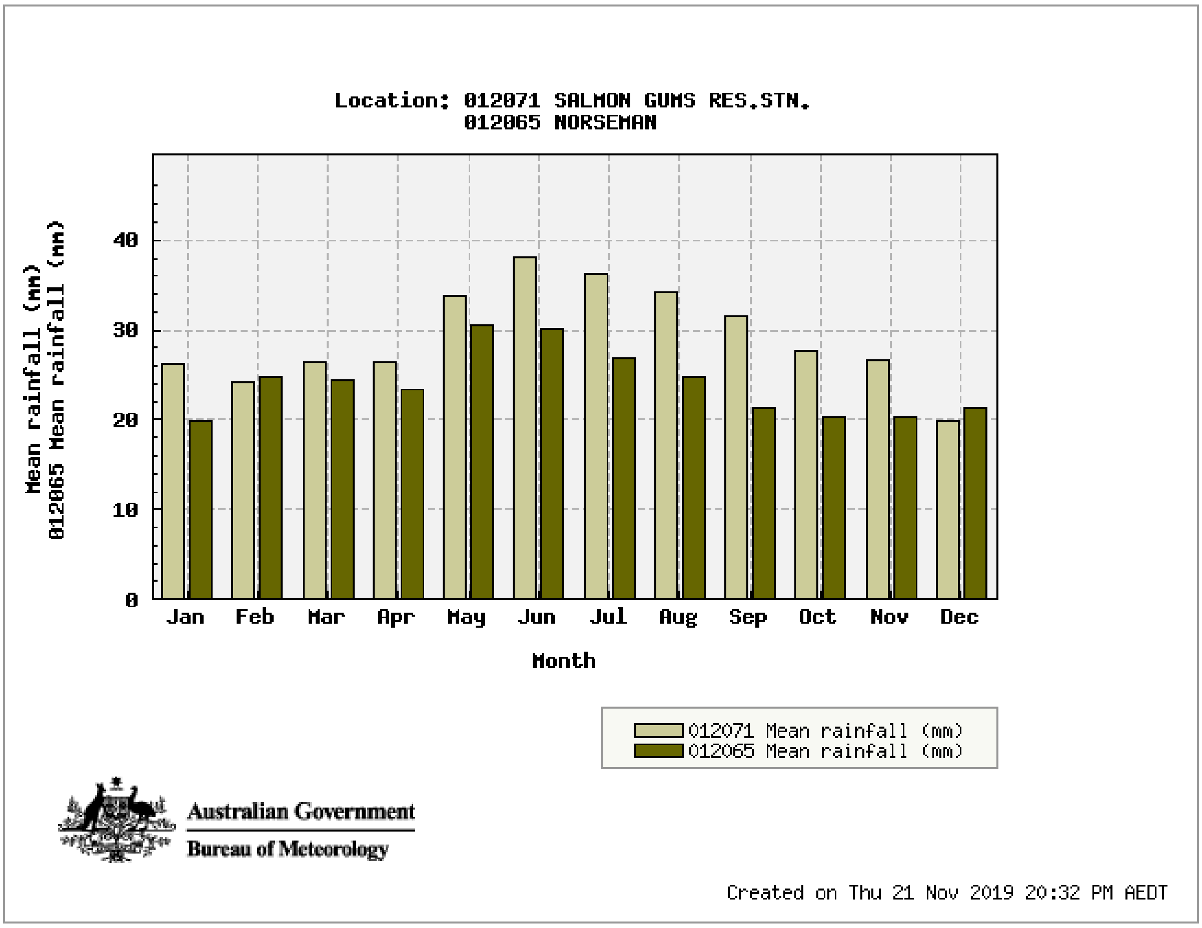



**Figure 3: Long-term Mean Monthly Rainfall for Salmon Gums and Norseman BoM Monitoring Sites**

Source: BoM

[1] Source: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=-290355523&p_stn_num=012070

[2] Source: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=-290355523&p_stn_num=012009

The 9 am and 3 pm annual wind roses for the Salmon Gums and Norseman monitoring sites are presented in Figure 4 and Figure 5. These wind roses indicate the Salmon Gums site experiences a higher percentage of stronger (i.e. > 5 m/s) winds in the morning and afternoon compared to the Norseman site. The wind direction tends northerly in the morning and southerly in the afternoon at Salmon Gums (Figure 4); while at Norseman the winds tend north-west through north-east in the morning and north-westerly in the afternoon (Figure 5).

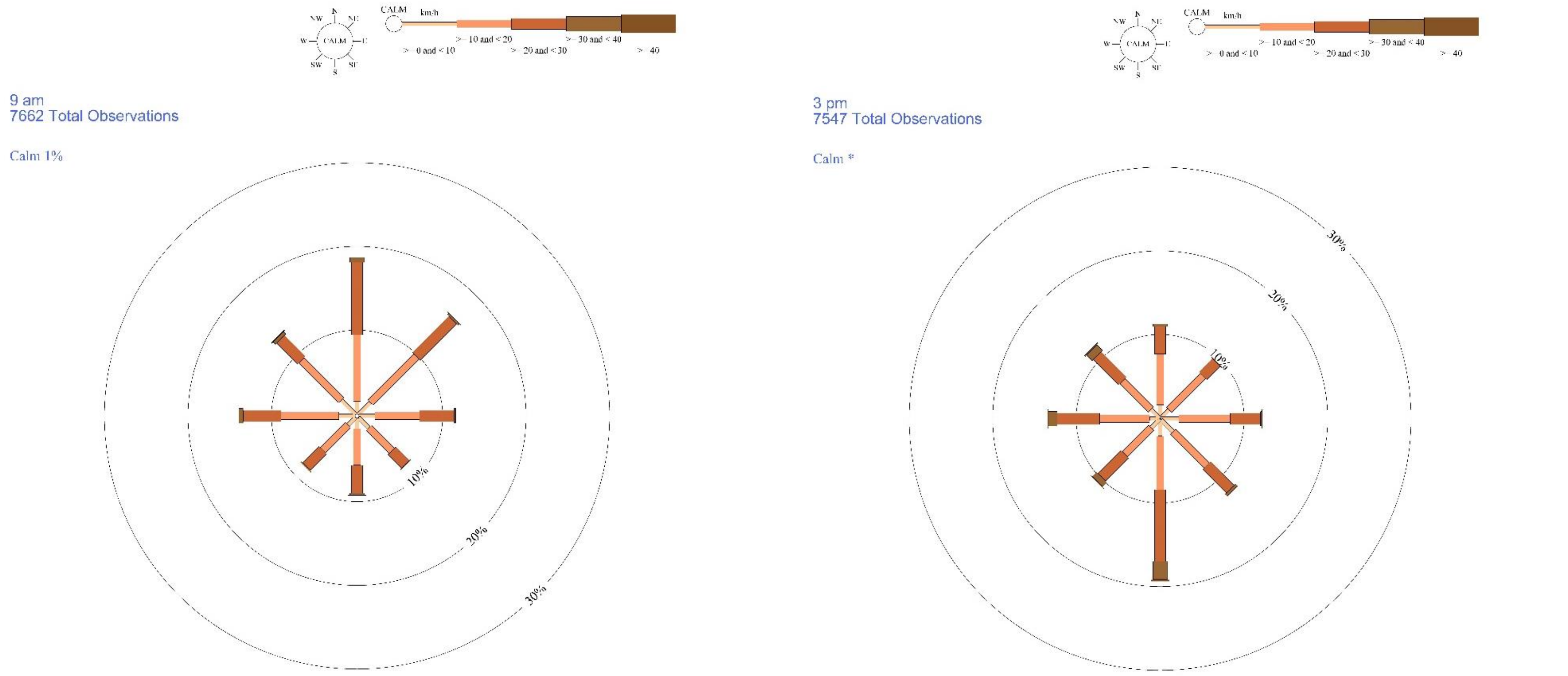
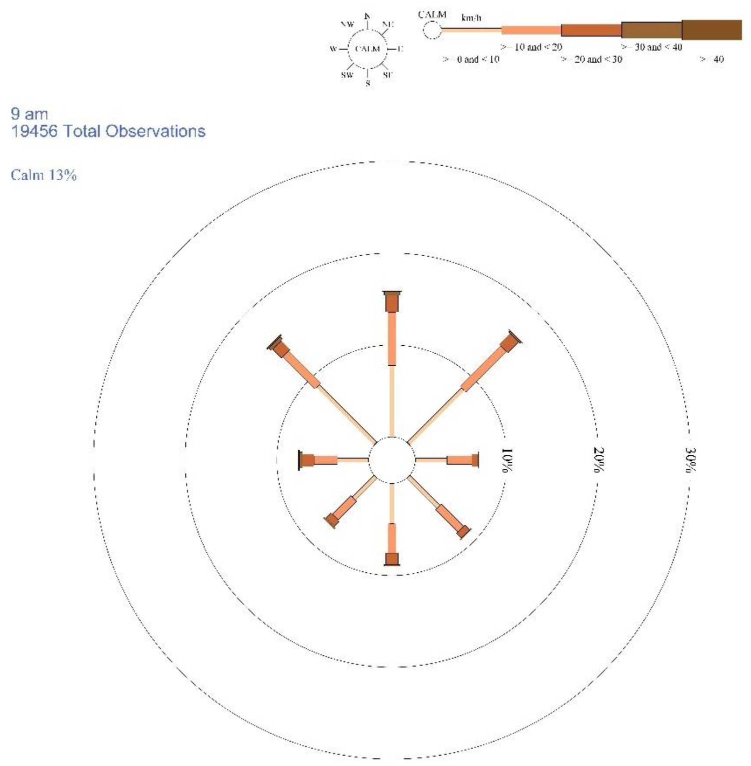



**Figure 4: Salmon Gums Annual 9 AM and 3 PM Wind Roses (Nov 1985 to Aug 2019)**

Source: BoM



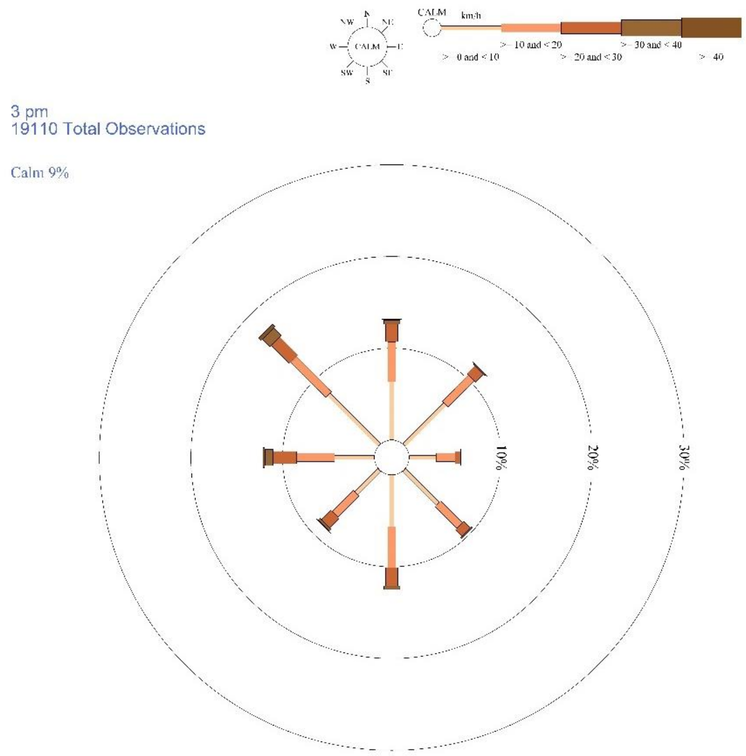




**Figure 5: Norseman Annual 9 AM and 3 PM Wind Roses (Jan 1957 to Aug 2012)**

Source: BoM

Hourly meteorological data were obtained from the BoM for the Salmon Gums site for a five-year period (from 2014 through 2018) for additional analysis. Annual wind roses are presented in Figure 6 and seasonal wind roses in Figure 7. The annual wind roses illustrate a relatively consistent pattern from year to year, with no clearly dominant wind component. However, review of the seasonal wind roses shows a clear distinction between the summer and winter months; moderate to strong easterly-through-southerly winds dominate the summer months, while light to moderate westerly-through-northerly winds characterise the winter months. During the transitional seasons of autumn and spring, the winds remain highly variable.

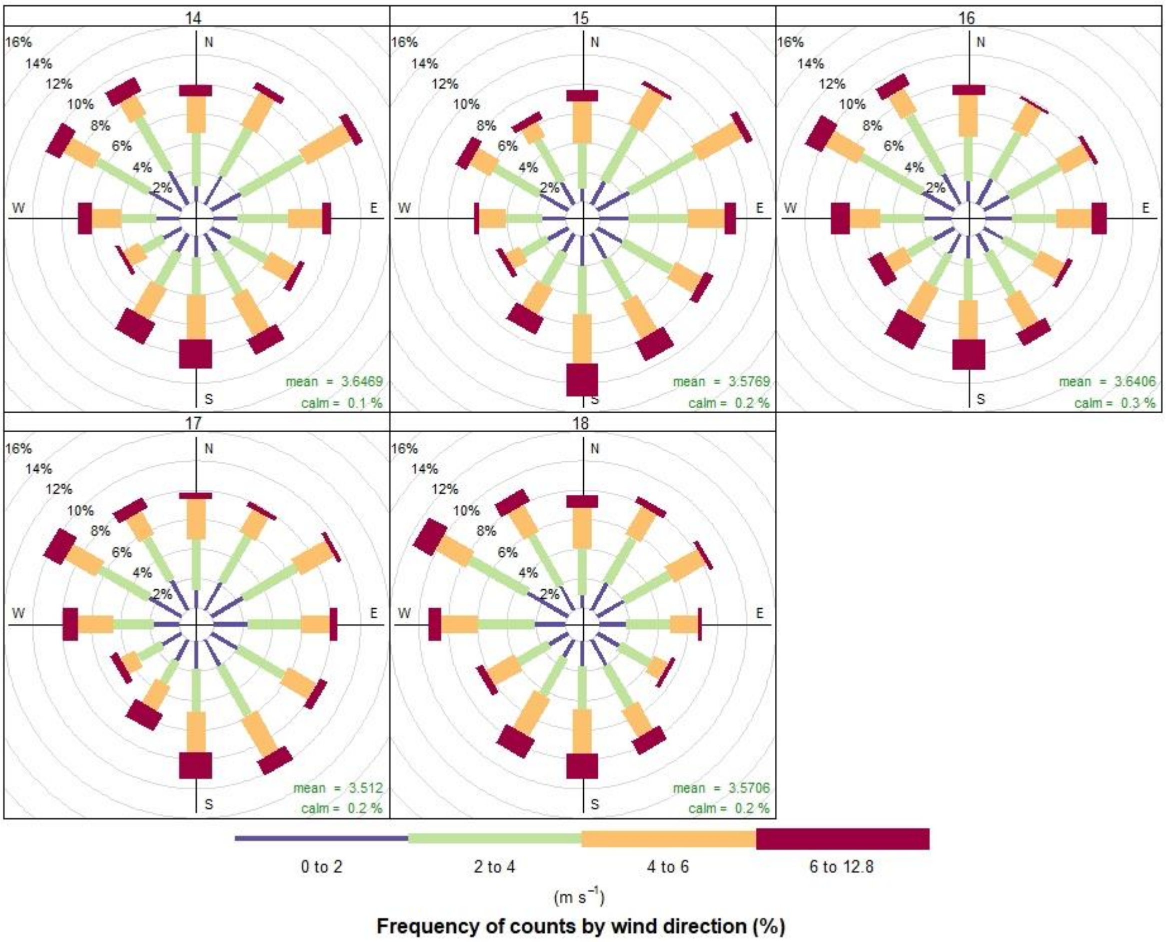



**Figure 6: Salmon Gums Annual Wind Roses (2014-2018)**

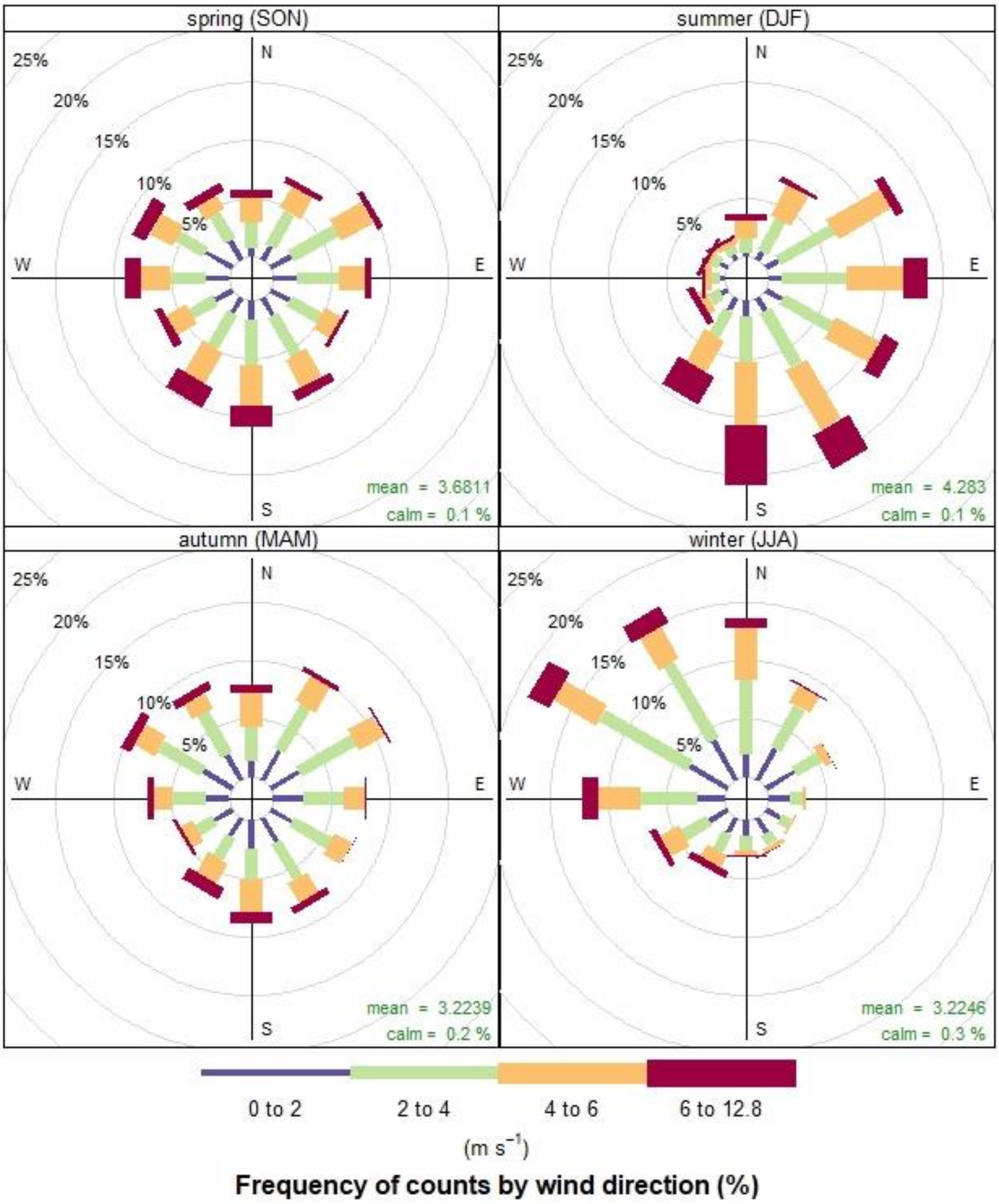



**Figure 7: Salmon Gums Seasonal Wind Roses (2014-2018)**

### 2.3 Existing Dust Deposition

Audalia have undertaken monthly dust deposition monitoring at the Project site since October 2018. The monitoring network comprises 12 dust deposition gauges, the locations of which are presented in Figure 8. Nine of the gauges are located within the mine development envelope (Figure 9) and two are within the proposed haul road envelope (DGM4 and DGM5). A background gauge is located approximately 18 km north-west of the proposed operations (DGM1).

The deposition gauges are collected on a monthly basis and sent to a NATA accredited laboratory for analysis. The samples are analysed in accordance with the applicable standards (AS3580.10.1:2016: Determination of particulate matter – Deposited matter – Gravimetric method) and results are reported for ash content, total soluble matter and total insoluble matter ($g/m^2$.month).

A summary of the monthly dust deposition monitoring results provided by Audalia is presented in Table 1. Total dust deposition has been calculated based on the sum of the total soluble and total insoluble matter. The average monthly dust deposition rates across all sites range between 0.08 $g/m^2$.month and 1.5 $g/m^2$.month.

A graphical representation of the monthly dust deposition rates is presented in Figure 10. The highest monthly deposition rates were reported in March and April 2019, the maximum being 5.2 $g/m^2$.month at DGM1 in April 2019. The exposure period for the March 2019 samples was 65 days, due to the presence of a regional fire which prohibited access for the monthly collection of the deposition gauges. Comparatively elevated depositions rates were also recorded for the 8 November 2018 sample period at DGM3, and the 29 November 2018 sample period at DGM4.


