APPENDIX D

CALPUFF Methodology

Table of Contents

List of Tables

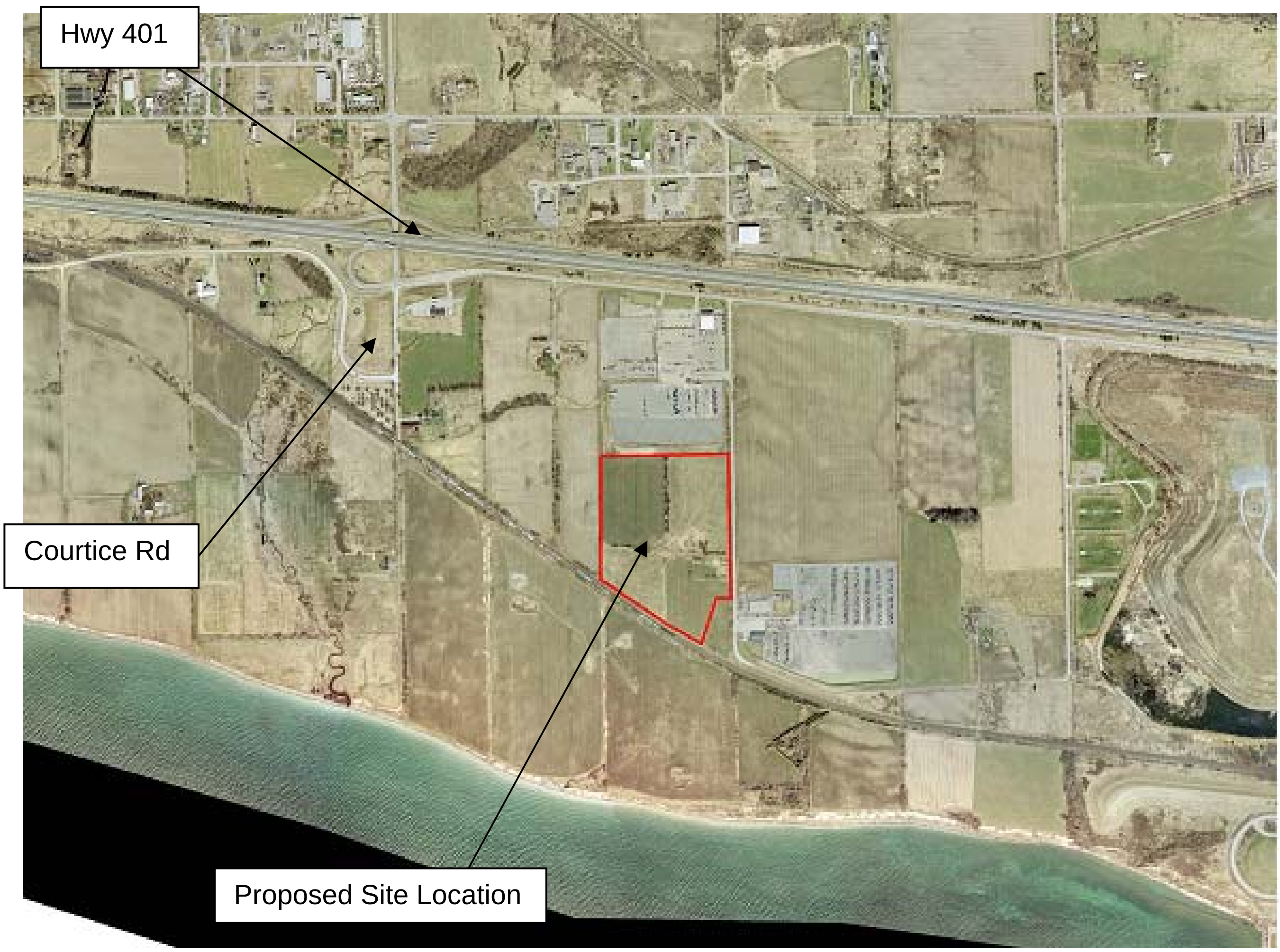
List of Figures

List of Attachments

1.0 INTRODUCTION

Jacques Whitford is currently conducting an Environmental Assessment (EA) of a proposed residual waste thermal treatment facility on behalf of the Regions of Durham and York. The proposed site is located near the town of Clarington, approximately 2 km west of the Darlington nuclear power plant and within 1 km of the shore of Lake Ontario. The land use and features surrounding the proposed site location are shown in Figure D1-1.

Figure D1-1 Proposed Site Location and Surrounding Region



To quantitatively assess potential changes in air quality and health due to Project-related emissions, dispersion modelling was conducted to predict maximum ground-level concentrations (GLC) and deposition rates in the Study Area (as defined in the main report). In consultation with the Ontario MOE (Liu, personal communication, Jan 23, 2009), the California PUFF (CALPUFF) modelling system was selected to conduct the predictive modelling of expected Project emissions.

This appendix provides the technical details and assumptions regarding the dispersion and deposition modelling conducted for air quality assessment. The following is a technical description of the CALPUFF model, and an overview of the initialization and parameterization of this model for this application. The results of the dispersion modelling can be found in the main body of this report.

1.1 The CALPUFF Modelling System

The core of the CALPUFF modelling system consists of a meteorological model CALMET, and a transport and dispersion model CALPUFF.

The CALMET meteorological model is used to provide the meteorological data necessary to initialize the CALPUFF dispersion model. This model is initialized with terrain and land use data describing the region of interest, as well as meteorological input from potentially numerous sources. Various user-defined parameters control both how the input meteorological data is interpolated to the grid, as well as which internal algorithms are applied to these input fields. More details regarding these options are provided in later sections. Output from the CALMET model includes hourly temperature and wind fields on a user-specified three-dimensional domain as well as additional two-dimensional variables used by the CALPUFF dispersion model.