**Figure 8: Locations of Dust Deposition Monitors – Haul Road**

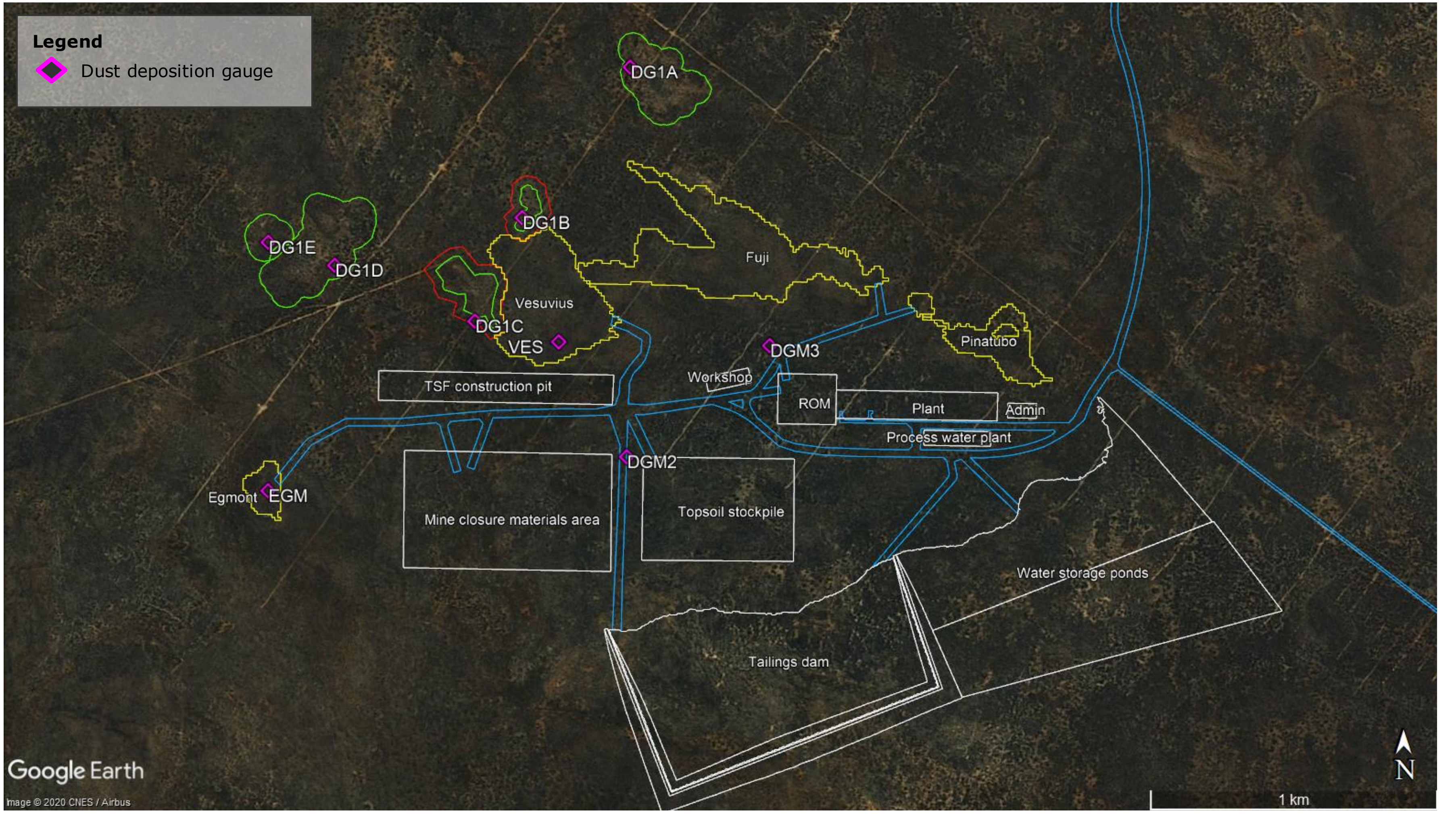



**Figure 9: Locations of Dust Deposition Monitors – Mine Envelope**

**Table 1: Summary of Dust Deposition Monitoring Results**

| Sampling Period | Exposure Period (Days)[1] | Total Dust Deposition (g/m$^2$.month) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DG1A | Mine Envelope | | | | | | | | | Haul Road | |
| | | | DG1B | DG1C | DG1D | DG1E | DGM1 | DGM2 | DGM3 | VES | EGM | DGM4 | DGM5 |
| 10/09/18 - 08/11/18 | 59[2] | 0.7 | 0.5 | 0.7 | 0.8 | 1 | 0.5 | 0.7 | 3 | ND | ND | 0.7 | 0.4 |
| 08/11/18 - 29/11/18 | 21 | 0.9 | 0.6 | 0.7 | 0.9 | 1.3 | 0.5 | 0.4 | 0.9 | 0.4 | 0.6 | 3.7 | 1.3 |
| 28/11/18 - 08/01/19 | 41 | 0.3 | 0.5 | 0.4 | 0.5 | 0.7 | 0.9 | 0.3 | 0.7 | 1.5 | 1.6 | 0.6 | 0.7 |
| 08/01/19 - 14/03/19 | 65[2] | 2.1 | 2.2 | 1.9 | 2.2 | 2.2 | ND | 1.9 | 2.6 | 2.0 | 2.4 | 1.8 | 0.9 |
| 14/03/19 - 16/04/19 | 33 | 2.7 | 2.1 | 1.7 | 3.1 | 1.2 | 5.2 | 1.8 | 2.3 | 0.8 | 0.8 | 2.6 | 3.3 |
| 16/04/19 - 22/05/19 | 36 | 0.4 | 0.5 | 0.4 | 0.6 | 0.5 | 2.4 | 0.3 | 0.5 | 0.4 | 0.5 | 0.4 | 2.5 |
| 22/05/19 - 03/07/19 | 42/34[3] | 0.3 | 0.3 | 0.4 | 0.4 | 1.3 | 0.5 | 0.2 | 0.3 | 1.1 | 1 | 0.5 | 0.4 |
| 03/07/19 - 31/07/19 | 30/36[4] | 0.3 | 0.4 | 1.1 | 0.3 | 0.4 | 0.5 | ND | 0.2 | 0.4 | 0.6 | 0.3 | 0.2 |
| 31/07/19 - 29/08/19 | 29 | 0.2 | 0.4 | 0.2 | 0.2 | 0.5 | 1.6 | 0.4 | 0.3 | 0.6 | 0.6 | 0.3 | 0.5 |
| Average | - | 0.9 | 0.8 | 0.8 | 1.0 | 1.0 | 1.5 | 0.8 | 1.2 | 0.9 | 1.0 | 1.2 | 1.1 |

Notes

1. Typical exposure period specified in AS3580.10.1:2016 is 30±2 days.
2. Presence of fire prohibited collection of dust deposition gauge within monthly period.
3. Sample exposure period is 34 days for DGM4 and DGM5 and 42 days for all other gauges.
4. Sample exposure period is 36 days for DGM4 and DGM5 and 30 days for all other gauges.
5. ND = No data.

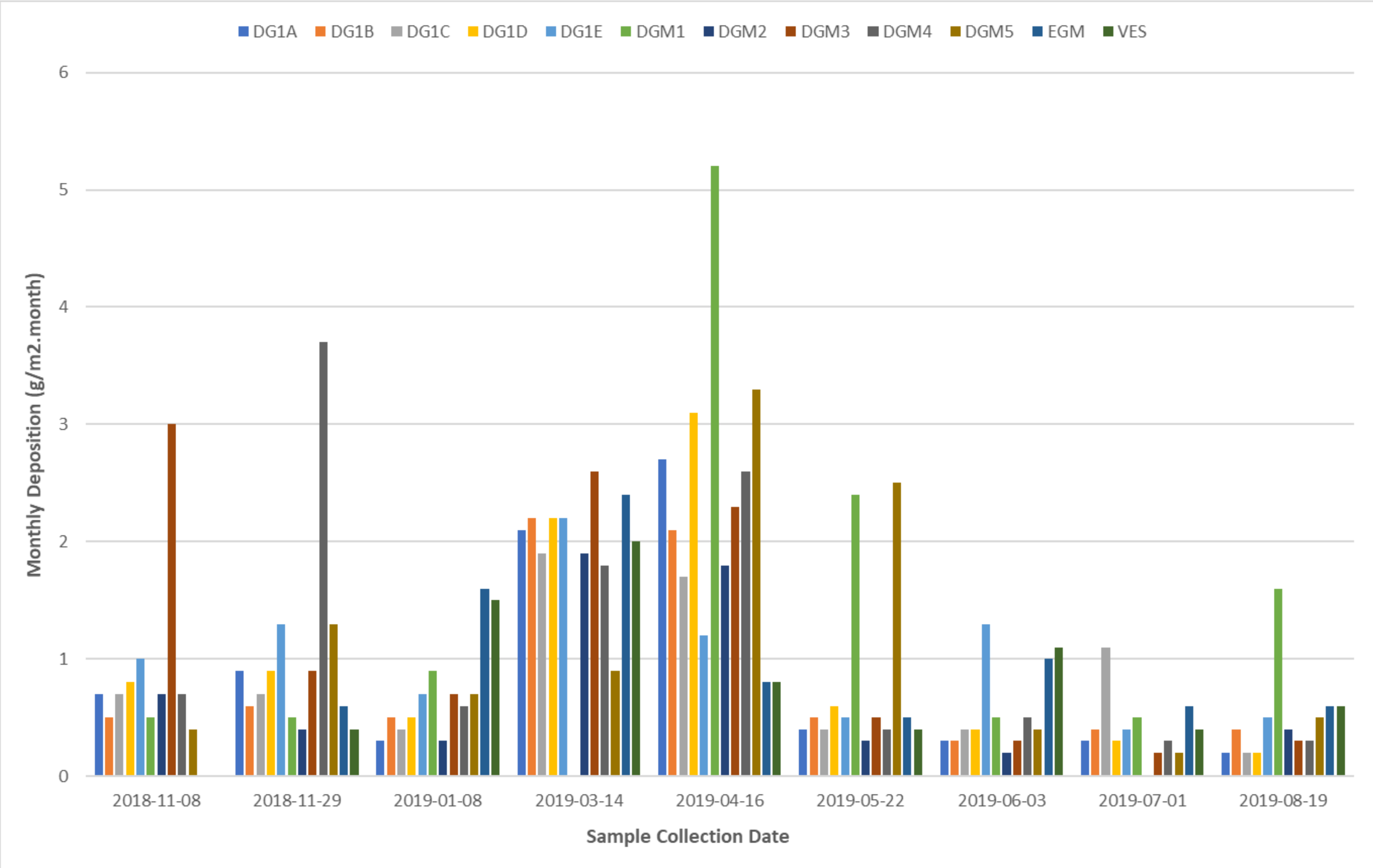



**Figure 10: Summary of Monthly Dust Deposition Rates**

# 3. ASSESSMENT CRITERIA

## 3.1 Particulate Deposition

There are no specific assessment guidelines available for impacts on vegetation from dust deposition, however a number of studies on impacts to vegetation from particulate deposition have been completed in Australia and globally.

Most studies of the effects of mineral dusts on vegetation have focussed on dusts that have chemical effects (e.g. cement dust) or where dust loads exceed 7 g/m$^2$. Relatively inert mineral dusts, such as those generated in the mining process or from unsealed haul roads principally influence light and temperature relations of leaves.

A study by Doley and Rossato (2010) used published data to assess the impacts of particulate deposition on photosynthesis in cotton leaves and canopies. The study indicated that many plants species have similar ranges of values for the photosynthetic parameters used in assessing the impacts on cotton and it is possible to use the cotton estimates as a general estimate for the purpose of modelling the impacts particulate deposition and thereby the environmental risks associated with dust generating activities. The results of the study indicated that at deposition levels of approximately 0.3 g/m$^2$/day, the estimated reductions in canopy photosynthesis of cotton plants would be less than 7% with a <1% decrease in productivity (Doley & Rossato, 2010).

Matsuki et al. (2016) sought to assess the relationship between dust accumulation on plant surfaces and plant health and survivorship using data from two medium-term monitoring studies undertaken in semi-arid Australia. The study sites were located at the Windarling Range (approximately 300 km north-west of the Project site), and Barrow Island (approximately 50 km off the Pilbara coast of Western Australia). Plant health and survivorship of a threatened subspecies (*Tetratheca paynterae paynterae*) were measured at varying distances from open pit mining operations at the Windarling Range study site between 2003 and 2014 and compared with dust load (assessed between 2004 and 2010) and dust deposition (measured between 2011 and 2013). At Barrow Island, plant health and floristic composition were measured at varying distances from a construction site between 2009 and 2012 and compared with dust deposition measurements.

Matsuki et al. (2016) report that neither plant health nor survivorship appear to be related to distance from the mining pit at the Windarling Range site. Dust deposition rates ranged between 0.6 to 20.1 g/m$^2$.month and were slightly higher closer to the edge of the pit (up to approximately 100 m), decreasing rapidly with distance; however, there was no significant difference in plant health condition over the same distance (Matsuki et al., 2016). The authors note that although plants adjacent to the pit showed higher dust loads and physiological signs of stress, this did not appear to have impacted the health condition or survivorship of the species in question. At the Barrow Island study site, dust deposition rates ranged between 0 and 77 g/m$^2$.month, although no statistically significant relationship was observed between deposition rates and distance from the source (Matsuki et al., 2016). Plant health condition was also reportedly unrelated to distance from the source of dust, instead affected by environmental conditions (namely rainfall).

It should be noted that as the area around the mine is an arid environment, it is likely that natural vegetation in the region would have a degree of tolerance to these conditions. Matsuki et al. (2016) note that plants in semi-arid environments are likely to be exposed to dust naturally and as a result, may be less likely to suffer from short-term impacts of dust. The Doley and

Rossato (2010) study also noted that in more complex plant associations, species that grow in heavily shaded understories are much more likely to be susceptible to dust deposition than plants exposed to direct sunlight. Ramboll understands the vegetation of the region does not typically contain dense undergrowth and this is therefore not considered as a factor for the air dispersion modelling study.

In summary, the Doley and Rosato (2010) study provides a general estimate for assessing the impacts of dust deposition on vegetation, namely that levels of 0.3 g/m$^2$/day or more may be associated with a reduction in canopy photosynthesis; while the Matsuki et al. (2016) report suggests plants within semi-arid regions, such as that of the Project site, may be able to tolerate higher deposition rates without significant impact to plant health condition.

### 3.2 Amenity

The New South Wales Department of Environment and Climate Change (NSW DECC) have published dust deposition criteria, designed to take into account potential amenity impacts, such as dust depositing on fabrics and buildings. The use of these guidelines serve as a reference as to the potential magnitude of the impacts associated with dust deposition, but are not intended to be used as an indication of acceptability of the predicted impacts.

The NSW guidelines are based on studies undertaken on coal dust deposition in the Hunter Valley in NSW by the National Energy Research and Demonstration Council (NERDC, 1988). While the dust deposition guideline is expressed as g/m$^2$/month, the NSW DECC has indicated that the monthly average deposition (to be compared against the guideline value) is to be determined from data spanning no less than one year, so as to account for seasonal variations.

**Table 2: Amenity Dust Deposition Criteria**

| Pollutant | Averaging Period | Criteria (g/m$^2$/month) |
|---|---|---|
| Deposited dust[1] | Annual (increase)[2] | 2 |
| | Annual (total)[3] | 4 |

Notes

1. Dust is assessed as insoluble solids as defined by AS 3580.10.1-1991 (AM-19).
2. Maximum increase in deposited dust level.
3. Maximum total deposited dust level.

The NSW Environmental Defender's Office (EDO) advises that the criteria for the maximum increase in deposited dust of 2 g/m$^2$/month is applicable when baseline data on deposited dust exists, while the total deposited dust criteria of 4 g/m$^2$/month criteria is applied when no baseline data exists.

# 4. AIR DISPERSION MODELLING AND METHODOLOGY

## 4.1 Air Dispersion Model

The CALPUFF modelling system has been used to predict the potential dust deposition rates associated with fugitive particulate emissions from the haulage of concentrate to the road train transfer area for the proposed Medcalf Project; and transfer of concentrate to road train. CALPUFF provides a non-steady state modelling approach which evaluates the effects of spatial changes in the meteorological and surface characteristics and has been listed by the United Stated Environmental Protection Agency (USEPA) as an alternative model for situations involving complex terrain and wind conditions, where typical steady-state plume dispersion models (such as AERMOD) have limited capability.

The focus of the study is to assess the impacts of fugitive dust emissions released over a 75 km distance and as meteorological and surface characteristics have the potential to change across this distance, CALPUFF is the preferred model of choice for this assessment.

## 4.2 Meteorological Data

In the absence of site-specific meteorological monitoring data suitable for use in dispersion modelling, The Air Pollution Model (TAPM) (Version 4) was used to generate a gridded meteorological dataset for the model domain. TAPM was developed by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) and consists of coupled prognostic meteorological and air pollution dispersion model components. The meteorological component of TAPM predicts the local-scale meteorological features, such as sea breezes and terrain-induced circulations, using the larger-scale synoptic meteorology as boundary conditions combined with other data including terrain, land use, soil and surface types. TAPM has been used extensively throughout Australia for generating site specific meteorological files for use in air dispersion modelling studies.

It is noted that past versions of TAPM under-predicted the frequency of occurrence of low wind speeds, although this has been improved considerably in Version 4. In addressing the light wind issue, TAPM Version 4 tends to under-predict the high winds at the surface, which is important particularly for fugitive dust assessments involving wind erosion. However, comparison of the TAPM predicted wind speeds for the 2014 to 2018 calendar years to the wind speed data measured at the BoM Salmon Gums site indicates similar percentage distributions in both datasets, across a range of wind speed categories, particularly in relation to higher wind speeds (i.e. > 6 m/s) (Figure 11).

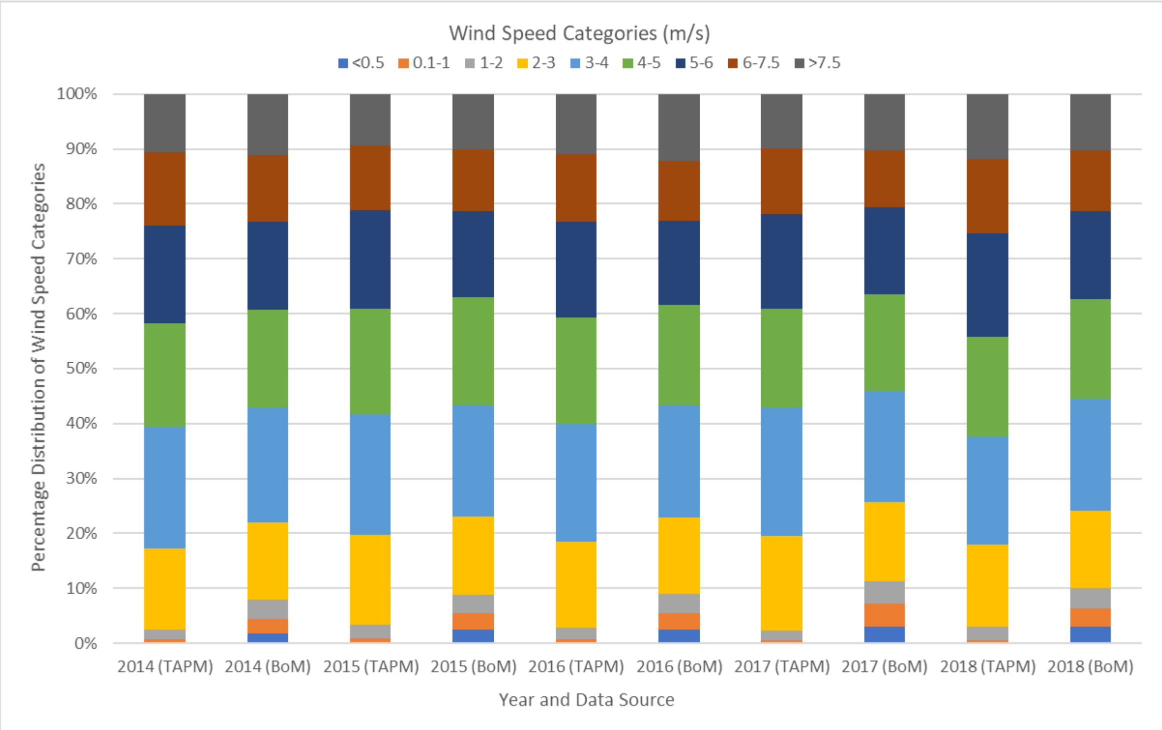



**Figure 11: Percentage Distribution of Wind Speeds**

Annual wind roses derived from the TAPM predicted meteorological dataset are presented in Figure 12 for the calendar years 2014 to 2018. Comparison of these wind roses to those presented in Figure 6 (based on meteorological monitoring data for the BoM Salmon Gums site) shows similar wind speed and direction, with no clearly dominate wind component.

The TAPM predicted meteorological data for the 2018 calendar year was selected for use in the model. These data are considered comparable to the available regional meteorological monitoring data and have the highest annual average wind speed (3.8 m/s) of all years considered. A seasonal wind rose for the 2018 (TAPM predicted) calendar year is presented in Figure 13. This figure illustrates a similar pattern of seasonal wind distributions, as compared to the seasonal wind roses based on the BoM data presented in Figure 7.

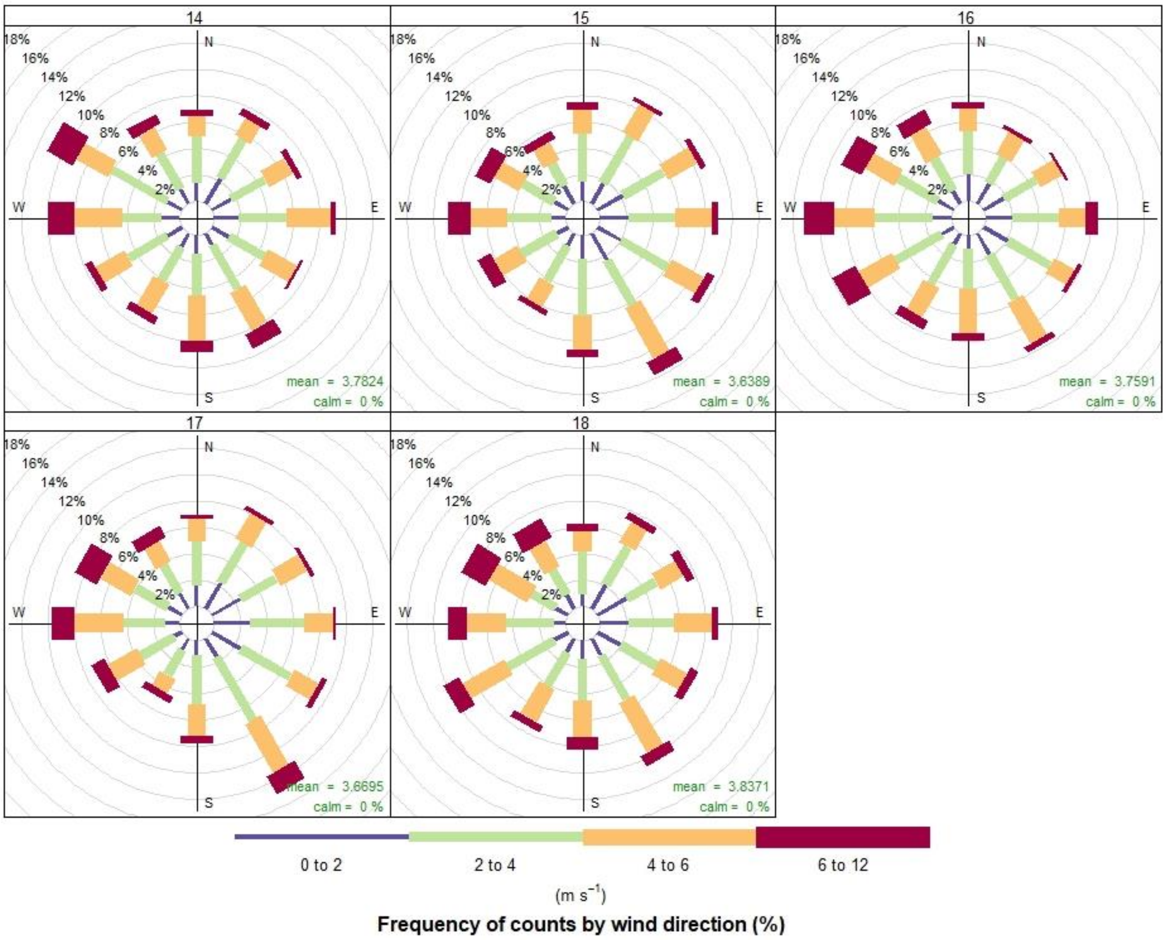



**Figure 12: TAPM Predicted Annual Wind Roses (2014-2018)**

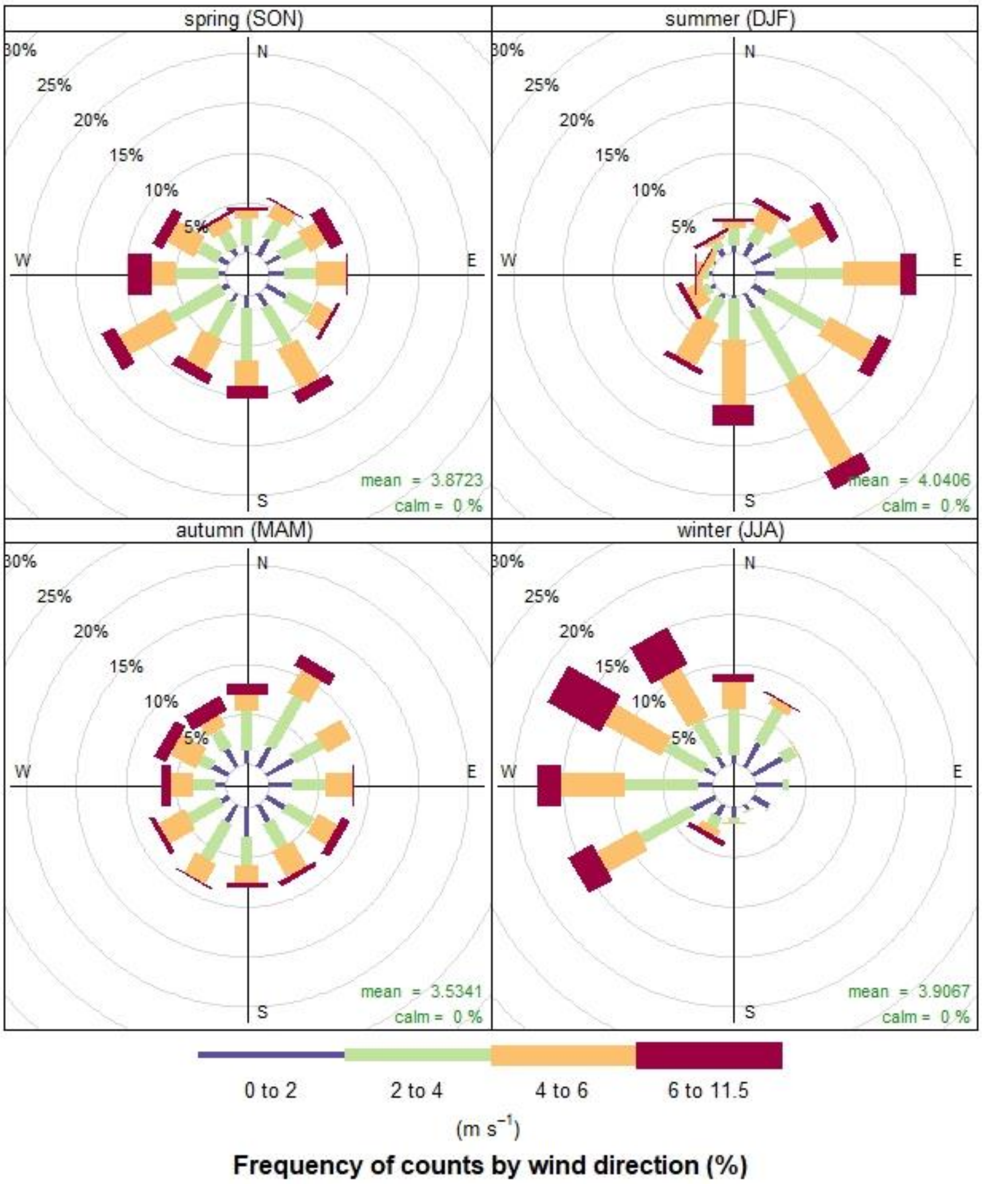



Figure 13: TAPM Predicted Seasonal Wind Rose (2018)

## 4.3 Model Parameterisation

### 4.3.1 CALMET

The CALMET meteorological processor was used to develop a meteorological file for input into the CALPUFF model. CALMET is a diagnostic meteorological model that produces three-dimensional wind fields based on parameterised treatments of terrain effects such as slope flows and terrain blocking effects. Meteorological observations are used to determine the wind field in areas of the domain within which the observations are representative. Fine scale terrain effects are determined by the diagnostic wind module in CALMET.

TAPM generated a gridded meteorological dataset was used as input to CALMET to produce the meteorological data file for use in CALPUFF. A meteorological grid of 230 km by 230 km with 10 km grid spacings was utilised in order to align with the TAPM outputs required to incorporate the full length of the 74 km haul road. Terrain elevation data for the model domain were obtained from the US National Aeronautics and Space Administration's (NASA) Shuttle Radar Topography Mission (SRTM3/SRTM1). A copy of the CALMET input file is provided in Appendix 1.

#### 4.3.2 CALPUFF

The following model set up options within CALPUFF were used:

- Computational grid of 90 km by 30 km encompassing the 74 km haul road, with grid spacings of 10 km;
- Multiple sampling grids were utilised with grid spacings between 250 m and 125 m for coverage of the haul road and transfer yard;
- Dry deposition and geometric mean mass diameter of 31.5 microns (assuming particle size upper limit of 50 microns);
- No chemical transformation;
- Transitional plume rise;
- Puff modelling method; and
- Default partial plume path adjustment.

Each emission source was individually modelled in CALPUFF using a fixed emission rate and the resultant outputs for each source were scaled against the corresponding hourly variable emissions for total suspended particulate (TSP) to generate predicted dust deposition rates for each hour of the year, at each model grid point and sensitive receptor. The predicted deposition rates for each source were then combined to produce the monthly deposition rates predicted for the modelled scenario.

A sample of the CALPUFF input file is included as Appendix 2.

### 4.4 Emission Estimates

#### 4.4.1 Factors Influencing Dust Emissions

To predict particulate deposition rates in a realistic manner, hourly estimates of particulate emissions are required from all major sources in the area. Factors which are important for particulate generation include:

- Ore type being handled. This is related to the size distribution of the material, shape and composition of the fines fraction;
- Moisture content. Increasing the moisture content decreases the dustiness of the ores with there normally being a moisture threshold above which particulate generation by material handling is negligible, known as practical extinction. This occurs as moisture acts to apply adhesive forces between particles;
- The operation occurring. Factors which are important are the drop height, the degree to which the falling ore is exposed to the wind such that winnowing can occur, and the particulate control mechanism used. Control mechanisms may include enclosing the operation, the use of water sprays and particulate extraction to a bag filter or to a wet scrubber;
- Quantity of ore/overburden being moved and the number of movements;
- Size of stockpiles and level of activity;
- Level of vehicle traffic; and
- Ambient wind speed. For material handling operations exposed to the air, particulate emissions increase with increasing wind speed. For wind erosion, particulate emissions are negligible below a wind speed threshold, but increase rapidly above the threshold. Dust emissions from wind erosion are also dependent on the erodibility of the material which is dependent on the size distribution of the material and whether a crust has been developed.

### 4.4.2 Emission Estimation

Emission factors and control efficiencies were based on the National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual for Mining 2012 Version 3.1 (NPI, 2012). The emission factors are considered conservative in that they allow for variation in the moisture content of the ores and some failure in control equipment to occur. The emissions factors for wheel generated dust emissions rely on moisture content and silt content of the road surface material in determining an emission rate. In the absence of site specific information, the default NPI values for moisture content (2%) and silt content (10%) were utilised.

The calculation of emission estimates associated with haulage and material handling activities have conservatively been based on a maximum concentrate production rate of 2 Mtpa (as per information provided by Audalia).

A summary of the TSP emission estimates associated with operational activities is presented in Table 3. The emission estimates have been calculated assuming operations occur during the day shift only (nominally between 06:00 and 18:00 hrs), as advised by Audalia. The effects of wind and rainfall on emission estimates were also taken into consideration, as per the methodologies described Section 4.4.2.1 and Section 4.4.2.3. The calculation of wind erosion from the exposed surface area of the concentrate transfer yard is outline in Section 4.4.2.2. It is noted that dust emission estimates for fugitive dust sources contain a degree of uncertainty due to the complexity of characterising emission rates and control efficiencies.

**Table 3: Summary of Fugitive Particulate Emission Estimates**

| Location | Activity | Emission Factor | | Emission Factor Variable | | Dust Control | | TSP Emission Rate |
|---|---|---|---|---|---|---|---|---|
| | | TSP | Unit | Rate | Unit | Measure | Efficiency | g/s |
| **Scenario 1 – Haulage of dry concentrate** | | | | | | | | |
| Haul road – wheel generate dust emissions | Loaded haul truck out | 9.6[1,2] | kg/km | 729,270[3] | km/yr | Watering (2 L/m$^2$/hr) | 50% | 222 |
| | Empty haul truck return | 5.2[1,2] | | | | | | 120 |
| | LVs out | 1.1[1,4] | | 135,050[5] | | | | 4.6 |
| | LVs in | 1.1[1,4] | | | | | | 4.6 |
| Concentrate transfer yard – material handing | Truck dumping | 0.012 | kg/t | 2,000,000 | tpa | None | NA | 1.5 |
| | Concentrate reclaim (FEL) | 0.025 | | | | Water sprays | 50% | 1.6 |
| | Road train loading (FEL) | 0.025 | | | | | | 1.6 |
| **Scenario 2 – Concentrate slurry piped to transfer yard** | | | | | | | | |
| Haul road – wheel generate dust emissions | LVs out | 1.1[1,4] | kg/km | 135,050[5] | km/yr | Watering (2 L/m$^2$/hr) | 50% | 4.6 |
| | LVs in | 1.1[1,4] | | | | | | 4.6 |
| Concentrate transfer yard – material handing | Truck loading (hopper) | 0.0003 | kg/t | 2,000,000 | tpa | Water sprays | 50% | 0.02 |
| | Truck dumping | 0.012 | | | | | | 0.8 |
| | Concentrate reclaim (FEL) | 0.025 | | | | | | 1.6 |
| | Road train loading (FEL) | 0.025 | | | | | | 1.6 |

Notes
1. Assumes default NPI parameters for silt content (10%) and moisture content (2%).
2. Assumes 220 t capacity haul truck: 296 t loaded, 76 t unloaded.
3. Assumes 27 round trips per day.
4. Assumes LV weight 2.8 t.
5. Assumes 5 round trips per day.

#### 4.4.2.1 Wind Speed Dependence for Material Handling

For all material handling processes exposed to the wind, increasing wind speed acts to increase dust emissions through winnowing of the particles from the falling ore. The USEPA batch drop equations (USEPA, 2004a) specify that the dust emission increases with the wind speed to the power of 1.3, as follows:

$$E_{Actual} = E_{2.2} (WS/2.2)^{1.3}$$

Where:

WS is the wind speed at the drop height;
$E_{2.2}$ is the dust emission given for a wind speed of 2.2 m/s; and
$E_{Actual}$ is the final emission rate.

The average source height was assumed to be 5 m above the surface, with the 10 m wind speeds used to estimate the 5 m wind speeds using the 1/7 power law given by:

$$WS_5 = WS_{10} (5/10)^{(1/7)}$$

Where:

$WS_{10}$ is the wind speed at 10 m.
$WS_5$ is the calculated wind speed at 5 m.

#### 4.4.2.2 Wind Erosion

Dust emissions generated by wind are generally negligible below a wind speed threshold, but increase rapidly when wind speeds exceed the threshold. Dust emissions from wind erosion are also dependent on the erodibility of the material which in turn is dependent on the size distribution of the material and whether a crust has developed. In general, material with a large (>50%) fraction of non-erodible particles (generally particles greater than 1 mm to 2 mm) will not erode as the erodible fraction is protected by these particles. Fine ores are generally much more erodible by wind erosion, particularly if they have a large fraction of particles in the range from 0.1 mm to 0.25 mm which can be dislodged by wind and then rolled and skipped along the surface (saltation). These larger particles can then dislodge the smaller (<50 µm) dust fraction which can remain suspended in the air.

The NPI Emission Estimation Technique (EET) Manual for Mining (NPI, 2011) specifies a wind erosion factor of 0.2 kg/ha/hr for all sources with the exception of coal stockpiles. However, this factor is considered approximate as it does not take into account variations in the climate of an area or the soil or ore type. Previous studies investigating the impact of dust emissions from mining facilities have used the Shao (2000) equation to parameterise particulate emissions for live stockyards and surrounding roads. The same method was also adopted to estimate the wind erosion factor for this assessment, as follows:

$$E_{wind} = 5.2E\text{-}07 * WS^3 * (1- (WST/WS10)^2))$$

Where:

WST is the threshold for wind erosion in m/s, taken to be 7.5 m/s (SKM, 2003); and
$E_{wind}$ is the $PM_{10}$ emissions ($g/m^2/s$).

Dust emissions generated by wind erosion were considered in this assessment for the exposed surface area of the concentrate stockpile yard.

#### 4.4.2.3 Rainfall Dependence

To account for the effects of rainfall in reducing dust emissions, a simple scheme was adopted. With regards to wind erosion, rainfall was assumed to not only suppress dust emissions at the time rain was occurring, but to also result in a suppression of the dust emissions that gradually decreases over time as the areas dry out. Without stockpile activity, material can form a strong crust and be resistant to wind erosion for extended periods.

Dust emissions were taken to linearly return to a rainfall unaffected state within 400 hours of the rainfall evaporating if the rainfall event was greater than 25 mm. During the period when it was raining or if the rainfall had not evaporated, emissions were set to zero. The evaporation rate at the surface was assumed to be 1.25 times the amount from a Class A pan with a limit to the amount of water on/near the surface of 75 mm. Daily average evaporation rates for each month were obtained from the BoM for the Salmon Gums monitoring station.

These time scales have been adopted from previous dust assessments (ENVIRON, 2004) and were originally based on observations of the time taken for high dust levels to return following a large rainfall event in the Pilbara region. It is noted that the return to dusty conditions is not just a function of the evaporation of the water, but is determined more importantly from the activity level within the stockpile area, as surfaces are disturbed and fresh surfaces are created as a result of reclaiming, stacking and vehicle movement.

# 5. MODELLING RESULTS

### 5.1 Predicted Particulate Deposition Rates

A summary of the maximum predicted daily and monthly average deposition rates predicted at the locations of dust deposition monitors DGM4 and DGM5 for Scenarios 1 and 2, is presented in Table 4. As illustrated in Figure 8, DGM4 is located adjacent to the proposed haul road route, approximately 25 km east of the mining operations; and DGM5 is located approximately 75 m south of the proposed concentrate transfer yard. Contours of the predicted daily and monthly average deposition rates for Scenarios 1 and 2 are presented in Figure 14 to Figure 21.

**Table 4: Summary of Maximum Predicted Dust Deposition Rates**

| Scenario | Receptor | Maximum Predicted Dust Deposition Rate ($g/m^2$) | |
|---|---|---|---|
| | | 24-hour Average | Monthly Average |
| Scenario 1 – Haulage of dry concentrate | DGM4 | 0.6 | 3.7 |
| | DGM5 | 0.7 | 4.8 |
| Scenario 2 – Concentrate slurry piped to transfer yard | DGM4 | 0.02 | 0.1 |
| | DGM5 | 0.6 | 2.9 |

The maximum predicted 24-hour average dust deposition rate for Scenario 1 is 0.6 $g/m^2$ at DGM4 and 0.7 $g/m^2$ at DGM5 (Table 4). Contours of the 24-hour average deposition rates for Scenario 1 indicate that maximum deposition is predicted to occur within the haul road and transfer yard development envelope (Figure 14). At distances of 300 m or more from the haul road boundary, the daily deposition rate is expected to remain below 0.3 $g/m^2$ (Figure 14).

The maximum predicted monthly average deposition rate for Scenario 1 is 3.7 $g/m^2$ at DGM4 and 4.8 $g/m^2$ at DGM5 (Table 4). Contours of the predicted monthly average deposition rates indicate peak impacts are also expected to occur within the proposed development envelope (Figure 15). At distances of 300 m or more from the haul road boundary, the monthly deposition rate is expected to remain below 2.0 $g/m^2$ (Figure 15). Review of the contours predicted in and around the concentrate transfer yard indicate the maximum predicted 24-hour average deposition rate falls below 0.3 $g/m^2$ approximately 800 m from the proposed concentrate stockpiles (Figure 16); and the maximum predicted monthly average deposition rate is below 2 $g/m^2$ at around 500 m from the stockpile yard (Figure 17).

The maximum predicted 24-hour average dust deposition rate for Scenario 2 is 0.02 $g/m^2$ at DGM4 and 0.6 $g/m^2$ at DGM5 (Table 4). Contours of the 24-hour average deposition rates for Scenario 2 indicate that the highest impacts are predicted at the proposed concentrate transfer yard, while the impacts along the haul road route remain negligible as traffic is assumed to comprise LVs only (Figure 18). Contours of the monthly average deposition rates similarly indicate peak deposition rates are predicted to occur within the transfer yard and impacts along the haul road remain negligible (Figure 19). The maximum predicted monthly average deposition rates at DGM4 and DGM5 are 0.1 $g/m^2$ and 2.9 $g/m^2$ respectively (Table 4).

Review of the contours predicted at the concentrate transfer yard for Scenario 2 indicate the maximum predicted 24-hour average deposition rate falls below 0.3 $g/m^2$ at a distance of approximately 750 m from the proposed concentrate stockpiles (Figure 20); and the maximum predicted monthly average deposition rate is below 2 $g/m^2$ at around 500 m from the stockpile yard (Figure 21).

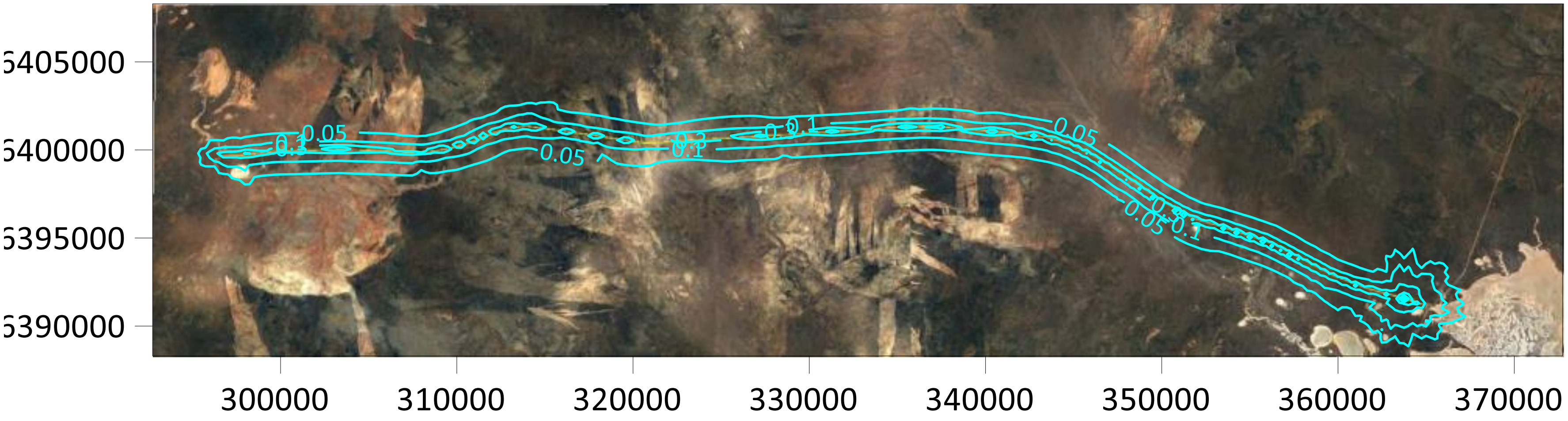



**Figure 14: Maximum Predicted 24-hr Average Deposition (g/m²) – Scenario 1**

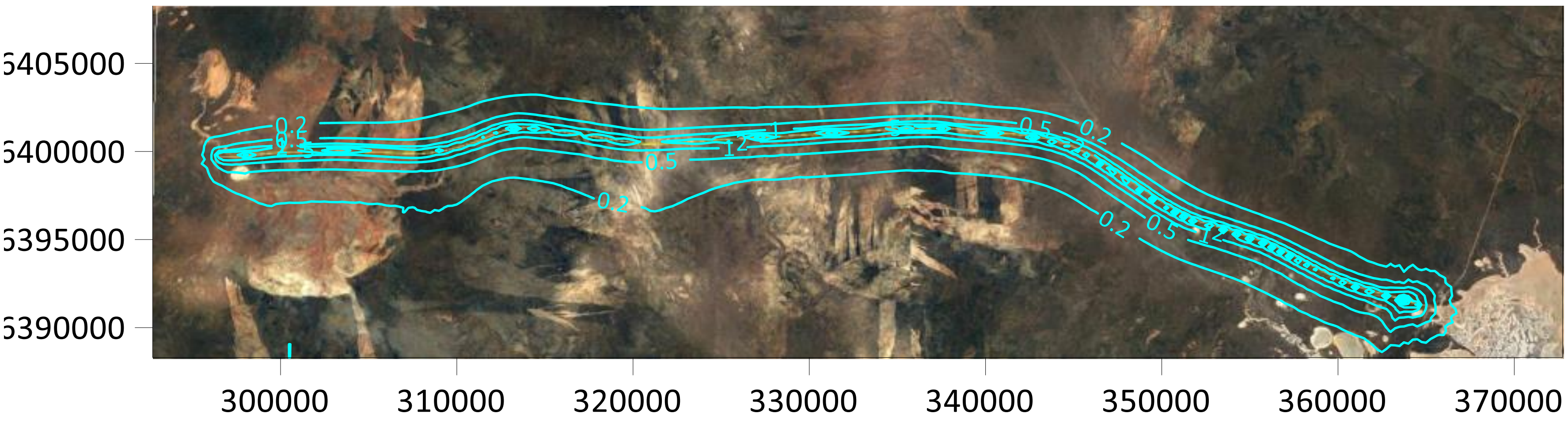



**Figure 15: Maximum Predicted Monthly Average Deposition (g/m²) – Scenario 1**

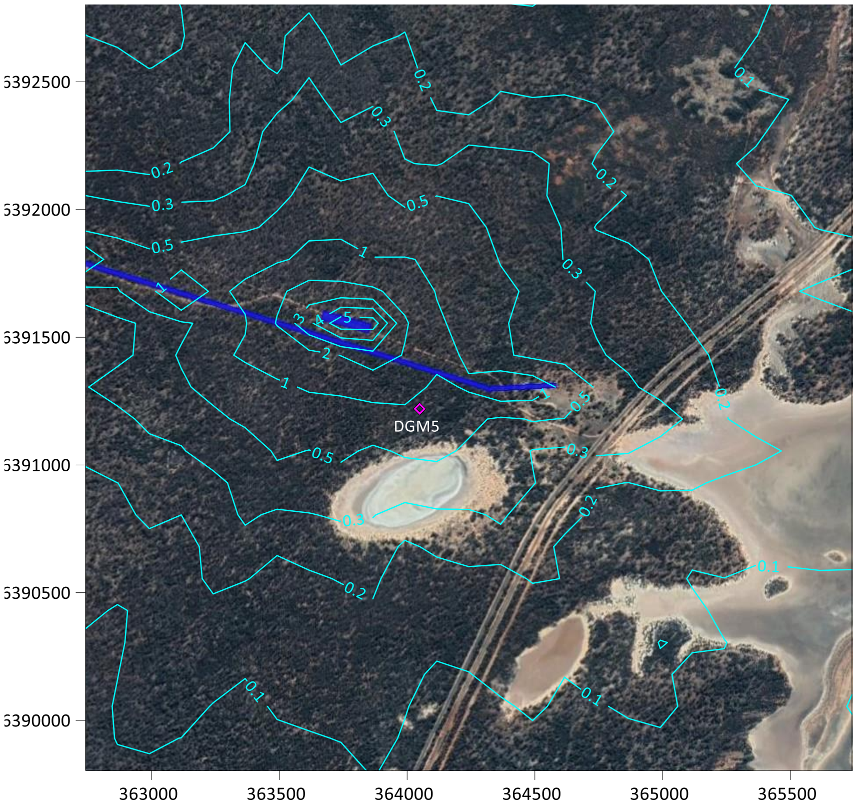



**Figure 16: Maximum Predicted 24-hour Average Deposition (g/m$^2$) (Transfer Yard) – Scenario 1**

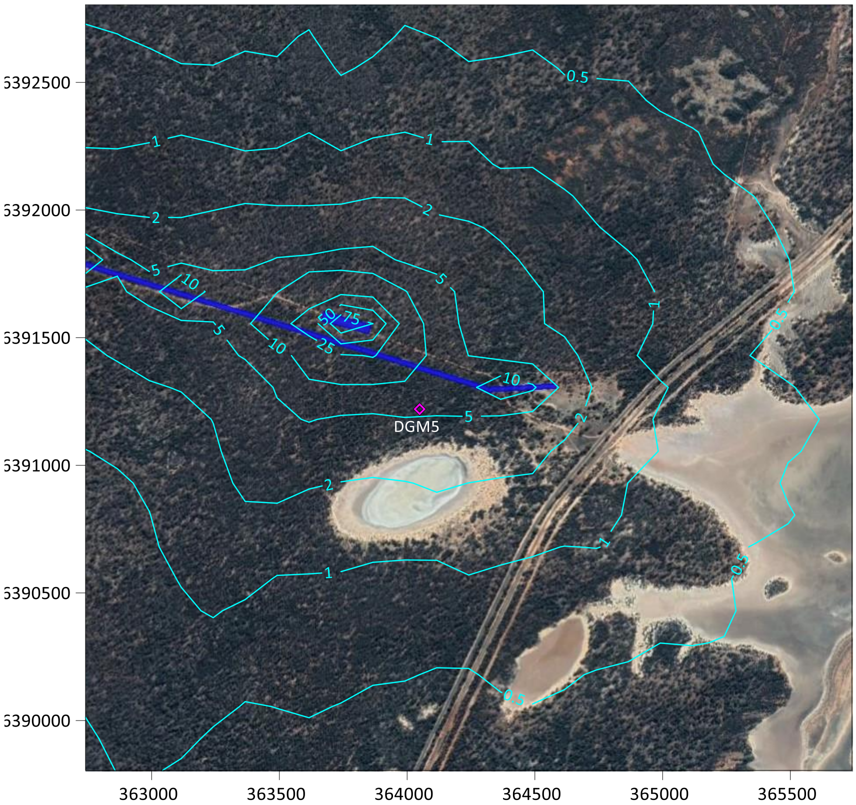



**Figure 17: Maximum Predicted Monthly Average Deposition (g/m$^2$) (Transfer Yard) – Scenario 1**

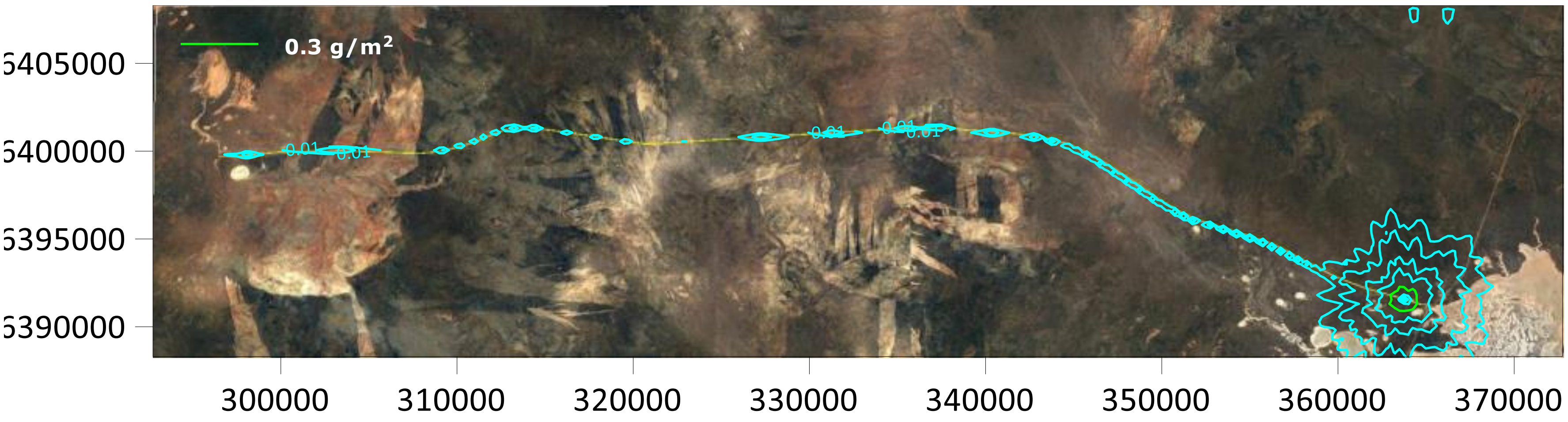



**Figure 18: Maximum Predicted 24-hr Average Deposition (g/m²) – Scenario 2**

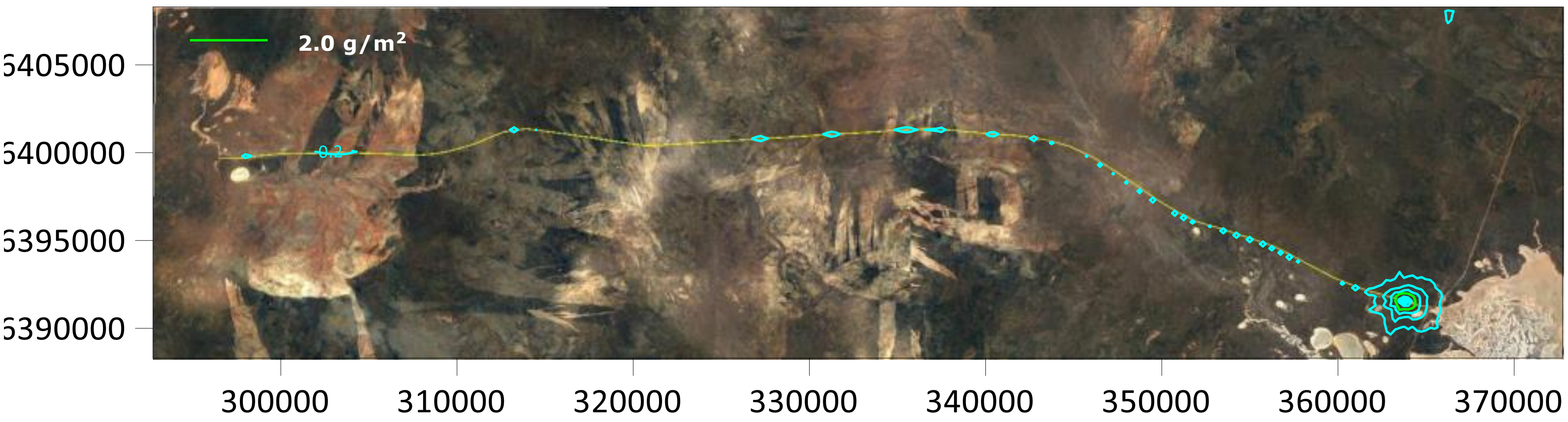



**Figure 19: Maximum Predicted Monthly Average Deposition (g/m²) – Scenario 2**

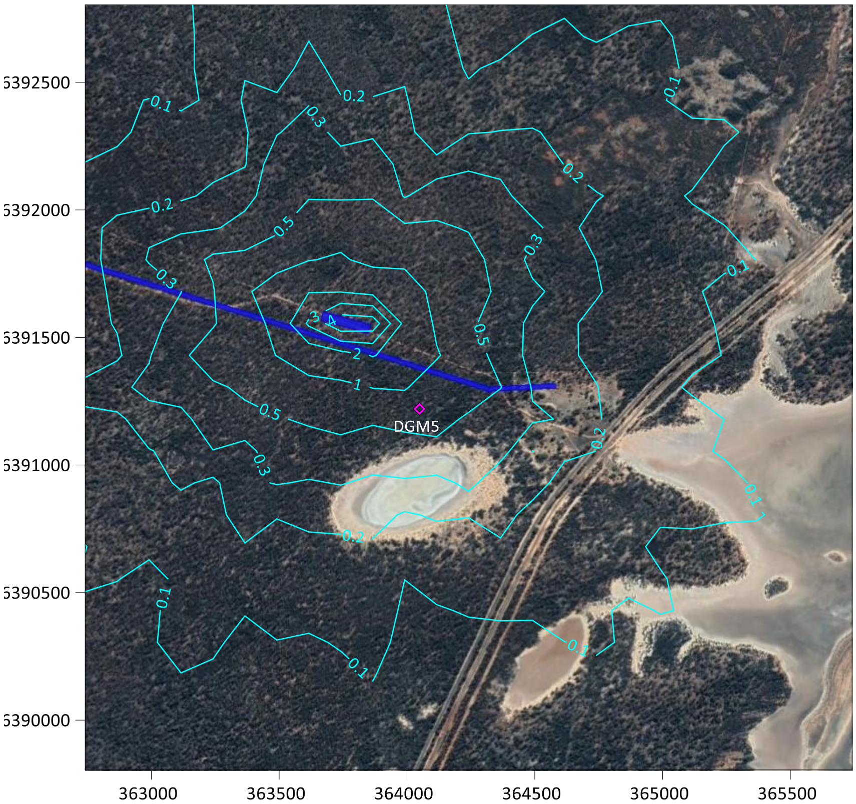



**Figure 20: Maximum Predicted 24-hour Average Deposition (g/m²) (Transfer Yard) – Scenario 2**

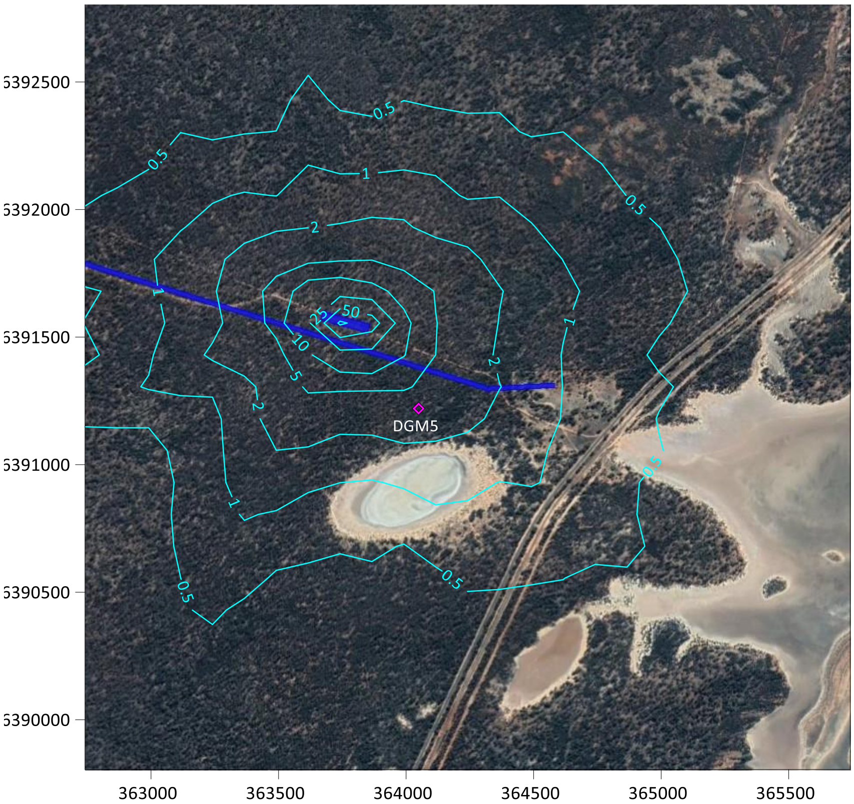



**Figure 21: Maximum Predicted Monthly Average Deposition (g/m²) (Transfer Yard) – Scenario 2**

In the absence of specific assessment guidelines for impacts on vegetation from dust deposition, it is difficult to definitely assess the potential impact of the predicted dust deposition rates on the receiving environment. Assuming haulage of the concentrate from the mine site to the transfer yard (Scenario 1), the maximum predicted daily deposition rates are greater than the deposition levels at which reductions in canopy photosynthesis of cotton plants are reported (i.e. 0.3 g/m$^2$.day) for distances of up to 300 m from the haul road; and up to 800 m from the concentrate stockpiles. However, the monthly dust deposition rates predicted outside the immediate haul road and transfer yard footprint remain well below the maximum measured deposition rates reported by Matsuki et al. (2016) (i.e. up to 20 g/m$^2$.day at the Windarling Range study site), for which no significant association between plant health and dust deposition was reported.

Assuming concentrate slurry is piped rather than hauled from the mine site to the transfer yard (Scenario 2), the dust deposition rates predicted along the haul road route remain negligible, with traffic assumed to comprise LVs only. At the transfer yard, the maximum predicted daily deposition rates remain greater than 0.3 g/m$^2$.day for distances of up to 750 m from the concentrate stockpiles. However, as with Scenario 1, the monthly dust deposition rates predicted outside the immediate transfer yard envelope remain well below the maximum measured deposition rates reported by Matsuki et al. (2016).

Comparison of the maximum deposition rate predicted at DGM4 (i.e. 3.7 g/m$^2$.month) to the deposition rates measured at this location between October 2018 and August 2019 (see Section 2.3), shows the maximum predicted impact is within the range of measured depositions (i.e. up to 3.7 g/m$^2$.month). The maximum monthly deposition rate predicted at DGM5 (i.e. 4.8 g/m$^2$.month) is slightly higher than the maximum measured deposition (i.e. 3.3 g/m$^2$.month). Conservatively assuming the maximum predicted monthly deposition rates were to occur within the same period as the maximum measured deposition rates, the cumulative impacts at these monitoring locations would be up to 8 g/m$^2$.month. This rate remains within the range reported by Matsuki et al. (2016), for which no significant association between plant health and dust deposition was reported.

# 6. CONCLUSION

Audalia is proposing to develop the Medcalf Project, a vanadium, titanium and iron project located approximately 470 km south east of Perth near Lake Johnston, Western Australia. The proposal includes the development of four open mine pits, beneficiation plant, tailings storage facility, waste rehabilitation stockpile (to be removed post-mining operations), evaporation ponds, process water facility, private haul road, concentrate transfer area and associated infrastructure such as laydown areas, borrow and gravel pits, borefield, workshops and accommodation camp.

Mining will be by conventional load and haul, with ROM ore processed onsite at a beneficiation plant, incorporating a comminution circuit and a magnetic separation circuit, upgrading the ROM ore to a primary concentrate. The primary concentrate will be transported along a 74 km private haul road from the mine to a dedicated road train transfer area adjacent to the Coolgardie-Esperance. The primary concentrate will be stockpiled at this transfer area, and then loaded onto highway-approved road trains for the remainder of the journey to the Esperance Port. Audalia are currently considering two concentrate transport options:

- **Scenario 1:** Concentrate transferred by road train from the mine site to the transfer yard near the highway, stockpiled, then loaded to road trains; and
- **Scenario 2:** Concentrate transferred by slurry pipeline from the mine site to the transfer yard near the highway, dewatered in a mobile unit, stockpiled, then loaded to road trains.

Air dispersion modelling has been undertaken to determine the potential dust deposition rates associated with the two concentrate transport options. Fugitive TSP emissions generated as a result of vehicle movements along the haul road and the handling of concentrate at the transfer yard have been considered in the assessment, as well as wind erosion from exposed surfaces at the transfer yard.

The maximum predicted 24-hour average dust deposition rates for Scenario 1 are predicted to occur within the haul road and transfer yard development envelope. The maximum daily deposition rate is expected to fall below 0.3 g/m$^2$ at distances of 300 more from the haul road boundary; and at distances of 800 m or more from the concentrate stockpiles. The highest daily deposition rates predicted at monitoring locations DGM4 and DGM5 are 0.6 g/m$^2$ and 0.7 g/m$^2$ respectively. The highest monthly deposition rates are also predicted to occur within the proposed development envelope and fall below 2.0 g/m$^2$ at distances of 300 m or more from the haul road boundary; and 500 m or more from the stockpile yard. At DGM4 and DGM5, the maximum predicted monthly deposition rates are 3.7 g/m$^2$ and 4.8 g/m$^2$ respectively.

The maximum predicted 24-hour average dust deposition rates for Scenario 2 are predicted to occur within the boundary of the transfer yard. The predicted impacts along the haul road route remain negligible as traffic is assumed to comprise LVs only. The maximum daily deposition rate is expected to fall below 0.3 g/m$^2$ at distances of 750 m or more from the concentrate stockpiles; and the highest daily deposition rates predicted at DGM4 and DGM5 are 0.02 g/m$^2$ and 0.6 g/m$^2$ respectively. The maximum monthly deposition rates are predicted to fall below 2.0 g/m$^2$ at distances of 500 m from the concentrate stockpiles; and the highest monthly deposition rates predicted at DGM4 and DGM5 are 0.1 g/m$^2$ and 2.9 g/m$^2$ respectively.

In the absence of specific assessment guidelines for impacts on vegetation from dust deposition, it is difficult to definitely assess the potential impact of the predicted dust deposition rates on the receiving environment. The maximum predicted daily dust deposition rates remain above the deposition levels at which reductions in canopy photosynthesis of cotton plants are reported in the literature, for distances of up to 300 m from the haul road (Scenario 1 only) and 800 m from the concentrate stockpiles (Scenarios 1 and 2). However, the monthly dust deposition rates predicted outside the immediate development envelope remain below the maximum deposition rates recorded at the Windarling Range study site by Matsuki et al. (2016), for which no significant association between plant health and dust deposition was reported.

In considering these results it should also be noted that the prediction of dust deposition rates from fugitive sources by air dispersion modelling is difficult primarily due to the complexity and uncertainty in estimating dust emissions due to numerous factors that can affect the emissions.

# 7. LIMITATIONS

Ramboll prepared this report in accordance with the scope of work as outlined in our proposal to Audalia dated 27 February 2020 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent Ramboll's professional judgement based on information made available during the course of this assignment and are true and correct to the best of Ramboll's knowledge as at the date of the assessment.

Ramboll did not independently verify all of the written or oral information provided during the course of this investigation. While Ramboll has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

## 7.1 User Reliance

This report has been prepared for Audalia and may not be relied upon by any other person or entity without Ramboll's express written permission.

# 8. REFERENCES

Doley, D. & Rossato, L. 2010 'Mineral Particulates and Vegetation: Modelled effects of Dust on Photosynthesis in Plant Canopies', *Air Quality and Climate Change*, Volume 44 No.2, May 2010.

ENVIRON Australia Pty Ltd. 2004. 'Port Hedland Dust Modelling Assessment.' Report prepared for Fortescue Metals Group Limited, August 2004.

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NSW EPA (2016). 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales'. State of New South Wales and the Environment Protection Authority, November 2016.

Roadmiles. 2017. 'Medcalf Long Haul Road Coolgardie-Esperance Highway Trans-Shipment Area'. Report prepared for Audalia Resources, 30 April 2017.

# APPENDIX 1
# CALMET INPUT FILES

CALMET.INP 2.2 Generated by CALPUFF View 8.5.0 - 24-Mar-20

---------------- Run title (3 lines) -----------------------------------------

CALMET MODEL CONTROL FILE
-------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

Subgroup (a)
------------
Default Name Type File Name
------------ ---- ---------
GEO.DAT input ! GEODAT = Audalia_Haul_Road_geo\GEO.DAT !
SURF.DAT input * SRFDAT = *
CLOUD.DAT input * CLDDAT = *
PRECIP.DAT input * PRCDAT = *
WT.DAT input * WTDAT = *

CALMET.LST output ! METLST = CALMET.LST !
CALMET.DAT output ! METDAT = CALMET.DAT !
PACOUT.DAT output * PACDAT = *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
T = lower case ! LCFILES = F !
F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

Number of upper air stations (NUSTA) No default ! NUSTA = 0 !
Number of overwater met stations
(NOWSTA) No default ! NOWSTA = 0 !

NUMBER OF PROGNOSTIC and IGF-CALMET FILEs:

Number of MM4/MM5/3D.DAT files
(NM3D) No default ! NM3D = 1 !

Number of IGF-CALMET.DAT files
(NIGF) No default ! NIGF = 0 !

!END!
-------------------------------------------------------------------------------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name Type File Name
------------ ---- ---------

-------------------------------------------------------------------------------
Subgroup (c)
-----------------------------------------
Overwater station files (one per station)
-----------------------------------------
Default Name Type File Name
------------ ---- ---------
* OVERWATERFILES = *
-------------------------------------------------------------------------------
Subgroup (d)
-------------------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
-------------------------------------------------
Default Name Type File Name
------------ ---- ---------
MM41.DAT input 1 ! M3DDAT=..\CALTAPM2.M3D! ! END !

-------------------------------------------------------------------------------
Subgroup (e)
-------------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
-------------------------------------------------
Default Name Type File Name
------------ ---- ---------
* IGFDATFILES = *
-------------------------------------------------------------------------------
Subgroup (f)
----------------
Other file names
----------------

Default Name Type File Name
------------ ---- ---------
DIAG.DAT input * DIADAT = *
PROG.DAT input * PRGDAT = *

TEST.PRT output * TSTPRT = *
TEST.OUT output * TSTOUT = *
TEST.KIN output * TSTKIN = *
TEST.FRD output * TSTFRD = *
TEST.SLP output * TSTSLP = *
DCST.GRD output * DCSTGD = *

-------------------------------------------------------------------------------
NOTES: (1) File/path names can be up to 70 characters in length
(2) Subgroups (a) and (f) must have ONE 'END' (surrounded by
delimiters) at the end of the group
(3) Subgroups (b) through (e) are included ONLY if the corresponding
number of files (NUSTA, NOWSTA, NM3D, NIGF) is not 0, and each must have
an 'END' (surround by delimiters) at the end of EACH LINE

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

Starting date: Year (IBYR) -- No default ! IBYR = 2018 !
Month (IBMO) -- No default ! IBMO = 1 !
Day (IBDY) -- No default ! IBDY = 1 !
Starting time: Hour (IBHR) -- No default ! IBHR = 0 !
Second (IBSEC) -- No default ! IBSEC = 0 !

Ending date: Year (IEYR) -- No default ! IEYR = 2018 !
Month (IEMO) -- No default ! IEMO = 12 !
Day (IEDY) -- No default ! IEDY = 31 !
Ending time: Hour (IEHR) -- No default ! IEHR = 0 !

Second (IESEC) -- No default ! IESEC = 0 !

UTC time zone (ABTZ) -- No default ! ABTZ = UTC+0800 !
(character*8)
PST = UTC-0800, MST = UTC-0700 , GMT = UTC-0000
CST = UTC-0600, EST = UTC-0500

Length of modeling time-step (seconds)
Must divide evenly into 3600 (1 hour)
(NSECDT) Default:3600 ! NSECDT = 3600 !
Units: seconds

Run type (IRTYPE) -- Default: 1 ! IRTYPE = 1 !

0 = Computes wind fields only
1 = Computes wind fields and micrometeorological variables
(u*, w*, L, zi, etc.)
(IRTYPE must be 1 to run CALPUFF or CALGRID)

Compute special data fields required
by CALGRID (i.e., 3-D fields of W wind
components and temperature)
in additional to regular Default: T ! LCALGRD = T !
fields ? (LCALGRD)
(LCALGRD must be T to run CALGRID)

Flag to stop run after
SETUP phase (ITEST) Default: 2 ! ITEST = 2 !
(Used to allow checking
of the model inputs, files, etc.)
ITEST = 1 - STOPS program after SETUP phase
ITEST = 2 - Continues with execution of
COMPUTATIONAL phase after SETUP

Test options specified to see if
they conform to regulatory
values? (MREG) No Default ! MREG = 0 !

0 = NO checks are made
1 = Technical options must conform to USEPA guidance
IMIXH -1 Maul-Carson convective mixing height
over land; OCD mixing height overwater
ICOARE 0 OCD deltaT method for overwater fluxes
THRESHL 0.0 Threshold buoyancy flux over land needed
to sustain convective mixing height growth
ISURFT > 0 in OBS mode (pick one representative station)
-2 in NOOBS mode (itprog=2) (average all
surface prognostic temperatures to get
a single representative sf. temp)
IUPT > 0 in OBS mode (pick one representative station)
-2 in NOOBS mode (ITPROG>0) (average all surface
prognostic temperatures to get a single
representative sf. temp)
IZICRLX 0 Do NOT use convective mixing height relaxation
to equilibrium value

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Map Projection and Grid control parameters
--------------

Projection for all (X,Y):
-------------------------

Map projection
(PMAP) Default: UTM ! PMAP = UTM !

UTM : Universal Transverse Mercator
TTM : Tangential Transverse Mercator
LCC : Lambert Conformal Conic
PS : Polar Stereographic
EM : Equatorial Mercator
LAZA : Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin
(Used only if PMAP= TTM, LCC, or LAZA)
(FEAST) Default=0.0 ! FEAST = 0.0 !
(FNORTH) Default=0.0 ! FNORTH = 0.0 !

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN) No Default ! IUTMZN = 51 !

Hemisphere for UTM projection?
(Used only if PMAP=UTM)
(UTMHEM) Default: N ! UTMHEM = S !
N : Northern hemisphere projection
S : Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0) No Default * RLAT0 = *
(RLON0) No Default * RLON0 = *

TTM : RLON0 identifies central (true N/S) meridian of projection
RLAT0 selected for convenience
LCC : RLON0 identifies central (true N/S) meridian of projection
RLAT0 selected for convenience
PS : RLON0 identifies central (grid N/S) meridian of projection
RLAT0 selected for convenience
EM : RLON0 identifies central meridian of projection
RLAT0 is REPLACED by 0.0N (Equator)
LAZA: RLON0 identifies longitude of tangent-point of mapping plane
RLAT0 identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1) No Default ! XLAT1 = 30S !
(XLAT2) No Default ! XLAT2 = 60S !

LCC : Projection cone slices through Earth's surface at XLAT1 and XLAT2
PS : Projection plane slices through Earth at XLAT1
(XLAT2 is not used)

----------
Note: Latitudes and longitudes should be positive, and include a

letter N,S,E, or W indicating north or south latitude, and
east or west longitude. For example,
35.9 N Latitude = 35.9N
118.7 E Longitude = 118.7E

Datum-region
------------

The Datum-Region for the coordinates is identified by a character
string. Many mapping products currently available use the model of the
Earth known as the World Geodetic System 1984 (WGS-84). Other local
models may be in use, and their selection in CALMET will make its output
consistent with local mapping products. The list of Datum-Regions with
official transformation parameters is provided by the National Imagery and
Mapping Agency (NIMA).

NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
WGS-84 WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84 NWS 6370KM Radius, Sphere
ESR-S ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM) Default: WGS-84 ! DATUM = WGS-84 !

Horizontal grid definition:
---------------------------

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

No. X grid cells (NX) No default ! NX = 23 !
No. Y grid cells (NY) No default ! NY = 23 !

Grid spacing (DGRIDKM) No default ! DGRIDKM = 10 !
Units: km

Reference grid coordinate of
SOUTHWEST corner of grid cell (1,1)

X coordinate (XORIGKM) No default ! XORIGKM = 177.7410 !
Y coordinate (YORIGKM) No default ! YORIGKM = 6283.3050 !
Units: km

Vertical grid definition:
-------------------------

No. of vertical layers (NZ) No default ! NZ = 10 !

Cell face heights in arbitrary
vertical grid (ZFACE(NZ+1)) No defaults
Units: m
! ZFACE = 0.00,20.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00 !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output Options
--------------

DISK OUTPUT OPTION

Save met. fields in an unformatted
output file ? (LSAVE) Default: T ! LSAVE = T !
(F = Do not save, T = Save)

Type of unformatted output file:
(IFORMO) Default: 1 ! IFORMO = 1 !

1 = CALPUFF/CALGRID type file (CALMET.DAT)
2 = MESOPUFF-II type file (PACOUT.DAT)

LINE PRINTER OUTPUT OPTIONS:

Print met. fields ? (LPRINT) Default: F ! LPRINT = F !
(F = Do not print, T = Print)
(NOTE: parameters below control which
met. variables are printed)

Print interval
(IPRINF) in hours Default: 1 ! IPRINF = 1 !
(Meteorological fields are printed
every 6 hours)

Specify which layers of U, V wind component
to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T) Defaults: NZ*0
* IUVOUT = *
-----------------------

Specify which levels of the W wind component to print
(NOTE: W defined at TOP cell face -- 6 values)
(IWOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
Defaults: NZ*0
* IWOUT = *

Specify which levels of the 3-D temperature field to print
(ITOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
Defaults: NZ*0
* ITOUT = *

Specify which meteorological fields
to print
(used only if LPRINT=T) Defaults: 0 (all variables)
-----------------------

Variable Print ?
(0 = do not print,
1 = print)

-------- ------------------

! STABILITY = 0 ! - PGT stability class
! USTAR = 0 ! - Friction velocity
! MONIN = 0 ! - Monin-Obukhov length
! MIXHT = 0 ! - Mixing height
! WSTAR = 0 ! - Convective velocity scale
! PRECIP = 0 ! - Precipitation rate
! SENSHEAT = 0 ! - Sensible heat flux
! CONVZI = 0 ! - Convective mixing ht.

Testing and debug print options for
micrometeorological module

Print input meteorological data and
internal variables (LDB) Default: F ! LDB
= F !
(F = Do not print, T = print)
(NOTE: this option produces large amounts of
output)

First time step for which debug data
are printed (NN1) Default: 1 ! NN1
= 1 !

Last time step for which debug data
are printed (NN2) Default: 1 ! NN2
= 1 !

Print distance to land
internal variables (LDBCST) Default: F !
LDBCST = F !
(F = Do not print, T = print)
(Output in .GRD file DCST.GRD, defined in input
group 0)

Testing and debug print options for wind field module
(all of the following print options control output to
wind field module's output files: TEST.PRT,
TEST.OUT,
TEST.KIN, TEST.FRD, and TEST.SLP)

Control variable for writing the test/debug
wind fields to disk files (IOUTD)
(0=Do not write, 1=write) Default: 0 !
IOUTD = 0 !

Number of levels, starting at the surface,
to print (NZPRN2) Default: 1 !
NZPRN2 = 1 !

Print the INTERPOLATED wind components ?
(IPR0) (0=no, 1=yes) Default: 0 !
IPR0 = 0 !

Print the TERRAIN ADJUSTED surface wind
components ?
(IPR1) (0=no, 1=yes) Default: 0 !
IPR1 = 0 !

Print the SMOOTHED wind components and
the INITIAL DIVERGENCE fields ?
(IPR2) (0=no, 1=yes) Default: 0 !
IPR2 = 0 !

Print the FINAL wind speed and direction
fields ?
(IPR3) (0=no, 1=yes) Default: 0 !
IPR3 = 0 !

Print the FINAL DIVERGENCE fields ?
(IPR4) (0=no, 1=yes) Default: 0 !
IPR4 = 0 !

Print the winds after KINEMATIC effects
are added ?
(IPR5) (0=no, 1=yes) Default: 0 !
IPR5 = 0 !

Print the winds after the FROUDE NUMBER
adjustment is made ?
(IPR6) (0=no, 1=yes) Default: 0 !
IPR6 = 0 !

Print the winds after SLOPE FLOWS
are added ?
(IPR7) (0=no, 1=yes) Default: 0 !
IPR7 = 0 !

Print the FINAL wind field components ?
(IPR8) (0=no, 1=yes) Default: 0 !
IPR8 = 0 !

!END!

--------------------------------------------------------------
---------------

INPUT GROUP: 4 -- Meteorological data options
--------------

NO OBSERVATION MODE (NOOBS) Default: 0
! NOOBS = 2 !
0 = Use surface, overwater, and upper air stations
1 = Use surface and overwater stations (no upper
air observations)
Use MM4/MM5/3D for upper air data
2 = No surface, overwater, or upper air
observations
Use MM4/MM5/3D for surface, overwater, and
upper air data

NUMBER OF SURFACE & PRECIP. METEOROLOGICAL
STATIONS

Number of surface stations (NSSTA) No default
! NSSTA = 0 !

Number of precipitation stations
(NPSTA=-1: flag for use of MM5/3D precip data)
(NPSTA) No default ! NPSTA
= -1 !

CLOUD DATA OPTIONS
Output option - output a CLOUD.DAT file (yes or no)
0=no, 1=yes
(ICLDOUT) Default:999 !
ICLDOUT = 0 !

Method to compute cloud fields:
(MCLOUD) Default: 999 !
MCLOUD = 3 !
MCLOUD = 1 - Clouds data generated from surface
observations
MCLOUD = 2 - Gridded CLOUD.DAT read from
CLOUD.DAT file (no output
is possible since already exist)
MCLOUD = 3 - Gridded cloud cover from Prognostic
Rel. Humidity
at 850mb (Teixera)
MCLOUD = 4 - Gridded cloud cover from Prognostic
Rel. Humidity
at all levels (MM5toGrads algorithm)

FILE FORMATS

Surface meteorological data file format
(IFORMS) Default: 2 !
IFORMS = 2 !
(1 = unformatted (e.g., SMERGE output))
(2 = formatted (free-formatted user input))

Precipitation data file format

(IFORMP) Default: 2 ! IFORMP = 2 !
(1 = unformatted (e.g., PMERGE output))
(2 = formatted (free-formatted user input))

Cloud data file format
(IFORMC) Default: 2 ! IFORMC = 1 !
(1 = unformatted - CALMET unformatted output)
(2 = formatted - free-formatted CALMET output or user input)

!END!

--------------------------------------------------------------------------------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------

WIND FIELD MODEL OPTIONS
Model selection variable (IWFCOD) Default: 1 ! IWFCOD = 1 !
0 = Objective analysis only
1 = Diagnostic wind module

Compute Froude number adjustment
effects ? (IFRADJ) Default: 1 ! IFRADJ = 1 !
(0 = NO, 1 = YES)

Compute kinematic effects ? (IKINE) Default: 0 ! IKINE = 0 !
(0 = NO, 1 = YES)

Use O'Brien procedure for adjustment
of the vertical velocity ? (IOBR) Default: 0 ! IOBR = 0 !
(0 = NO, 1 = YES)

Compute slope flow effects ? (ISLOPE) Default: 1 ! ISLOPE = 1 !
(0 = NO, 1 = YES)

Extrapolate surface wind observations
to upper layers ? (IEXTRP) Default: -4 ! IEXTRP = 1 !
(1 = no extrapolation is done,
2 = power law extrapolation used,
3 = user input multiplicative factors
for layers 2 - NZ used (see FEXTRP array)
4 = similarity theory used
-1, -2, -3, -4 = same as above except layer 1 data
at upper air stations are ignored

Extrapolate surface winds even
if calm? (ICALM) Default: 0 ! ICALM = 0 !
(0 = NO, 1 = YES)

Layer-dependent biases modifying the weights of
surface and upper air stations (BIAS(NZ))
-1<=BIAS<=1
Negative BIAS reduces the weight of upper air stations
(e.g. BIAS=-0.1 reduces the weight of upper air stations
by 10%; BIAS= -1, reduces their weight by 100 %)
Positive BIAS reduces the weight of surface stations
(e.g. BIAS= 0.2 reduces the weight of surface stations
by 20%; BIAS=1 reduces their weight by 100%)
Zero BIAS leaves weights unchanged (1/R**2 interpolation)
Default: NZ*0
! BIAS = 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0 !

Minimum distance from nearest upper air station
to surface station for which extrapolation
of surface winds at surface station will be allowed
(RMIN2: Set to -1 for IEXTRP = 4 or other situations
where all surface stations should be extrapolated)
Default: 4. ! RMIN2 = 4 !

Use gridded prognostic wind field model
output fields as input to the diagnostic
wind field model (IPROG) Default: 0 ! IPROG = 14 !
(0 = No, [IWFCOD = 0 or 1]
1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]
3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]
4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]
5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]
13 = Yes, use winds from MM5/3D.DAT file as Step 1 field [IWFCOD = 0]
14 = Yes, use winds from MM5/3D.DAT file as initial guess field [IWFCOD = 1]
15 = Yes, use winds from MM5/3D.DAT file as observations [IWFCOD = 1]

Timestep (seconds) of the prognostic
model input data (ISTEPPGS) Default: 3600 ! ISTEPPGS = 3600 !

Use coarse CALMET fields as initial guess fields (IGFMET)
(overwrites IGF based on prognostic wind fields if any)
Default: 0 ! IGFMET = 0 !

RADIUS OF INFLUENCE PARAMETERS

Use varying radius of influence Default: F ! LVARY = F !
(if no stations are found within RMAX1,RMAX2,
or RMAX3, then the closest station will be used)

Maximum radius of influence over land
in the surface layer (RMAX1) No default ! RMAX1 = 0 !
Units: km
Maximum radius of influence over land
aloft (RMAX2) No default ! RMAX2 = 0 !
Units: km
Maximum radius of influence over water
(RMAX3) No default ! RMAX3 = 0 !
Units: km

OTHER WIND FIELD INPUT PARAMETERS

Minimum radius of influence used in
the wind field interpolation (RMIN) Default: 0.1 ! RMIN = 5 !
Units: km
Radius of influence of terrain
features (TERRAD) No default ! TERRAD = 50 !

Units: km
Relative weighting of the first
guess field and observations in the

SURFACE layer (R1) No default ! R1 = 0 !
(R1 is the distance from an Units: km
observational station at which the
observation and first guess field are
equally weighted)

Relative weighting of the first
guess field and observations in the
layers ALOFT (R2) No default ! R2 = 0 !
(R2 is applied in the upper layers Units: km
in the same manner as R1 is used in
the surface layer).

Relative weighting parameter of the
prognostic wind field data (RPROG) No default ! RPROG = 0 !
(Used only if IPROG = 1) Units: km
-----------------------

Maximum acceptable divergence in the
divergence minimization procedure
(DIVLIM) Default: 5.E-6 ! DIVLIM = 5E-006 !

Maximum number of iterations in the
divergence min. procedure (NITER) Default: 50 ! NITER = 50 !

Number of passes in the smoothing
procedure (NSMTH(NZ))
NOTE: NZ values must be entered
Default: 2,(mxnz-1)*4 ! NSMTH = 2,9*4 !

Maximum number of stations used in
each layer for the interpolation of
data to a grid point (NINTR2(NZ))
NOTE: NZ values must be entered Default: 99. ! NINTR2 = 10*99 !

Critical Froude number (CRITFN) Default: 1.0 ! CRITFN = 1 !

Empirical factor controlling the
influence of kinematic effects
(ALPHA) Default: 0.1 ! ALPHA = 0.1 !

Multiplicative scaling factor for
extrapolation of surface observations
to upper layers (FEXTR2(NZ)) Default: NZ*0.0
* FEXTR2 = *
(Used only if IEXTRP = 3 or -3)

BARRIER INFORMATION

Number of barriers to interpolation
of the wind fields (NBAR) Default: 0 ! NBAR = 0 !

Level (1 to NZ) up to which barriers
apply (KBAR) Default: NZ ! KBAR = 10 !

THE FOLLOWING 4 VARIABLES ARE INCLUDED
ONLY IF NBAR > 0
NOTE: NBAR values must be entered No defaults
for each variable Units: km

X coordinate of BEGINNING
of each barrier (XBBAR(NBAR)) * XBBAR = *
Y coordinate of BEGINNING
of each barrier (YBBAR(NBAR)) * YBBAR = *

X coordinate of ENDING
of each barrier (XEBAR(NBAR)) * XEBAR = *
Y coordinate of ENDING
of each barrier (YEBAR(NBAR)) * YEBAR = *

DIAGNOSTIC MODULE DATA INPUT OPTIONS

Surface temperature (IDIOPT1) Default: 0 ! IDIOPT1 = 0 !
0 = Compute internally from
hourly surface observations or prognostic fields
1 = Read preprocessed values from
a data file (DIAG.DAT)

Surface met. station to use for
the surface temperature (ISURFT) Default: -1 ! ISURFT = -1 !
(Must be a value from 1 to NSSTA
or -1 to use 2-D spatially varying
surface temperatures).
or -2 to use a domain-average prognostic
lapse rate (only with ITPROG=2)
(Used only if IDIOPT1 = 0)
--------------------------

Temperature lapse rate used in the Default: 0 ! IDIOPT2 = 0 !
computation of terrain-induced
circulations (IDIOPT2)
0 = Compute internally from (at least) twice-daily
upper air observations or prognostic fields
1 = Read hourly preprocessed values
from a data file (DIAG.DAT)

Upper air station to use for
the domain-scale lapse rate (IUPT) Default: -1 ! IUPT = -1 !
(Must be a value from 1 to NUSTA
or -1 to use 2-D spatially varying lapse rate)
or -2 to use a domain-average prognostic
lapse rate (only with ITPROG>0)
(Used only if IDIOPT2 = 0)
--------------------------

Depth through which the domain-scale
lapse rate is computed (ZUPT) Default: 200. ! ZUPT = 200 !
(Used only if IDIOPT2 = 0) Units: meters
--------------------------

Initial Guess Field Winds
(IDIOPT3) Default: 0 ! IDIOPT3 = 0 !
0 = Compute internally from
observations or prognostic wind fields
1 = Read hourly preprocessed domain-average wind values
from a data file (DIAG.DAT)

Upper air station to use for
the initial guess winds (IUPWND) Default: -1 ! IUPWND = -1 !
(Must be a value from -1 to NUSTA, with
-1 indicating 3-D initial guess fields,
and IUPWND>1 domain-scaled (i.e. constant) IGF
(Used only if IDIOPT3 = 0 and noobs=0)
-----------------------------------

Bottom and top of layer through
which the domain-scale winds
are computed
(ZUPWND(1), ZUPWND(2)) Defaults: 1., 1000. ! ZUPWND= 1.0, 1.00 !
(Used only if IDIOPT3 = 0, NOOBS>0 and IUPWND>0) Units: meters
--------------------------

Observed surface wind components

for wind field module (IDIOPT4) Default: 0 !
IDIOPT4 = 0 !
0 = Read WS, WD from a surface
data file (SURF.DAT)
1 = Read hourly preprocessed U, V from
a data file (DIAG.DAT)

Observed upper air wind components
for wind field module (IDIOPT5) Default: 0 !
IDIOPT5 = 0 !
0 = Read WS, WD from an upper
air data file (UP1.DAT, UP2.DAT, etc.)
1 = Read hourly preprocessed U, V from
a data file (DIAG.DAT)

LAKE BREEZE INFORMATION

Use Lake Breeze Module (LLBREZE)
Default: F ! LLBREZE =
F !

Number of lake breeze regions (NBOX) !
NBOX = 0 !

X Grid line 1 defining the region of interest
* XG1 = *
X Grid line 2 defining the region of interest
* XG2 = *
Y Grid line 1 defining the region of interest
* YG1 = *
Y Grid line 2 defining the region of interest
* YG2 = *

X Point defining the coastline (Straight line)
(XBCST) (KM) Default: none * XBCST =
*

Y Point defining the coastline (Straight line)
(YBCST) (KM) Default: none * YBCST =
*

X Point defining the coastline (Straight line)
(XECST) (KM) Default: none * XECST =
*

Y Point defining the coastline (Straight line)
(YECST) (KM) Default: none * YECST =
*

Number of stations in the region Default: none *
NLB = *
(Surface stations + upper air stations)

Station ID's in the region (METBXID(NLB))
(Surface stations first, then upper air stations)
* METBXID = *

!END!

-----------------------------------------------------------------
---------------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters
--------------

EMPIRICAL MIXING HEIGHT CONSTANTS

Neutral, mechanical equation
(CONSTB) Default: 1.41 !
CONSTB = 1.41 !
Convective mixing ht. equation
(CONSTE) Default: 0.15 !
CONSTE = 0.15 !
Stable mixing ht. equation
(CONSTN) Default: 2400. !
CONSTN = 2400 !
Overwater mixing ht. equation
(CONSTW) Default: 0.16 !
CONSTW = 0.16 !
Absolute value of Coriolis
parameter (FCORIOL) Default: 1.E-4 !
FCORIOL = 0.0001 !
Units: (1/s)

SPATIAL AVERAGING OF MIXING HEIGHTS

Conduct spatial averaging
(IAVEZI) (0=no, 1=yes) Default: 1 !
IAVEZI = 1 !

Max. search radius in averaging
process (MNMDAV) Default: 1 !
MNMDAV = 1 !
Units: Grid
cells
Half-angle of upwind looking cone
for averaging (HAFANG) Default: 30. !
HAFANG = 30 !
Units: deg.
Layer of winds used in upwind
averaging (ILEVZI) Default: 1 !
ILEVZI = 1 !
(must be between 1 and NZ)

CONVECTIVE MIXING HEIGHT OPTIONS:
Method to compute the convective
mixing height(IMIHXH) Default: 1 !
IMIXH = 1 !
1: Maul-Carson for land and water cells
-1: Maul-Carson for land cells only -
OCD mixing height overwater
2: Batchvarova and Gryning for land and water
cells
-2: Batchvarova and Gryning for land cells only
OCD mixing height overwater

Threshold buoyancy flux required to
sustain convective mixing height growth
overland (THRESHL) Default: 0.0 !
THRESHL = 0 !
(expressed as a heat flux units: W/m3
per meter of boundary layer)

Threshold buoyancy flux required to
sustain convective mixing height growth
overwater (THRESHW) Default: 0.05 !
THRESHW = 0.05 !
(expressed as a heat flux units: W/m3
per meter of boundary layer)

Option for overwater lapse rates used
in convective mixing height growth
(ITWPROG) Default: 0 !
ITWPROG = 0 !
0 : use SEA.DAT lapse rates and deltaT (or assume
neutral
conditions if missing)
1 : use prognostic lapse rates (only if IPROG>2)
and SEA.DAT deltaT (or neutral if missing)
2 : use prognostic lapse rates and prognostic delta T
(only if iprog>12 and 3D.DAT version# 2.0 or
higher)

Land Use category ocean in 3D.DAT datasets
(ILUOC3D) Default: 16 !
ILUOC3D = 16 !
Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16
if MM4.DAT, typically iluoc3d = 7

```
   OTHER MIXING HEIGHT VARIABLES

      Minimum potential temperature lapse
      rate in the stable layer above the
      current convective mixing ht.        Default: 0.001  !
DPTMIN = 0.001 !
      (DPTMIN)                          Units: deg. K/m
      Depth of layer above current conv.
      mixing height through which lapse     Default: 200.
! DZZI = 200 !
      rate is computed (DZZI)              Units: meters

      Minimum overland mixing height        Default:  50.
! ZIMIN = 50 !
      (ZIMIN)                           Units: meters
      Maximum overland mixing height        Default: 3000.
! ZIMAX = 3000 !
      (ZIMAX)                           Units: meters
      Minimum overwater mixing height       Default:   50.
! ZIMINW = 50 !
      (ZIMINW) -- (Not used if observed     Units: meters
      overwater mixing hts. are used)
      Maximum overwater mixing height       Default:
3000.  ! ZIMAXW = 3000 !
      (ZIMAXW) -- (Not used if observed     Units: meters
      overwater mixing hts. are used)


   OVERWATER SURFACE FLUXES METHOD and
PARAMETERS
         (ICOARE)                       Default: 10     !
ICOARE = 10 !
          0: original deltaT method (OCD)
         10: COARE with no wave parameterization
(jwave=0, Charnock)
         11: COARE with wave option jwave=1 (Oost et al.)
            and default wave properties
        -11: COARE with wave option jwave=1 (Oost et al.)
            and observed wave properties (must be in
SEA.DAT files)
         12: COARE with wave option 2 (Taylor and
Yelland)
            and default wave properties
        -12: COARE with wave option 2 (Taylor and
Yelland)
            and observed wave properties (must be in
SEA.DAT files)

         Note:  When ICOARE=0, similarity wind profile
stability PSI functions
               based on Van Ulden and Holtslag (1985) are
substituted for
               later formulations used with the COARE
module, and temperatures
               used for surface layer parameters are
obtained from either the
               nearest surface station temperature or
prognostic model 2D
               temperatures (if ITPROG=2).


         Coastal/Shallow water length scale (DSHELF)
         (for modified z0 in shallow water)
         ( COARE fluxes only)
                              Default : 0.       ! DSHELF =
0 !
                              units: km

          COARE warm layer computation (IWARM)
! IWARM = 0 !
          1: on - 0: off (must be off if SST measured with
          IR radiometer)              Default: 0

          COARE cool skin layer computation (ICOOL)
! ICOOL = 0 !
          1: on - 0: off (must be off if SST measured with
          IR radiometer)              Default: 0

   RELATIVE HUMIDITY PARAMETERS

      3D relative humidity from observations or
      from prognostic data? (IRHPROG)       Default:0
! IRHPROG = 1 !

         0 = Use RH from SURF.DAT file
             (only if NOOBS = 0,1)
         1 = Use prognostic RH
             (only if NOOBS = 0,1,2)

   TEMPERATURE PARAMETERS

      3D temperature from observations or
      from prognostic data? (ITPROG)        Default:0       !
ITPROG = 2 !

         0 = Use Surface and upper air stations
             (only if NOOBS = 0)
         1 = Use Surface stations (no upper air
observations)
             Use MM5/3D for upper air data
             (only if NOOBS = 0,1)
         2 = No surface or upper air observations
             Use MM5/3D for surface and upper air data
             (only if NOOBS = 0,1,2)

      Interpolation type
      (1 = 1/R ; 2 = 1/R**2)              Default:1       !
IRAD = 1 !

      Radius of influence for temperature
      interpolation (TRADKM)              Default: 500.    !
TRADKM = 500 !
                                          Units: km

      Maximum Number of stations to include
      in temperature interpolation (NUMTS)  Default: 5
! NUMTS = 5 !

      Conduct spatial averaging of temp-
      eratures (IAVET)  (0=no, 1=yes)       Default: 1
! IAVET = 1 !
      (will use mixing ht MNMDAV,HAFANG
       so make sure they are correct)

      Default temperature gradient          Default: -.0098 !
TGDEFB = -0.0098 !
      below the mixing height over          Units: K/m
      water (TGDEFB)

      Default temperature gradient          Default: -.0045 !
TGDEFA = -0.0045 !
      above the mixing height over          Units: K/m
      water (TGDEFA)

      Beginning (JWAT1) and ending (JWAT2)
      land use categories for temperature                  !
JWAT1 = 999 !
      interpolation over water -- Make                     !
JWAT2 = 999 !
      bigger than largest land use to disable

   PRECIP INTERPOLATION PARAMETERS

      Method of interpolation (NFLAGP)      Default: 2      !
NFLAGP = 2 !
       (1=1/R,2=1/R**2,3=EXP/R**2)
      Radius of Influence  (SIGMAP)         Default: 100.0 !
SIGMAP = 100. !
       (0.0 => use half dist. btwn          Units: km
        nearest stns w & w/out
        precip when NFLAGP = 3)
      Minimum Precip. Rate Cutoff (CUTP)    Default: 0.01
! CUTP = 0.01 !
       (values <CUTP = 0.0 mm/hr)           Units: mm/hr
!END!
```

--------------------------------------------------------------------------------

INPUT GROUP: 7 -- Surface meteorological station parameters
--------------

SURFACE STATION VARIABLES
(One record per station -- 12 records in all)

```
    1     2
  Name    ID     X coord.   Y coord.    Time   Anem.
                 (km)       (km)        zone   Ht.(m)
  ----------------------------------------------------------------------------
```

1
Four character string for station name
(MUST START IN COLUMN 9)

2
Six digit integer for station ID

!END!

--------------------------------------------------------------------------------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

UPPER AIR STATION VARIABLES
(One record per station -- 3 records in all)

```
    1     2
  Name    ID      X coord.   Y coord.  Time zone
                  (km)       (km)
  ----------------------------------------------------------------------------
```

1
Four character string for station name
(MUST START IN COLUMN 9)

2
Five digit integer for station ID

!END!

--------------------------------------------------------------------------------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

PRECIPITATION STATION VARIABLES
(One record per station -- 2 records in all)
(NOT INCLUDED IF NPSTA = 0)

```
    1        2
  Name   Station    X coord.  Y coord.
         Code       (km)      (km)
  ------------------------------------------------------
```

1
Four character string for station name
(MUST START IN COLUMN 9)

2
Six digit station code composed of state code (first 2 digits) and station ID (last 4 digits)

!END!

# APPENDIX 2
# CALPUFF INPUT FILES

```
CALPUFF.INP      7.0              Generated by CALPUFF View
8.5.0 - 21-Apr-20


---------------- Run title (3 lines) ---------------------------
---------------

                 CALPUFF MODEL CONTROL FILE
                 --------------------------

---------------------------------------------------------------
---------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT = *
    or
ISCMET.DAT    input    * ISCDAT = *
    or
PLMMET.DAT    input    * PLMDAT = *
    or
PROFILE.DAT   input    * PRFDAT = *
SURFACE.DAT   input    * SFCDAT = *
RESTARTB.DAT  input    * RSTARTB = *
---------------------------------------------------------------
----------------
CALPUFF.LST   output   ! PUFLST = CALPUFF.LST !
CONC.DAT      output   ! CONDAT = CONC.DAT !
DFLX.DAT      output   ! DFDAT = DFLX.DAT !
WFLX.DAT      output   ! WFDAT = WFLX.DAT !

VISB.DAT      output   * VISDAT = *
TK2D.DAT      output   * T2DDAT = *
RHO2D.DAT     output   * RHODAT = *
RESTARTE.DAT  output   * RSTARTE = *
---------------------------------------------------------------
----------------
Other Files
-----------
OZONE.DAT     input    * OZDAT = *
VD.DAT        input    * VDDAT = *
CHEM.DAT      input    * CHEMDAT = *
AUX           input    * AUXEXT = *
(Extension added to METDAT filename(s) for files
 with auxiliary 2D and 3D data)
H2O2.DAT      input    * H2O2DAT = *
NH3Z.DAT      input    * NH3ZDAT = *
HILL.DAT      input    * HILDAT = *
HILLRCT.DAT   input    * RCTDAT = *
COASTLN.DAT   input    * CSTDAT = *
FLUXBDY.DAT   input    * BDYDAT = *
BCON.DAT      input    * BCNDAT = *
DEBUG.DAT     output   * DEBUG = *
MASSFLX.DAT   output   * FLXDAT = *
MASSBAL.DAT   output   * BALDAT = *
FOG.DAT       output   * FOGDAT = *
RISE.DAT      output   * RISDAT = *
PFTRAK.DAT    output   * TRKDAT = *
---------------------------------------------------------------
----------------
All file names will be converted to lower case if LCFILES =
T
Otherwise, if LCFILES = F, file names will be converted to
UPPER CASE
        T = lower case      ! LCFILES = F !
        F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in
length


Provision for multiple input files
----------------------------------
     Number of CALMET.DAT Domains (NMETDOM)
                              Default: 1       ! NMETDOM = 1 !

     Number of CALMET.DAT files (NMETDAT)
     (Total for ALL Domains)
                              Default: 1       ! NMETDAT = 16
!

     Number of PTEMARB.DAT files for run (NPTDAT)
                              Default: 0       ! NPTDAT = 0 !

     Number of BAEMARB.DAT files for run (NARDAT)
                              Default: 0       ! NARDAT = 0 !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                              Default: 0       ! NVOLDAT = 0 !

     Number of FLARE source files (FLEMARB.DAT)
     with time-varying data (NFLDAT)
                              Default: 0       ! NFLDAT = 0 !

     Number of ROAD source files (RDEMARB.DAT)
     with time-varying data (NRDDAT)
                              Default: 0       ! NRDDAT = 0 !

     Number of BUOYANT LINE source files
(LNEMARB.DAT)
     with time-varying data (NLNDAT)
                              Default: 0       ! NLNDAT = 0 !
     Note:  Only 1 BUOYANT LINE source file is allowed
     -----


!END!

-------------
Subgroup (0a)
-------------
  Provide a name for each CALMET domain if NMETDOM >
1
  Enter NMETDOM lines.
                               a,b
Default Name             Domain Name
------------             ------------
* DOMAINLIST = *


  The following CALMET.DAT filenames are processed in
sequence
  if NMETDAT > 1

  Enter NMETDAT lines, 1 line for each file name.

                                a,c,d
Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=CALMET_2018-01-01-00-
0000-2018-01-24-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-01-24-00-
0000-2018-02-16-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-02-16-00-
0000-2018-03-10-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-03-10-00-
0000-2018-04-02-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-04-02-00-
0000-2018-04-25-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-04-25-00-
0000-2018-05-17-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-05-17-00-
0000-2018-06-09-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-06-09-00-
0000-2018-07-02-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-07-02-00-
0000-2018-07-25-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-07-25-00-
0000-2018-08-17-00-0000.DAT    !  !END!
 none         input    ! METDAT=CALMET_2018-08-17-00-
0000-2018-09-08-00-0000.DAT    !  !END!
```

none input ! METDAT=CALMET_2018-09-08-00-0000-2018-10-01-00-0000.DAT ! !END!
none input ! METDAT=CALMET_2018-10-01-00-0000-2018-10-24-00-0000.DAT ! !END!
none input ! METDAT=CALMET_2018-10-24-00-0000-2018-11-15-00-0000.DAT ! !END!
none input ! METDAT=CALMET_2018-11-15-00-0000-2018-12-08-00-0000.DAT ! !END!
none input ! METDAT=CALMET_2018-12-08-00-0000-2018-12-31-00-0000.DAT ! !END!

-------------
a
The name for each CALMET domain and each CALMET.DAT file is treated
as a separate input subgroup and therefore must end with an input
group terminator.
b
Use DOMAIN1= to assign the name for the outermost CALMET domain.
Use DOMAIN2= to assign the name for the next inner CALMET domain.
Use DOMAIN3= to assign the name for the next inner CALMET domain, etc.
--------------------------------------------------------------------
| When inner domains with equal resolution (grid-cell size) |
| overlap, the data from the FIRST such domain in the list will |
| be used if all other criteria for choosing the controlling |
| grid domain are inconclusive. |
--------------------------------------------------------------------
c
Use METDAT1= to assign the file names for the outermost CALMET domain.
Use METDAT2= to assign the file names for the next inner CALMET domain.
Use METDAT3= to assign the file names for the next inner CALMET domain, etc.
d
The filenames for each domain must be provided in sequential order

-------------
Subgroup (0b) – PTEMARB.DAT files
-------------

POINT Source File Names
The following PTEMARB.DAT filenames are processed if NPTDAT>0
A total of NPTDAT lines is expected with one file name assigned per line
Each line is treated as an input group and must terminate with END
(surrounded by delimiters)
(Each file contains emissions parameters for the entire period modeled
for 1 or more sources)

Default Name Type File Name
------------ ---- ---------
* PTDATLIST = *

-------------
Subgroup (0c) – BAEMARB.DAT files
-------------

BUOYANT AREA Source File Names
The following BAEMARB.DAT filenames are processed if NARDAT>0
A total of NARDAT lines is expected with one file name assigned per line
Each line is treated as an input group and must terminate with END
(surrounded by delimiters)
(Each file contains emissions parameters for the entire period modeled
for 1 or more sources)

Default Name Type File Name
------------ ---- ---------
* ARDATLIST = *

-------------
Subgroup (0d) – VOLEMARB.DAT files
-------------

VOLUME Source File Names
The following VOLEMARB.DAT filenames are processed if NVOLDAT>0
A total of NVOLDAT lines is expected with one file name assigned per line
Each line is treated as an input group and must terminate with END
(surrounded by delimiters)
(Each file contains emissions parameters for the entire period modeled
for 1 or more sources)

Default Name Type File Name
------------ ---- ---------
* VOLDATLIST = *

-------------
Subgroup (0e) – FLEMARB.DAT files
-------------

FLARE Source File Names
The following FLEMARB.DAT filenames are processed if NFLDAT>0
A total of NFLDAT lines is expected with one file name assigned per line
Each line is treated as an input group and must terminate with END
(surrounded by delimiters)
(Each file contains emissions parameters for the entire period modeled
for 1 or more sources)

Default Name Type File Name
------------ ---- ---------
* FLEMARBLIST = *

-------------
Subgroup (0f) – RDEMARB.DAT files
-------------

ROAD Source File Names
The following RDEMARB.DAT filenames are processed if NRDDAT>0
A total of NRDDAT lines is expected with one file name assigned per line
Each line is treated as an input group and must terminate with END
(surrounded by delimiters)
(Each file contains emissions parameters for the entire period modeled
for 1 or more sources)

Default Name Type File Name
------------ ---- ---------
* RDEMARBLIST = *

-------------
Subgroup (0g) – LNEMARB.DAT file

-------------

BUOYANT LINE Source File Name (not more than 1)
The following LNEMARB.DAT filename is processed if NLNDAT>0
The assignment is treated as an input group and must terminate with END
(surrounded by delimiters)

Default Name Type File Name
------------ ---- ---------
* LNEMARBLIST = *

--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

Option to run all periods found
in the met. file (METRUN) Default: 0 ! METRUN = 0 !

METRUN = 0 - Run period explicitly defined below
METRUN = 1 - Run all periods in met. file

Starting date: Year (IBYR) -- No default ! IBYR = 2018 !
Month (IBMO) -- No default ! IBMO = 1 !
Day (IBDY) -- No default ! IBDY = 1 !
Starting time: Hour (IBHR) -- No default ! IBHR = 0 !
Minute (IBMIN) -- No default ! IBMIN = 0 !
Second (IBSEC) -- No default ! IBSEC = 0 !

Ending date: Year (IEYR) -- No default ! IEYR = 2018 !
Month (IEMO) -- No default ! IEMO = 12 !
Day (IEDY) -- No default ! IEDY = 31 !
Ending time: Hour (IEHR) -- No default ! IEHR = 0 !
Minute (IEMIN) -- No default ! IEMIN = 0 !
Second (IESEC) -- No default ! IESEC = 0 !

(These are only used if METRUN = 0)

Base time zone: (ABTZ) -- No default ! ABTZ = UTC+0800 !
(character*8)
The modeling domain may span multiple time zones. ABTZ defines the
base time zone used for the entire simulation. This must match the
base time zone of the meteorological data.
Examples:
Greenwich Mean Time (GMT) = UTC+0000
EST = UTC-0500
CST = UTC-0600
MST = UTC-0700
PST = UTC-0800
Los Angeles, USA = UTC-0800
New York, USA = UTC-0500
Santiago, Chile = UTC-0400
UK = UTC+0000
Western Europe = UTC+0100
Rome, Italy = UTC+0100
Cape Town, S.Africa = UTC+0200
Sydney, Australia = UTC+1000

Length of modeling time-step (seconds)
Equal to update period in the primary
meteorological data files, or an
integer fraction of it (1/2, 1/3 ...)
Must be no larger than 1 hour
(NSECDT) Default:3600 ! NSECDT = 3600 !
Units: seconds

Number of chemical species (NSPEC)
Default: 5 ! NSPEC = 2 !

Number of chemical species
to be emitted (NSE) Default: 3 ! NSE = 2 !

Flag to stop run after
SETUP phase (ITEST) Default: 2 ! ITEST = 2 !
(Used to allow checking
of the model inputs, files, etc.)
ITEST = 1 - STOPS program after SETUP phase
ITEST = 2 - Continues with execution of program
after SETUP

Restart Configuration:

Control flag (MRESTART) Default: 0 ! MRESTART = 0 !

0 = Do not read or write a restart file
1 = Read a restart file at the beginning of
the run
2 = Write a restart file during run
3 = Read a restart file at beginning of run
and write a restart file during run

Number of periods in Restart
output cycle (NRESPD) Default: 0 ! NRESPD = 0 !

0 = File written only at last period
>0 = File updated every NRESPD periods

Meteorological Data Format (METFM)
Default: 1 ! METFM = 1 !

METFM = 1 - CALMET binary file (CALMET.MET)
METFM = 2 - ISC ASCII file (ISCMET.MET)
METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
surface parameters file (SURFACE.DAT)
METFM = 5 - AERMET tower file (PROFILE.DAT) and
surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)
(used only for METFM = 1, 2, 3)
Default: 1 ! MPRFFM = 1 !

MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

Sigma-y is adjusted by the factor (AVET/PGTIME)**0.2 to either
decrease it if the averaging time selected is less than the base
averaging time, or increase it if the averaging time is greater.
The base averaging time is denoted as PGTIME due to historical
reasons as this adjustment was originally applied to the PG sigma
option. It is now applied to all dispersion options.
The factor is applied to the ambient turbulence sigma-v (m/s) and

```
     does not alter buoyancy enhancement or far-field
Heffter growth.

     Averaging Time (minutes) (AVET)
                              Default: 60.0   ! AVET = 60 !
     Base Averaging Time (minutes) (PGTIME)
                              Default: 60.0   ! PGTIME = 60 !

     Output units for binary concentration and flux files
     written in Dataset v2.2 or later formats
     (IOUTU)                     Default: 1     ! IOUTU = 1 !
         1 = mass      - g/m3 (conc) or g/m2/s (dep)
         2 = odour     - odour_units (conc)
         3 = radiation - Bq/m3 (conc) or Bq/m2/s (dep)

!END!


--------------------------------------------------------------
---------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                Default: 1     !
MGAUSS = 1 !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                        Default: 3     ! MCTADJ
= 3 !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                    Default: 0     ! MCTSG
= 0 !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)           Default: 0     !
MSLUG = 0 !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                        Default: 1     ! MTRANS
= 1 !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)          Default: 1     !
MTIP = 1 !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                  Default: 1     !
MRISE = 1 !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Apply stack-tip downwash to FLARE sources?
     (MTIP_FL)                       Default: 0     ! MTIP_FL
= 0 !
        0 = no  (no stack-tip downwash)
        1 = yes (apply stack-tip downwash)

     Plume rise module for FLARE sources
     (MRISE_FL)                      Default: 2     !
MRISE_FL = 2 !
        1 = Briggs module
        2 = Numerical rise module

     Method used to simulate building
     downwash? (MBDW)                   Default: 1     !
MBDW = 1 !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                Default: 0     !
MSHEAR = 0 !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)     Default: 0     !
MSPLIT = 0 !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)      Default: 1     !
MCHEM = 0 !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
            computed (MESOPUFF II scheme for OH)
        5 = user-specified half-life with or
            without transfer to child species
        6 = transformation rates computed
            internally (Updated RIVAD scheme with
            ISORROPIA  equilibrium)
        7 = transformation rates computed
            internally (Updated RIVAD scheme with
            ISORROPIA  equilibrium and CalTech SOA)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 6, or 7)       Default: 0     !
MAQCHEM = 0 !
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates and wet
            scavenging coefficients adjusted
            for in-cloud aqueous phase reactions
            (adapted from RADM cloud model
             implementation in CMAQ/SCICHEM)

     Liquid Water Content flag (MLWC)
     (Used only if MAQCHEM = 1)           Default: 1     !
MLWC = 1 !
        0 = water content estimated from cloud cover
            and presence of precipitation
        1 = gridded cloud water data read from CALMET
            water content output files (filenames are
            the CALMET.DAT names PLUS the extension
            AUXEXT provided in Input Group 0)

     Wet removal modeled ? (MWET)         Default: 1     !
MWET = 0 !
        0 = no
        1 = yes

     Dry deposition modeled ? (MDRY)      Default: 1     !
MDRY = 1 !
        0 = no
        1 = yes
        (dry deposition method specified
         for each species in Input Group 3)


     Gravitational settling (plume tilt)
```

modeled ? (MTILT) Default: 0 ! MTILT = 0 !
0 = no
1 = yes
(puff center falls at the gravitational
settling velocity for 1 particle species)

Restrictions:
- MDRY = 1
- NSPEC = 1 (must be particle species as well)
- sg = 0 GEOMETRIC STANDARD DEVIATION in Group 8 is
set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP) Default: 3 ! MDISP = 3 !

1 = dispersion coefficients computed from measured values
of turbulence, sigma v, sigma w
2 = dispersion coefficients from internally calculated
sigma v, sigma w using micrometeorological variables
(u*, w*, L, etc.)
3 = PG dispersion coefficients for RURAL areas (computed using
the ISCST multi-segment approximation) and MP coefficients in
urban areas
4 = same as 3 except PG coefficients computed using
the MESOPUFF II eqns.
5 = CTDM sigmas used for stable and neutral conditions.
For unstable conditions, sigmas are computed as in
MDISP = 3, described above. MDISP = 5 assumes that
measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5) Default: 3 ! MTURBVW = 3 !
1 = use sigma-v or sigma-theta measurements
from PROFILE.DAT to compute sigma-y
(valid for METFM = 1, 2, 3, 4, 5)
2 = use sigma-w measurements
from PROFILE.DAT to compute sigma-z
(valid for METFM = 1, 2, 3, 4, 5)
3 = use both sigma-(v/theta) and sigma-w
from PROFILE.DAT to compute sigma-y and sigma-z
(valid for METFM = 1, 2, 3, 4, 5)
4 = use sigma-theta measurements
from PLMMET.DAT to compute sigma-y
(valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2) Default: 3 ! MDISP2 = 3 !
(used only if MDISP = 1 or 5)
2 = dispersion coefficients from internally calculated
sigma v, sigma w using micrometeorological variables
(u*, w*, L, etc.)
3 = PG dispersion coefficients for RURAL areas (computed using
the ISCST multi-segment approximation) and MP coefficients in
urban areas
4 = same as 3 except PG coefficients computed using
the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY) Default: 0 ! MTAULY = 0 !
0 = Draxler default 617.284 (s)
1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
10 <Direct user input (s) -- e.g., 306.9

[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV) Default: 0 ! MTAUADV = 0 !
0 = No turbulence advection
1 = Computed (OPTION NOT IMPLEMENTED)
10 <Direct user input (s) -- e.g., 800

Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB) Default: 1 ! MCTURB = 1 !
1 = Standard CALPUFF subroutines
2 = AERMOD subroutines

PG sigma-y,z adj. for roughness? Default: 0 ! MROUGH = 0 !
(MROUGH)
0 = no
1 = yes

Partial plume penetration of Default: 1 ! MPARTL = 1 !
elevated inversion modeled for
point sources?
(MPARTL)
0 = no
1 = yes

Partial plume penetration of Default: 1 ! MPARTLBA = 0 !
elevated inversion modeled for
buoyant area sources?
(MPARTLBA)
0 = no
1 = yes

Strength of temperature inversion Default: 0 ! MTINV = 0 !
provided in PROFILE.DAT extended records?
(MTINV)
0 = no (computed from measured/default gradients)
1 = yes

PDF used for dispersion under convective conditions?
Default: 0 ! MPDF = 0 !
(MPDF)
0 = no
1 = yes

Sub-Grid TIBL module used for shore line?
Default: 0 ! MSGTIBL = 0 !
(MSGTIBL)
0 = no
1 = yes

Boundary conditions (concentration) modeled?
Default: 0 ! MBCON = 0 !
(MBCON)
0 = no
1 = yes, using formatted BCON.DAT file
2 = yes, using unformatted CONC.DAT file

Note: MBCON > 0 requires that the last species modeled
be 'BCON'. Mass is placed in species BCON when
generating boundary condition puffs so that clean
air entering the modeling domain can be simulated
in the same way as polluted air. Specify zero
emission of species BCON for all regular sources.

Individual source contributions saved?
Default: 0 ! MSOURCE = 0 !
(MSOURCE)
0 = no
1 = yes

Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors. Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
Default: 0 ! MFOG = 0 !
(MFOG)
0 = no
1 = yes - report results in PLUME Mode format
2 = yes - report results in RECEPTOR Mode format

Test options specified to see if
they conform to regulatory
values? (MREG) Default: 1 ! MREG = 0 !

0 = NO checks are made
1 = Technical options must conform to USEPA
Long Range Transport (LRT) guidance
METFM 1 or 2
AVET 60. (min)
PGTIME 60. (min)
MGAUSS 1
MCTADJ 3
MTRANS 1
MTIP 1
MRISE 1
MCHEM 1 or 3 (if modeling SOx, NOx)
MWET 1
MDRY 1
MDISP 2 or 3
MPDF 0 if MDISP=3
1 if MDISP=2
MROUGH 0
MPARTL 1
MPARTLBA 0
SYTDEP 550. (m)
MHFTSZ 0
SVMIN 0.5 (m/s)

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

The following species are modeled:

! CSPEC = 1 ! !END!
! CSPEC = 2 ! !END!

| | SPECIES NAME (Limit: 12 Characters in length) | MODELED (0=NO, 1=YES) | EMITTED (0=NO, 1=YES) | Dry DEPOSITED (0=NO, 1=COMPUTED-GAS 2=COMPUTED-PARTICLE 3=USER-SPECIFIED) | OUTPUT GROUP NUMBER (0=NONE, 1=1st CGRUP, 2=2nd CGRUP, 3= etc.) | |
|---|---|---|---|---|---|---|
| ! | 1 = | 1, | 1, | 2, | 1 | ! |
| ! | 2 = | 1, | 1, | 2, | 2 | ! |

!END!

Note: The last species in (3a) must be 'BCON' when using the
boundary condition option (MBCON > 0). Species BCON should
typically be modeled as inert (no chem transformation or
removal).

-------------
Subgroup (3b)
-------------

The following names are used for Species-Groups in which results
for certain species are combined (added) prior to output. The
CGRUP name will be used as the species name in output files.
Use this feature to model specific particle-size distributions
by treating each size-range as a separate species.
Order must be consistent with 3(a) above.

! CGRUP = GROUP_1 ! !END!
! CGRUP = GROUP_2 ! !END!

-------------------------------------------------------------------------------

INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

Projection for all (X,Y):
-------------------------

Map projection
(PMAP) Default: UTM ! PMAP = UTM !

UTM : Universal Transverse Mercator
TTM : Tangential Transverse Mercator
LCC : Lambert Conformal Conic
PS : Polar Stereographic
EM : Equatorial Mercator
LAZA : Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin
(Used only if PMAP= TTM, LCC, or LAZA)
(FEAST) Default=0.0 ! FEAST = 0.0 !
(FNORTH) Default=0.0 ! FNORTH = 0.0 !

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN) No Default ! IUTMZN = 51 !

Hemisphere for UTM projection?
(Used only if PMAP=UTM)
(UTMHEM) Default: N ! UTMHEM = S !
N : Northern hemisphere projection
S : Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0) No Default ! RLAT0 = 0.00N !
(RLON0) No Default ! RLON0 = 0.00E !

TTM : RLON0 identifies central (true N/S) meridian of projection
RLAT0 selected for convenience
LCC : RLON0 identifies central (true N/S) meridian of projection
RLAT0 selected for convenience
PS : RLON0 identifies central (grid N/S) meridian of projection
RLAT0 selected for convenience
EM : RLON0 identifies central meridian of projection
RLAT0 is REPLACED by 0.0N (Equator)
LAZA: RLON0 identifies longitude of tangent-point of mapping plane
RLAT0 identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1) No Default ! XLAT1 = 30S !
(XLAT2) No Default ! XLAT2 = 60S !

LCC : Projection cone slices through Earth's surface at XLAT1 and XLAT2
PS : Projection plane slices through Earth at XLAT1
(XLAT2 is not used)

----------
Note: Latitudes and longitudes should be positive, and include a
letter N,S,E, or W indicating north or south latitude, and
east or west longitude. For example,
35.9 N Latitude = 35.9N
118.7 E Longitude = 118.7E

Datum-region
------------

The Datum-Region for the coordinates is identified by a character
string. Many mapping products currently available use the model of the
Earth known as the World Geodetic System 1984 (WGS-84). Other local
models may be in use, and their selection in CALMET will make its output
consistent with local mapping products. The list of Datum-Regions with
official transformation parameters is provided by the National Imagery and
Mapping Agency (NIMA).

NIMA Datum - Regions(Examples)
------------------------------------------------------------------------------
WGS-84 WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84 NWS 6370KM Radius, Sphere
ESR-S ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM) Default: WGS-84 ! DATUM = WGS-84 !

METEOROLOGICAL Grid (outermost if nested CALMET grids are used):

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

No. X grid cells (NX) No default ! NX = 23 !
No. Y grid cells (NY) No default ! NY = 23 !
No. vertical layers (NZ) No default ! NZ = 10 !

Grid spacing (DGRIDKM) No default ! DGRIDKM = 10 !
Units: km

Cell face heights
(ZFACE(nz+1)) No defaults
Units: m
! ZFACE = 0.0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0, 4000.0 !

Reference Coordinates
of SOUTHWEST corner of
grid cell(1, 1):

X coordinate (XORIGKM) No default ! XORIGKM = 177.7410 !
Y coordinate (YORIGKM) No default ! YORIGKM = 6283.3050 !
Units: km

COMPUTATIONAL Grid:

The computational grid is identical to or a subset of the MET. grid.
The lower left (LL) corner of the computational grid is at grid point
(IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the
computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
The grid spacing of the computational grid is the same as the MET. grid.

X index of LL corner (IBCOMP) No default ! IBCOMP = 12 !
(1 <= IBCOMP <= NX)

Y index of LL corner (JBCOMP) No default ! JBCOMP = 11 !

(1 <= JBCOMP <= NY)

X index of UR corner (IECOMP) No default ! IECOMP = 20 !
(1 <= IECOMP <= NX)

Y index of UR corner (JECOMP) No default ! JECOMP = 13 !
(1 <= JECOMP <= NY)

SAMPLING Grid (GRIDDED RECEPTORS):

The lower left (LL) corner of the sampling grid is at grid point
(IBSAMP, JBSAMP) of the MET. grid. The upper right (UR) corner of the
sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
The sampling grid must be identical to or a subset of the computational
grid. It may be a nested grid inside the computational grid.
The grid spacing of the sampling grid is DGRIDKM/MESHDN.

Logical flag indicating if gridded
receptors are used (LSAMP) Default: T ! LSAMP = T !
(T=yes, F=no)

X index of LL corner (IBSAMP) No default ! IBSAMP = 19 !
(IBCOMP <= IBSAMP <= IECOMP)

Y index of LL corner (JBSAMP) No default ! JBSAMP = 11 !
(JBCOMP <= JBSAMP <= JECOMP)

X index of UR corner (IESAMP) No default ! IESAMP = 20 !
(IBCOMP <= IESAMP <= IECOMP)

Y index of UR corner (JESAMP) No default ! JESAMP = 12 !
(JBCOMP <= JESAMP <= JECOMP)

Nesting factor of the sampling
grid (MESHDN) Default: 1 ! MESHDN = 80 !
(MESHDN is an integer >= 1)

!END!

--------------------------------------------------------------------------------

INPUT GROUP: 5 -- Output Options
--------------

| FILE | * DEFAULT VALUE | * VALUE THIS RUN |
|---|---|---|
| Concentrations (ICON) | 1 | ! ICON = 1 ! |
| Dry Fluxes (IDRY) | 1 | ! IDRY = 1 ! |
| Wet Fluxes (IWET) | 1 | ! IWET = 0 ! |
| 2D Temperature (IT2D) | 0 | ! IT2D = 0 ! |
| 2D Density (IRHO) | 0 | ! IRHO = 0 ! |
| Relative Humidity (IVIS) | 1 | ! IVIS = 0 ! |

(relative humidity file is
required for visibility
analysis)
Use data compression option in output file?
(LCOMPRS) Default: T ! LCOMPRS = T !

*
0 = Do not create file, 1 = create file

QA PLOT FILE OUTPUT OPTION:

Create a standard series of output files (e.g.
locations of sources, receptors, grids ...)
suitable for plotting?
(IQAPLOT) Default: 1 ! IQAPLOT = 1 !
0 = no
1 = yes

DIAGNOSTIC PUFF-TRACKING OUTPUT OPTION:

Puff locations and properties reported to
PFTRAK.DAT file for postprocessing?
(IPFTRAK) Default: 0 ! IPFTRAK = 0 !
0 = no
1 = yes, update puff output at end of each timestep
2 = yes, update puff output at end of each sampling step

DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

Mass flux across specified boundaries
for selected species reported?
(IMFLX) Default: 0 ! IMFLX = 0 !
0 = no
1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
are specified in Input Group 0)

Mass balance for each species
reported?
(IMBAL) Default: 0 ! IMBAL = 0 !
0 = no
1 = yes (MASSBAL.DAT filename is
specified in Input Group 0)

NUMERICAL RISE OUTPUT OPTION:

Create a file with plume properties for each rise
increment, for each model timestep?
This applies to sources modeled with numerical rise
and is limited to ONE source in the run.
(INRISE) Default: 0 ! INRISE = 0 !
0 = no
1 = yes (RISE.DAT filename is
specified in Input Group 0)

LINE PRINTER OUTPUT OPTIONS:

Print concentrations (ICPRT) Default: 0 ! ICPRT = 0 !
Print dry fluxes (IDPRT) Default: 0 ! IDPRT = 0 !
Print wet fluxes (IWPRT) Default: 0 ! IWPRT = 0 !
(0 = Do not print, 1 = Print)

Concentration print interval
(ICFRQ) in timesteps Default: 1 ! ICFRQ = 1 !
Dry flux print interval
(IDFRQ) in timesteps Default: 1 ! IDFRQ = 1 !
Wet flux print interval
(IWFRQ) in timesteps Default: 1 ! IWFRQ = 1 !

Units for Line Printer Output
(IPRTU) Default: 1 ! IPRTU = 3 !

| | for Concentration | for Deposition | |
|---|---|---|---|
| 1 = | g/m**3 | g/m**2/s | |
| 2 = | mg/m**3 | mg/m**2/s | |
| 3 = | ug/m**3 | ug/m**2/s | |
| 4 = | ng/m**3 | ng/m**2/s | |
| 5 = | Odour Units | | |
| 6 = | TBq/m**3 | TBq/m**2/s | TBq=terabecquerel |
| 7 = | GBq/m**3 | GBq/m**2/s | GBq=gigabecquerel |
| 8 = | Bq/m**3 | Bq/m**2/s | Bq=becquerel (disintegrations/s) |

Messages tracking progress of run
written to the screen ?
(IMESG) Default: 2 ! IMESG = 2 !
0 = no
1 = yes (advection step, puff ID)
2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)

SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

---- CONCENTRATIONS ---- ------ DRY FLUXES ------ ------ WET FLUXES ------ -- MASS FLUX --
SPECIES
/GROUP PRINTED? SAVED ON DISK? PRINTED? SAVED ON DISK? PRINTED? SAVED ON DISK? SAVED ON DISK?
------- ------------------------ ------------------------ ------------------------ ---------------
! GROUP_1 = 0, 1, 1, 1, 0, 0, 0 !
! GROUP_2 = 0, 1, 1, 1, 0, 0, 0 !

Note: Species BCON (for MBCON > 0) does not need to be saved on disk.

OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

Logical for debug output
(LDEBUG) Default: F ! LDEBUG = F !

First puff to track
(IPFDEB) Default: 1 ! IPFDEB = 1 !

Number of puffs to track
(NPFDEB) Default: 1 ! NPFDEB = 1000 !

Met. period to start output
(NN1) Default: 1 ! NN1 = 1 !

Met. period to end output
(NN2) Default: 10 ! NN2 = 10 !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
Number of terrain features (NHILL) Default: 0 ! NHILL = 0 !

Number of special complex terrain
receptors (NCTREC) Default: 0 ! NCTREC = 0 !

Terrain and CTSG Receptor data for
CTSG hills input in CTDM format ?
(MHILL) No Default ! MHILL = 2 !
1 = Hill and Receptor data created
by CTDM processors & read from
HILL.DAT and HILLRCT.DAT files
2 = Hill data created by OPTHILL &
input below in Subgroup (6b);
Receptor data in Subgroup (6c)

Factor to convert horizontal dimensions Default: 1.0 ! XHILL2M = 1.0 !
to meters (MHILL=1)

Factor to convert vertical dimensions Default: 1.0 ! ZHILL2M = 1.0 !
to meters (MHILL=1)

X-origin of CTDM system relative to No Default ! XCTDMKM = 0.0 !
CALPUFF coordinate system, in Kilometers (MHILL=1)

Y-origin of CTDM system relative to No Default ! YCTDMKM = 0.0 !
CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

1 **
HILL information

HILL XC YC THETAH ZGRID RELIEF EXPO 1 EXPO 2 SCALE 1 SCALE 2 AMAX1 AMAX2
NO. (km) (km) (deg.) (m) (m) (m) (m) (m) (m) (m) (m)
---- ---- ---- ------ ----- ------ ------ ------ ------- ------- ----- -----

---------------
Subgroup (6c)
---------------

COMPLEX TERRAIN RECEPTOR INFORMATION

XRCT YRCT ZRCT XHH
(km) (km) (m)
------ ----- ------ ----

-------------------
1
Description of Complex Terrain Variables:
XC, YC = Coordinates of center of hill
THETAH = Orientation of major axis of hill (clockwise from North)
ZGRID = Height of the 0 of the grid above mean sea level
RELIEF = Height of the crest of the hill above the grid elevation
EXPO 1 = Hill-shape exponent for the major axis
EXPO 2 = Hill-shape exponent for the major axis
SCALE 1 = Horizontal length scale along the major axis
SCALE 2 = Horizontal length scale along the minor axis
AMAX = Maximum allowed axis length for the major axis
BMAX = Maximum allowed axis length for the major axis

XRCT, YRCT = Coordinates of the complex terrain receptors
ZRCT = Height of the ground (MSL) at the complex terrain Receptor
XHH = Hill number associated with each complex terrain receptor
(NOTE: MUST BE ENTERED AS A REAL NUMBER)

**
NOTE: DATA for each hill and CTSG receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

---------------------------------------------------------------------------------

INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

SPECIES DIFFUSIVITY ALPHA STAR REACTIVITY MESOPHYLL RESISTANCE HENRY'S LAW COEFFICIENT
NAME (cm**2/s) (s/cm) (dimensionless)
------- ----------- ---------- ---------- -------------------- ----------------------
* DRYGAS = *

!END!

---------------------------------------------------------------------------------

INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

For SINGLE SPECIES, the mean and standard deviation are used to compute a deposition velocity for NINT (see group 9) size-ranges, and these are then averaged to obtain a mean deposition velocity.

For GROUPED SPECIES, the size distribution should be explicitly specified (by the 'species' in the group), and the standard deviation for each should be entered as 0. The model will then use the deposition velocity for the stated mean diameter.

SPECIES GEOMETRIC MASS MEAN GEOMETRIC STANDARD
NAME DIAMETER DEVIATION
(microns) (microns)
------- ------------------- ------------------
! 1 = 31.5, 0 !
! 2 = 31.5, 0 !

!END!

---------------------------------------------------------------------------------

INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

Reference cuticle resistance (s/cm)
(RCUTR) Default: 30 ! RCUTR = 30 !
Reference ground resistance (s/cm)
(RGR) Default: 10 ! RGR = 10 !
Reference pollutant reactivity
(REACTR) Default: 8 ! REACTR = 8 !

Number of particle-size intervals used to evaluate effective particle deposition velocity
(NINT) Default: 9 ! NINT = 9 !

Vegetation state in unirrigated areas
(IVEG) Default: 1 ! IVEG = 1 !
IVEG=1 for active and unstressed vegetation
IVEG=2 for active and stressed vegetation
IVEG=3 for inactive vegetation

!END!

---------------------------------------------------------------------------------

INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

Scavenging Coefficient -- Units: (sec)**(-1)

Pollutant Liquid Precip. Frozen Precip.
--------- -------------- --------------
* WETDEPOS = *
!END!

---------------------------------------------------------------------------------

INPUT GROUP: 11a, 11b -- Chemistry Parameters
---------------------

---------------
Subgroup (11a)

```
---------------

     Several parameters are needed for one or more of the
chemical transformation
     mechanisms.  Those used for each mechanism are:
                                                      S
                                M              B R O
                                A B R R R   C H 4 B
N
                           B   V C N N N M K - - C O
D
                           C M G K I I I H H I I K F V
E
                         M K N N N T T T 2 2 S S P R
C C
                         O O H H H E E E O O R R M
A N A
     Mechanism (MCHEM)       Z 3 3 3 3 1 2 3 2 2 P
P F C X Y
     --------------------   --------------------------------------
------------
     0 None                .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
     1 MESOPUFF II           X X . . X X X X . . . . .
. . .
     2 User Rates            .  .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
     3 RIVAD               X X . . X . . . . . . . . . .
.
     4 SOA                 X X . . . . . . . . . . X X X
.
     5 Radioactive Decay     .  .  .  .  .  .  .  .  .  .  .  .  .  .  .
X
     6 RIVAD/ISORRPIA        X X X X X X . . X X X
X . . . .
     7 RIVAD/ISORRPIA/SOA     X X X X X X . . X X
X X X X . .


     Ozone data input option (MOZ)     Default: 1            !
MOZ =  1 !
     (Used only if MCHEM = 1,3,4,6 or 7)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations in ppb (BCKO3)
     (Used only if MCHEM = 1,3,4,6, or 7 and either
        MOZ = 0, or
        MOZ = 1 and all hourly O3 data missing)
                                Default: 12*80.
     ! BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00, 80.00, 80.00, 80.00 !

     Ammonia data option (MNH3)        Default: 0            !
MNH3 = 0 !
     (Used only if MCHEM = 6 or 7)
        0 = use monthly background ammonia values
(BCKNH3) - no vertical variation
        1 = read monthly background ammonia values for
each layer from
            the NH3Z.DAT data file

     Ammonia vertical averaging option (MAVGNH3)
     (Used only if MCHEM = 6 or 7, and MNH3 = 1)
        0 = use NH3 at puff center height (no averaging is
done)
        1 = average NH3 values over vertical extent of puff
                                Default: 1           ! MAVGNH3
= 1 !

     Monthly ammonia concentrations in ppb (BCKNH3)
     (Used only if MCHEM = 1 or 3, or
              if MCHEM = 6 or 7, and MNH3 = 0)
                                Default: 12*10.
     ! BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00 !

     Nighttime SO2 loss rate in %/hour (RNITE1)
     (Used only if MCHEM = 1, 6 or 7)
     This rate is used only at night for MCHEM=1
     and is added to the computed rate both day
     and night for MCHEM=6,7 (heterogeneous reactions)
                                Default: 0.2         ! RNITE1 =
0.2 !

     Nighttime NOx loss rate in %/hour (RNITE2)
     (Used only if MCHEM = 1)
                                Default: 2.0         ! RNITE2 =
2 !

     Nighttime HNO3 formation rate in %/hour (RNITE3)
     (Used only if MCHEM = 1)
                                Default: 2.0         ! RNITE3 =
2 !

     H2O2 data input option (MH2O2)    Default: 1
! MH2O2 = 1 !
     (Used only if MCHEM = 6 or 7, and MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations in ppb (BCKH2O2)
     (Used only if MQACHEM = 1 and either
        MH2O2 = 0 or
        MH2O2 = 1 and all hourly H2O2 data missing)
                                Default: 12*1.
     ! BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00, 1.00, 1.00, 1.00 !

 --- Data for ISORROPIA Option
     (used only if MCHEM = 6 or 7)

     Minimum relative humidity used in ISORROPIA
computations (RH_ISRP)
                                Default: 50.         ! RH_ISRP
= 50.0 !
                                Units: %

     Minimum SO4 used in ISORROPIA computations
(SO4_ISRP)
                                Default: 0.4         ! SO4_ISRP
= 0.4 !
                                Units: ug/m3

  --- Data for SECONDARY ORGANIC AEROSOL (SOA)
Options
     (used only if MCHEM = 4 or 7)

     The MCHEM = 4 SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3
(BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)

     The MCHEM = 7 SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3
(BCKPMF)
          Organic fraction of fine particulate     (OFRAC)

     These characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month   1    2    3    4    5    6    7    8    9   10   11
12
              Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep
Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
1.   1.
         OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20
.20  .20  .15
         VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.
50.  50.  50.
```

Clean Marine (surface)
BCKPMF .5 .5 .5 .5 .5 .5 .5 .5 .5 .5 .5 .5
OFRAC .25 .25 .30 .30 .30 .30 .30 .30 .30 .30 .30 .25
VCNX 50. 50. 50. 50. 50. 50. 50. 50. 50. 50. 50. 50.

Urban - low biogenic (controls present)
BCKPMF 30. 30. 30. 30. 30. 30. 30. 30. 30. 30. 30. 30.
OFRAC .20 .20 .25 .25 .25 .25 .25 .25 .20 .20 .20 .20
VCNX 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.

Urban - high biogenic (controls present)
BCKPMF 60. 60. 60. 60. 60. 60. 60. 60. 60. 60. 60. 60.
OFRAC .25 .25 .30 .30 .30 .55 .55 .55 .35 .35 .35 .25
VCNX 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15.

Regional Plume
BCKPMF 20. 20. 20. 20. 20. 20. 20. 20. 20. 20. 20. 20.
OFRAC .20 .20 .25 .35 .25 .40 .40 .40 .30 .30 .30 .20
VCNX 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15. 15.

Urban - no controls present
BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
OFRAC .30 .30 .35 .35 .35 .55 .55 .55 .35 .35 .35 .30
VCNX 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.

Default: Clean Continental
! BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !
! OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15 !
! VCNX = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00 !

--- End Data for SECONDARY ORGANIC AEROSOL (SOA) Options

Number of half-life decay specification blocks provided in Subgroup 11b
(Used only if MCHEM = 5)
(NDECAY) Default: 0 ! NDECAY = 0 !

!END!

--------------
Subgroup (11b)
--------------

Each species modeled may be assigned a decay half-life (sec), and the associated
mass lost may be assigned to one or more other modeled species using a mass yield
factor. This information is used only for MCHEM=5.

Provide NDECAY blocks assigning the half-life for a parent species and mass yield
factors for each child species (if any) produced by the decay.
Set HALF_LIFE=0.0 for NO decay (infinite half-life).

a b

SPECIES Half-Life Mass Yield
NAME (sec) Factor
------- --------- ----------
* SPECHLLIST = *

--------
a
Specify a half life that is greater than or equal to zero for 1 parent species
in each block, and set the yield factor for this species to -1
b
Specify a yield factor that is greater than or equal to zero for 1 or more child
species in each block, and set the half-life for each of these species to -1

NOTE: Assignments in each block are treated as a separate input
subgroup and therefore must end with an input group terminator.
If NDECAY=0, no assignments and input group terminators should appear.

-------------------------------------------------------------------------------

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

Horizontal size of puff (m) beyond which
time-dependent dispersion equations (Heffter)
are used to determine sigma-y and
sigma-z (SYTDEP) Default: 550. ! SYTDEP = 550 !

Switch for using Heffter equation for sigma z
as above (0 = Not use Heffter; 1 = use Heffter
(MHFTSZ) Default: 0 ! MHFTSZ = 0 !

Stability class used to determine plume
growth rates for puffs above the boundary
layer (JSUP) Default: 5 ! JSUP = 5 !

Vertical dispersion constant for stable
conditions (k1 in Eqn. 2.7-3) (CONK1) Default: 0.01 ! CONK1 = 0.01 !

Vertical dispersion constant for neutral/
unstable conditions (k2 in Eqn. 2.7-4)
(CONK2) Default: 0.1 ! CONK2 = 0.1 !

Factor for determining Transition-point from
Schulman-Scire to Huber-Snyder Building Downwash
scheme (SS used for Hs <Hb + TBD * HL)
(TBD) Default: 0.5 ! TBD = 0.5 !
TBD <0 ==> always use Huber-Snyder
TBD = 1.5 ==> always use Schulman-Scire
TBD = 0.5 ==> ISC Transition-point

Range of land use categories for which
urban dispersion is assumed
(IURB1, IURB2) Default: 10 ! IURB1 = 10 !
19 ! IURB2 = 19 !

Site characterization parameters for single-point Met data files ---------
(needed for METFM = 2,3,4,5)

Land use category for modeling domain

(ILANDUIN) Default: 20 !
ILANDUIN = 20 !

Roughness length (m) for modeling domain
(Z0IN) Default: 0.25 ! Z0IN
= .25 !

Leaf area index for modeling domain
(XLAIIN) Default: 3.0 !
XLAIIN = 3.0 !

Elevation above sea level (m)
(ELEVIN) Default: 0.0 !
ELEVIN = .0 !

Latitude (degrees) for met location
(XLATIN) Default: -999. !
XLATIN = -999.0 !

Longitude (degrees) for met location
(XLONIN) Default: -999. !
XLONIN = -999.0 !

Specialized information for interpreting single-point
Met data files -----

Anemometer height (m) (Used only if METFM = 2,3)
(ANEMHT) Default: 10. !
ANEMHT = 10.0 !

Form of lateral turbulance data in PROFILE.DAT file
(Used only if METFM = 4,5 or MTURBVW = 1 or 3)
(ISIGMAV) Default: 1 !
ISIGMAV = 1 !
0 = read sigma-theta
1 = read sigma-v

Choice of mixing heights (Used only if METFM = 4)
(IMIXCTDM) Default: 0 !
IMIXCTDM = 0 !
0 = read PREDICTED mixing heights
1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN) Default: 1.0 !
XMXLEN = 1 !

Maximum travel distance of a puff/slug (in
grid units) during one sampling step
(XSAMLEN) Default: 1.0 !
XSAMLEN = 1 !

Maximum Number of slugs/puffs release from
one source during one time step
(MXNEW) Default: 99 !
MXNEW = 99 !

Maximum Number of sampling steps for
one puff/slug during one time step
(MXSAM) Default: 99 !
MXSAM = 99 !

Number of iterations used when computing
the transport wind for a sampling step
that includes gradual rise (for CALMET
and PROFILE winds)
(NCOUNT) Default: 2 !
NCOUNT = 2 !

Minimum sigma y for a new puff/slug (m)
(SYMIN) Default: 1.0 !
SYMIN = 1 !

Minimum sigma z for a new puff/slug (m)
(SZMIN) Default: 1.0 !
SZMIN = 1 !

Maximum sigma z (m) allowed to avoid
numerical problem in calculating virtual
time or distance. Cap should be large
enough to have no influence on normal events.
Enter a negative cap to disable.
(SZCAP_M) Default: 5.0e06 !
SZCAP_M = 5000000 !

Default minimum turbulence velocities sigma-v and
sigma-w
for each stability class over land and over water (m/s)
(SVMIN(12) and SWMIN(12))

---------- LAND ---------- ---------
WATER ----------
Stab Class : A B C D E F A B C
D E F
--- --- --- --- --- --- --- --- --- ---
--- ---
Default SVMIN : .50, .50, .50, .50, .50, .50, .37,
.37, .37, .37, .37, .37
Default SWMIN : .20, .12, .08, .06, .03, .016, .20,
.12, .08, .06, .03, .016

! SVMIN = 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37,
0.37, 0.37, 0.37, 0.37 !
! SWMIN = 0.2, 0.12, 0.08, 0.06, 0.03, 0.016,
0.2, 0.12, 0.08, 0.06, 0.03, 0.016 !

Divergence criterion for dw/dz across puff
used to initiate adjustment for horizontal
convergence (1/s)
Partial adjustment starts at CDIV(1), and
full adjustment is reached at CDIV(2)
(CDIV(2)) Default: 0.0,0.0 !
CDIV = 0, 0 !

Search radius (number of cells) for nearest
land and water cells used in the subgrid
TIBL module
(NLUTIBL) Default: 4 !
NLUTIBL = 4 !

Minimum wind speed (m/s) allowed for
non-calm conditions. Also used as minimum
speed returned when using power-law
extrapolation toward surface
(WSCALM) Default: 0.5 !
WSCALM = 0.5 !

Maximum mixing height (m)
(XMAXZI) Default: 3000. !
XMAXZI = 3000 !

Minimum mixing height (m)
(XMINZI) Default: 50. !
XMINZI = 50 !

Temperatures (K) used for defining upper bound of
categories for emissions scale-factors
11 upper bounds (K) are entered; the 12th class has
no upper limit
(TKCAT(11))
Default : 265., 270., 275., 280., 285., 290.,
295., 300., 305., 310., 315. (315.+)
<< << << << <<
<Temperature Class : 1 2 3 4 5 6 7 8
9 10 11 (12)
---- ---- ---- ---- ---- ---- ---- ---
- ---- ---- ----
! TKCAT = 265., 270., 275., 280., 285., 290.,
295., 300., 305., 310., 315. !

Default wind speed profile power-law
exponents for stabilities 1-6
(PLX0(6)) Default : ISC RURAL values
ISC RURAL : .07, .07, .10, .15,
.35, .55

ISC URBAN : .15, .15, .20, .25, .30, .30

Stability Class : A B C D E F
--- --- --- --- --- ---
! PLX0 = 0.07, 0.07, 0.1, 0.15, 0.35, 0.55 !

Default potential temperature gradient
for stable classes E, F (degK/m)
(PTG0(2)) Default: 0.020, 0.035
! PTG0 = 0.02, 0.035 !

Default plume path coefficients for
each stability class (used when option
for partial plume height terrain adjustment
is selected -- MCTADJ=3)
(PPC(6)) Stability Class : A B C D E F
Default PPC : .50, .50, .50, .50, .35, .35
--- --- --- --- --- ---
! PPC = 0.5, 0.5, 0.5, 0.5, 0.35, 0.35 !

Slug-to-puff transition criterion factor
equal to sigma-y/length of slug
(SL2PF) Default: 10. ! SL2PF = 10 !

Receptor-specific puff/slug properties (e.g., sigmas and height above
ground at the time when the trajectory is nearest the receptor) may be
extrapolated forward or backward in time along the current step using
the current dispersion, for receptors that lie upwind of the puff/slug
position at the start of a step, or downwind at the end of a step.
Specify the upwind/downwind extrapolation zone in sigma-y units.
Using FCLIP=1.0 clips the the upwind zone at one sigma-y at the start
of the step and the downwind zone at one sigma-y at the end of the step.
This is consistent with the sampling done in CALPUFF versions through
v6.42 prior to the introduction of the FCLIP option.
The default is No Extrapolation, FCLIP=0.0.
(FCLIP) Default: 0.0 ! FCLIP = 0 !

Puff-splitting control variables ------------------------

VERTICAL SPLIT
--------------

Number of puffs that result every time a puff
is split - nsplit=2 means that 1 puff splits
into 2
(NSPLIT) Default: 3 ! NSPLIT = 3 !

Time(s) of a day when split puffs are eligible to
be split once again; this is typically set once
per day, around sunset before nocturnal shear develops.
24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
0=do not re-split 1=eligible for re-split
(IRESPLIT(24)) Default: Hour 17 = 1
! IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

Split is allowed only if last hour's mixing
height (m) exceeds a minimum value
(ZISPLIT) Default: 100. ! ZISPLIT = 100 !

Split is allowed only if ratio of last hour's
mixing ht to the maximum mixing ht experienced
by the puff is less than a maximum value (this
postpones a split until a nocturnal layer develops)
(ROLDMAX) Default: 0.25 ! ROLDMAX = 0.25 !

HORIZONTAL SPLIT
----------------

Number of puffs that result every time a puff
is split - nsplith=5 means that 1 puff splits
into 5
(NSPLITH) Default: 5 ! NSPLITH = 5 !

Minimum sigma-y (Grid Cells Units) of puff
before it may be split
(SYSPLITH) Default: 1.0 ! SYSPLITH = 1 !

Minimum puff elongation rate (SYSPLITH/hr) due to
wind shear, before it may be split
(SHSPLITH) Default: 2. ! SHSPLITH = 2 !

Minimum concentration (g/m^3) of each
species in puff before it may be split
Enter array of NSPEC values; if a single value is
entered, it will be used for ALL species
(CNSPLITH) Default: 1.0E-07 ! CNSPLITH = 0 !

Integration control variables ------------------------

Fractional convergence criterion for numerical SLUG
sampling integration
(EPSSLUG) Default: 1.0e-04 ! EPSSLUG = 0.0001 !

Fractional convergence criterion for numerical AREA
source integration
(EPSAREA) Default: 1.0e-06 ! EPSAREA = 1E-006 !

Trajectory step-length (m) used for numerical rise
integration
(DSRISE) Default: 1.0 ! DSRISE = 1.0 !

Boundary Condition (BC) Puff control variables ------------------------

Minimum height (m) to which BC puffs are mixed as they are emitted
(MBCON=2 ONLY). Actual height is reset to the current mixing height
at the release point if greater than this minimum.
(HTMINBC) Default: 500. ! HTMINBC = 500 !

Search radius (km) about a receptor for sampling nearest BC puff.
BC puffs are typically emitted with a spacing of one grid cell
length, so the search radius should be greater than DGRIDKM.
(RSAMPBC) Default: 10. ! RSAMPBC = 10 !

Near-Surface depletion adjustment to concentration profile used when

sampling BC puffs?
(MDEPBC) Default: 1 ! MDEPBC = 1 !
0 = Concentration is NOT adjusted for depletion
1 = Adjust Concentration for depletion

!END!

-------------------------------------------------------------------------------

INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

Number of point sources with
parameters provided below (NPT1) No default ! NPT1 = 0 !

Units used for point source
emissions below (IPTU) Default: 1 ! IPTU = 1 !
1 = g/s
2 = kg/hr
3 = lb/hr
4 = tons/yr
5 = Odour Unit * m**3/s (vol. flux of odour compound)
6 = Odour Unit * m**3/min
7 = metric tons/yr
8 = Bq/s (Bq = becquerel = disintegrations/s)
9 = GBq/yr

Number of source-species
combinations with variable
emissions scaling factors
provided below in (13d) (NSPT1) Default: 0 ! NSPT1 = 0 !

Number of point sources with
variable emission parameters
provided in external file (NPT2) No default ! NPT2 = 0 !

(If NPT2 > 0, these point
source emissions are read from
the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------

a
POINT SOURCE: CONSTANT DATA
-----------------------------

b c
Source X Y Stack Base Stack Exit Exit Bldg. Emission
No. Coordinate Coordinate Height Elevation Diameter Vel. Temp. Dwash Rates
(km) (km) (m) (m) (m) (m/s) (deg. K)
------ ---------- ---------- ------ ------ -------- ----- -------- ----- --------

--------

a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source
(No default)
X is an array holding the source data listed by the column headings
(No default)
SIGYZI is an array holding the initial sigma-y and sigma-z (m)
(Default: 0.,0.)
FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent
the effect of rain-caps or other physical configurations that
reduce momentum rise associated with the actual exit velocity.
(Default: 1.0 -- full momentum used)
ZPLTFM is the platform height (m) for sources influenced by an isolated
structure that has a significant open area between the surface
and the bulk of the structure, such as an offshore oil platform.
The Base Elevation is that of the surface (ground or ocean),
and the Stack Height is the release height above the Base (not
above the platform). Building heights entered in Subgroup 13c
must be those of the buildings on the platform, measured from
the platform deck. ZPLTFM is used only with MBDW=1 (ISC
downwash method) for sources with building downwash.
(Default: 0.0)

b
0. = No building downwash modeled
1. = Downwash modeled for buildings resting on the surface
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
NOTE: must be entered as a REAL number (i.e., with decimal point)

c
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are
modeled, but not emitted. Units are specified by IPTU
(e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
-------------------------------------------------------
Source a
No. Effective building height, width, length and X/Y offset (in meters)
every 10 degrees. LENGTH, XBADJ, and YBADJ are only needed for
MBDW=2 (PRIME downwash option)
------ --------------------------------------------------------------------

--------

a
Building height, width, length, and X/Y offset from the source are treated

as a separate input subgroup for each source and therefore must end with
an input group terminator. The X/Y offset is the position, relative to the
stack, of the center of the upwind face of the projected building, with the
x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------

a
POINT SOURCE: EMISSION-RATE SCALING FACTORS
-------------------------------------------

Use this subgroup to identify temporal variations in the emission
rates given in 13b. Factors assigned multiply the rates in 13b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

Sets of emission-rate scale factors are defined in Input Group 19, and
are referenced by the FACTORNAME. Provide NSPT1 lines that identify the
emission-rate scale factor table for each source-species combination that
uses the scaling option. Note that a scale-factor table can be used with
more than one source-species combination so a FACTORNAME can be repeated.

| Source-Species No. | Source Name b (SRCNAM) | Species Name c (CSPEC) | Scale-factor table Name d (FACTORNAME) |
|---|---|---|---|

--------
a
Assignment for each source-specie is treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Source name must match one of the SRCNAM names defined in Input Group 13b
c
Species name must match one of the CSPEC names of emitted species defined in Input Group 3
d
Scale-factor name must match one of the FACTORNAME names defined in Input Group 19

-------------------------------------------------------------------------------

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

Number of polygon area sources with
parameters specified below (NAR1) No default ! NAR1 = 0 !

Units used for area source
emissions below (IARU) Default: 1 ! IARU = 1 !
1 = g/m**2/s
2 = kg/m**2/hr
3 = lb/m**2/hr
4 = tons/m**2/yr
5 = Odour Unit * m/s (vol. flux/m**2 of odour compound)
6 = Odour Unit * m/min
7 = metric tons/m**2/yr
8 = Bq/m**2/s (Bq = becquerel = disintegrations/s)
9 = GBq/m**2/yr

Number of source-species
combinations with variable
emissions scaling factors
provided below in (14d) (NSAR1) Default: 0 ! NSAR1 = 0 !

Number of buoyant polygon area sources
with variable location and emission
parameters (NAR2) No default ! NAR2 = 0 !
(If NAR2 > 0, ALL parameter data for
these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------

a
AREA SOURCE: CONSTANT DATA
----------------------------

| Source No. | Effect. Height (m) | Base Elevation (m) | Initial Sigma z (m) | b Emission Rates |
|---|---|---|---|---|

--------
a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.
b
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are
modeled, but not emitted. Units are specified by IARU
(e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
--------------------------------------------------------

| Source No. | Ordered list of X followed by list of Y, grouped by source a |
|---|---|

--------
a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

---------------
Subgroup (14d)
---------------

a
AREA SOURCE: EMISSION-RATE SCALING FACTORS
-------------------------------------------

Use this subgroup to identify temporal variations in the emission
rates given in 14b. Factors assigned multiply the rates in 14b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

Sets of emission-rate scale factors are defined in Input Group 19, and
are referenced by the FACTORNAME. Provide NSAR1 lines that identify the
emission-rate scale factor table for each source-species combination that
uses the scaling option. Note that a scale-factor table can be used with
more than one source-species combination so a FACTORNAME can be repeated.

Source- Source Species Scale-factor table
Species Name b Name c Name d
No. (SRCNAM) (CSPEC) (FACTORNAME)
------ ------------ ------------ --------------------
-

--------
a
Data for each species are treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Source name must match one of the SRCNAM names defined in Input Group 14b
c
Species name must match one of the CSPEC names of emitted species defined in Input Group 3
d
Scale-factor name must match one of the FACTORNAME names defined in Input Group 19

---------------------------------------------------------------
---------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
--------------------------

---------------
Subgroup (15a)
---------------

Number of buoyant line sources
with variable location and emission
parameters (NLN2) No default ! NLN2 = 0 !

(If NLN2 > 0, ALL parameter data for
these sources are read from the file: LNEMARB.DAT)

Number of buoyant line sources (NLINES) No default ! NLINES = 0 !

Units used for line source
emissions below (ILNU) Default: 1 ! ILNU = 1 !
1 = g/s
2 = kg/hr
3 = lb/hr
4 = tons/yr
5 = Odour Unit * m**3/s (vol. flux of odour compound)
6 = Odour Unit * m**3/min
7 = metric tons/yr
8 = Bq/s (Bq = becquerel = disintegrations/s)
9 = GBq/yr

Number of source-species
combinations with variable
emissions scaling factors
provided below in (15c) (NSLN1) Default: 0 ! NSLN1 = 0 !

Maximum number of segments used to model
each line (MXNSEG) Default: 7 ! MXNSEG = 7 !

The following variables are required only if NLINES > 0. They are
used in the buoyant line source plume rise calculations.

Number of distances at which Default: 6 ! NLRISE = 6 !
transitional rise is computed

Average building length (XL) No default * XL = *
(in meters)

Average building height (HBL) No default * HBL = *
(in meters)

Average building width (WBL) No default * WBL = *
(in meters)

Average line source width (WML) No default * WML = *
(in meters)

Average separation between buildings (DXL) No default * DXL = *
(in meters)

Average buoyancy parameter (FPRIMEL) No default * FPRIMEL = *
(in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

BUOYANT LINE SOURCE: CONSTANT DATA
----------------------------------

a
Source Beg. X Beg. Y End. X End. Y Release Base Emission
No. Coordinate Coordinate Coordinate Coordinate Height Elevation Rates
(km) (km) (km) (km) (m) (m)
------ ---------- ---------- --------- ---------- ------- ---------- ---------

--------

a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

b
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are
modeled, but not emitted. Units are specified by ILNTU
(e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------

a
BUOYANT LINE SOURCE: EMISSION-RATE SCALING FACTORS
-------------------------------------------------

Use this subgroup to identify temporal variations in the emission
rates given in 15b. Factors assigned multiply the rates in 15b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use LNEMARB.DAT and NLN2 > 0.

Sets of emission-rate scale factors are defined in Input Group 19, and
are referenced by the FACTORNAME. Provide NSLN1 lines that identify the
emission-rate scale factor table for each source-species combination that
uses the scaling option. Note that a scale-factor table can be used with
more than one source-species combination so a FACTORNAME can be repeated.

Source- Source Species Scale-factor table
Species Name b Name c Name d
No. (SRCNAM) (CSPEC) (FACTORNAME)
------ ------------ ------------ ---------------------

--------
a
Data for each species are treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Source name must match one of the SRCNAM names defined in Input Group 15b
c
Species name must match one of the CSPEC names of emitted species defined in Input Group 3
d
Scale-factor name must match one of the FACTORNAME names defined in Input Group 19

-------------------------------------------------------------------------------

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
--------------------------

---------------
Subgroup (16a)
---------------

Number of volume sources with
parameters provided in 16b,c (NVL1) No default ! NVL1 = 4157 !

Units used for volume source
emissions below in 16b (IVLU) Default: 1 ! IVLU = 1 !
1 = g/s
2 = kg/hr
3 = lb/hr
4 = tons/yr
5 = Odour Unit * m**3/s (vol. flux of odour compound)
6 = Odour Unit * m**3/min
7 = metric tons/yr
8 = Bq/s (Bq = becquerel = disintegrations/s)
9 = GBq/yr

Number of source-species
combinations with variable
emissions scaling factors
provided below in (16c) (NSVL1) Default: 0 ! NSVL1 = 0 !

Number of volume sources with
variable location and emission
parameters (NVL2) No default ! NVL2 = 0 !

(If NVL2 > 0, ALL parameter data for
these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------

a
VOLUME SOURCE: CONSTANT DATA
------------------------------

b
Source X Y Effect. Base Initial Initial Emission
No. Coordinate Coordinate Height Elevation Sigma y Sigma z Rates
(km) (km) (m) (m) (m) (m)
------ ---------- ---------- ------ ------ -------- -------- --------

1 ! SRCNAM = SRC_1_1 !
1 ! X = 296.504, 6399.733, 3.54, 317.63, 7.91, 3.3, 0.0002408, 0 !
!END!
2 ! SRCNAM = SRC_1_2 !
2 ! X = 296.521, 6399.734, 3.54, 317.65, 7.91, 3.3, 0.0002408, 0 !
!END!

**[Volume-Line source parameters for sources 3 to 4152 removed for reporting purposes]**

!END!
4153 ! SRCNAM = SRC_1_4153 !
4153 ! X = 364.562, 6391.321, 3.54, 247.3, 7.91, 3.3, 0.0002408, 0 !
!END!
4154 ! SRCNAM = SRC_2_1 !
4154 ! X = 363.835, 6391.547, 2.5, 253.24, 23.91, 2.33, 0, 0.25 !
!END!
4155 ! SRCNAM = SRC_2_2 !

4155 ! X = 363.785, 6391.561, 2.5, 253.27, 23.91, 2.33, 0, 0.25 !
!END!
4156 ! SRCNAM = SRC_2_3 !
4156 ! X = 363.736, 6391.575, 2.5, 253.3, 23.91, 2.33, 0, 0.25 !
!END!
4157 ! SRCNAM = SRC_2_4 !
4157 ! X = 363.686, 6391.589, 2.5, 253.33, 23.91, 2.33, 0, 0.25 !
!END!

--------
a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

b
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are
modeled, but not emitted. Units are specified by IVLU
(e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
a
VOLUME SOURCE: EMISSION-RATE SCALING FACTORS
-------------------------------------------

Use this subgroup to identify temporal variations in the emission
rates given in 16b. Factors assigned multiply the rates in 16b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

Sets of emission-rate scale factors are defined in Input Group 19, and
are referenced by the FACTORNAME. Provide NSVL1 lines that identify the
emission-rate scale factor table for each source-species combination that
uses the scaling option. Note that a scale-factor table can be used with
more than one source-species combination so a FACTORNAME can be repeated.

| Source-Species No. | Source Name b (SRCNAM) | Species Name c (CSPEC) | Scale-factor table Name d (FACTORNAME) |
|---|---|---|---|
| ------ | ------------ | ------------ | --------------------- |

--------
a
Data for each species are treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Source name must match one of the SRCNAM names defined in Input Group 16b
c
Species name must match one of the CSPEC names of emitted species defined in Input Group 3
d
Scale-factor name must match one of the FACTORNAME names defined in Input Group 19

-------------------------------------------------------------------------------

INPUT GROUP: 17 -- FLARE source control parameters (variable emissions file)
---------------

Number of flare sources defined in FLEMARB.DAT file(s)
(NFL2) Default: 0 ! NFL2 = 0 !

(At least 1 FLEMARB.DAT file is needed if NFL2 > 0)

!END!

-------------------------------------------------------------------------------

INPUT GROUPS: 18a, 18b, 18c -- Road Emissions parameters
---------------------------

---------------
Subgroup (18a)
---------------

Emissions from roads are generated from individual line segments defined
by a sequence of coordinates provided for each road-link. Each link
is entered as a discrete source and is defined as a section of the road
for which emissions are uniform.

A long, winding isolated road might be characterized by a single link made
up of many coordinate triples (x,y,z) that describe its pathway. These
points should be sufficient to resolve curves, but need not have uniform
spacing. For example, a straight flat segment can be defined by 2 points,
regardless of the distance covered. Long line segments are automatically
divided further within the model into segments that are limited by the
grid-cell boundaries (no segment may extend across multiple cells).
One emission rate (g/m/s) for each species is used for the entire road.

Near a congested intersection, many short links may be required to resolve
the spatial and temporal distribution of emissions. Each is entered and
modeled as a discrete source.

Number of road-links with emission parameters
provided in Subgroup 18b (NRD1) No default ! NRD1 = 0 !

Number of road-links with arbitrarily time-varying
emission parameters (NRD2) No default ! NRD2 = 0 !
(If NRD2 > 0, ALL variable road data
are read from the file: RDEMARB.DAT)

Emissions from one or more of the roads presented in Subgroup 18b

may vary over time-based cycles or by meteorology. This variability
is modeled by applying an emission-rate scale factor specified for
particular road links and species in Subgroup 18c.

Number of road links and species combinations
with variable emission-rate scale-factors
(NSFRDS) Default: 0 ! NSFRDS = 0 !

!END!

---------------
Subgroup (18b)
---------------

DATA FOR ROADS WITH CONSTANT OR SCALED EMISSION PARAMETERS [a]
-----------------------------------------------------------

| Road No. | Effect. Height (mAGL) | Initial Sigma z (m) | Initial Sigma y (m) | Emission Rates [b] (g/s/m) |
|---|---|---|---|---|
| c | | | | |

--------
a
Data for each of the NRD1 roads are treated as a separate input subgroup
and therefore must end with an input group terminator.
b
NSPEC Emission rates must be entered (one for every pollutant modeled).
Enter emission rate of zero for secondary pollutants.
c
Road-source names are entered without spaces, and may be 16 characters long.

---------------
Subgroup (18c)
---------------

EMISSION-RATE SCALING FACTORS [a]
------------------------------

Use this subgroup to identify temporal variations in the emission
rates given in 18b. Factors assigned multiply the rates in 18b.
Skip sources here that have constant emissions. For more elaborate
variation in source parameters, use RDEMARB.DAT and NRD2 > 0.

Sets of emission-rate scale factors are defined in Input Group 19, and
are referenced by the FACTORNAME. Provide NSFRDS lines that identify the
emission-rate scale factor table for each source-species combination that
uses the scaling option. Note that a scale-factor table can be used with
more than one source-species combination so a FACTORNAME can be repeated.

| Source-Species No. | Source Name b (SRCNAM) | Species Name c (CSPEC) | Scale-factor table Name d (FACTORNAME) |
|---|---|---|---|

--------
a
Assignment for each source-specie is treated as a separate input subgroup
and therefore must end with an input group terminator.
b
Source name must match one of the SRCNAM names defined in Input Group 18b
c
Species name must match one of the CSPEC names of emitted species defined in Input Group 3
d
Scale-factor name must match one of the FACTORNAME names defined in Input Group 19

---------------
Subgroup (18d)
---------------

COORDINATES FOR EACH NAMED ROAD [a]
-------------------------------

| Coordinate No. | X Coordinate (km) | Y Coordinate (km) | Ground Elevation (m) |
|---|---|---|---|

--------
a
Each line of coordinates is treated as a separate input subgroup
and therefore must end with an input group terminator.

------------------------------------------------------------------------------

INPUT GROUPS: 19a, 19b -- Emission rate scale-factor tables
----------------------

Use this group to enter variation factors applied to emission rates for any
source-specie combinations that use this feature. The tables of emission-rate
scale factors are referenced by the name assigned to FACTORNAME. These names
do not need to include specific source or species names used in the simulation,
particularly if one factor table is used for many types of sources and species,
but should be descriptive. But if a factor table applies to just one source,
the reference name for it should generally contain that source-name.
FACTORNAME must NOT include spaces.

The FACTORTYPE for each table must be one of the following:

CONSTANT1 1 scaling factor
MONTH12 12 scaling factors: months 1-12
DAY7 7 scaling factors: days 1-7
[SUNDAY,MONDAY, ... FRIDAY,SATURDAY]
HOUR24 24 scaling factors: hours 1-24
HOUR24_DAY7 168 scaling factors: hours 1-24,
repeated 7 times: SUNDAY, MONDAY, ... SATURDAY
HOUR24_MONTH12 288 scaling factors: hours 1-24,

                        repeated 12 times: months 1-12
        WSP6               6    scaling factors: wind speed classes 1-6
                        [speed classes (WSCAT) defined in Group 12]
        WSP6_PGCLASS6      36  scaling factors: wind speed classes 1-6
                        repeated  6 times: PG classes A,B,C,D,E,F
                        [speed classes (WSCAT) defined in Group 12]
        TEMPERATURE12      12  scaling factors: temperature classes 1-12
                        [temperature classes (TKCAT) defined in Group 12]

The number of tables defined may exceed the number of tables referenced in the input groups for each source type above (for convenience), but tables for all FACTORNAME names referenced must be present here.

---------------
Subgroup (19a)
---------------

Number of Emission Scale-Factor tables (NSFTAB) Default: 0  ! NSFTAB = 0 !

!END!

---------------
Subgroup (19b)
---------------

a,b,c
Enter factors for NSFTAB Emission Scale-Factor tables

--------
a
Assignments for each table are treated as a separate input subgroup and therefore must end with an input group terminator.
b
FACTORNAME must be no longer than 40 characters
c
Spaces are NOT allowed in any FACTORNAME or FACTORTYPE assignment, and the names are NOT case-sensitive

------------------------------------------------------------------------------

INPUT GROUPS: 20a, 20b, 20c -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (20a)
---------------

Number of non-gridded receptors (NREC)  No default  ! NREC = 0 !

Group names can be used to assign receptor locations in Subgroup 17c and thereby provide an identification that can be referenced when postprocessing receptors. The default assignment name X is used when NRGRP = 0.

Number of receptor group names (NRGRP)  Default: 0  ! NRGRP = 0 !

!END!

---------------
Subgroup (20b)
---------------

Provide a name for each receptor group if NRGRP>0.
Enter NRGRP lines.
a,b
Group Name
----------
* RGRPNAMLIST = *

-------------
a
Each group name provided is treated as a separate input subgroup and therefore must end with an input group terminator.
b
Receptor group names must not include blanks.

---------------
Subgroup (20c)
---------------

a
NON-GRIDDED (DISCRETE) RECEPTOR DATA
------------------------------------

|  | c | X | Y | Ground | Height b |
|---|---|---|---|---|---|
| Receptor | Group | Coordinate | Coordinate | Elevation | Above Ground |
| No. | Name | (km) | (km) | (m) | (m) |
| -------- | ----- | ---------- | ---------- | --------- | ------------ |

-------------
a
Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

b
Receptor height above ground is optional.  If no value is entered, the receptor is placed on the ground.
c
Receptors can be assigned using group names provided in 17b.  If no group names are used (NRGRP=0) then the default assignment name X must be used.