CALPUFF is a non-steady-state Gaussian puff dispersion model capable of simulating the effects of time and space-varying meteorological conditions on pollutant transport, transformation, and removal. This model requires time-variant two-dimensional and three-dimensional meteorological data output from a model such as CALMET, as well as information regarding the relative location and nature of the sources to be modelled for the application. A more detailed discussion of the available and implemented model options is also provided herein. Output from the CALPUFF model includes ground-level concentrations of the species considered, as well as dry and wet deposition fluxes.

1.2 Model Selection

The CALPUFF model was selected for this study, primarily because of the model's superior ability to account for dispersion in complex environments such as the proposed site location, which is near the shore of Lake Ontario. The Guideline on Air Quality Models (US EPA 2009a) recommends the use of CALPUFF over other regulatory dispersion models for applications where the terrain contains relief, the ground cover is not uniform, where wind circulation may driven by lake or sea breezes, flow along coastlines, such that the assumption of steady-state straight line transport is not appropriate.

CALPUFF is accepted by the Ontario MOE as an alternative model requiring site-specific consideration and approval (MOE 2009a). To this end, extensive pre-consultation for the purposes of the Environmental Assessment (EA) was conducted with the MOE to ensure that the input data and model parameterizations selected for the EA study were appropriate (Liu, personal communication, Jan 23, 2009). The MOE requested that form #5352 requesting the use of the CALPUFF modelling system as an alternate model be completed and submitted for this project. This form was provided as an attachment to the proposed CALMET work plan document, submitted to the Ontario MOE on November 19, 2008 (JW, 2008a) and is included in this document for informational purposes in Attachment D-1. It should be noted that the air quality technical study conducted for the EA is separate from the certificate of approval process that would be required for the Facility under O. Reg. 419, and the completion of form #5352 for the use of CALPUFF was specific to this assessment. The Reg. 419 permitting for the Facility will involve a separate study and review process at a later date if approval of the EA for the project is granted.

In addition to the CALMET work plan submitted to the MOE on November 19, 2008, a work plan for the CALPUFF modelling portion of the air quality assessment was also submitted to the MOE for review and approval on February 5, 2009. The CALPUFF methodology was reviewed and approved by the MOE.

1.3 Overview of Contents

This appendix is a supporting document to the air quality main report, which in turn provides information for the EA conducted for this Project. The contents of this appendix are organized into four major sections, as follows.

- Section 1 is a general introduction and background information about this Technical Supplement.
- Section 2 provides a description of the CALMET meteorological model, details concerning the initialization and parameterization of the model for this study, and a summary of the CALMET outputs.
- Section 3 provides a description of the CALPUFF dispersion model and details concerning the initialization and parameterization of the model for this study.
- Section 4 contains a discussion on model prediction confidence.

This appendix is part of, and should be read in conjunction with, the main body of the report prepared for the Project.

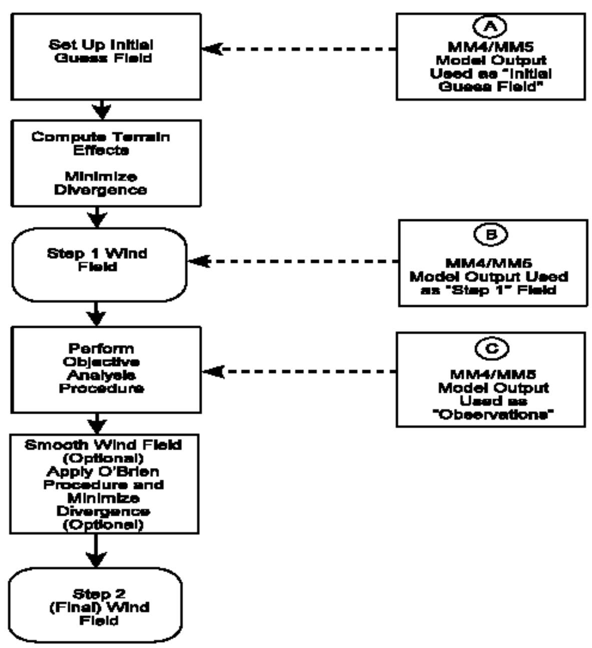
2.0 CALMET MODELLING

2.1 Model Description

The following description of the CALMET model's major model algorithms and options are all excerpts from the CALMET model's user manual (Scire et al., 2000a).

The CALMET meteorological model consists of a diagnostic wind field module and micrometeorological modules for overwater and overland boundary layers. The diagnostic wind field module uses a two-step approach to the computation of the wind fields (Douglas and Kessler, 1988), as illustrated in Figure D2-1.

Figure D2-1 Flow Diagram of Diagnostic Wind Module in CALMET



Source: Scire et al., 2000a

In the first step, an initial guess wind field is adjusted for kinematic effects of terrain, slope flows, and terrain blocking effects to produce a Step 1 wind field. The initial guess field is either a uniform field based on available observational data or the output from the NCAR/PSU Mesoscale Modelling System (MM4/MM5). The second step consists of an objective analysis procedure to introduce observational data into the Step 1 wind field to produce a final wind field. An option is provided to allow gridded prognostic wind fields to be used by CALMET, which may better represent regional flows and certain aspects of sea breeze circulations and slope/valley circulations. Wind fields generated by the prognostic wind field module can be input to CALMET as either the initial guess field or the Step 1 wind field.

2.1.1 Diagnostic Wind Field Module

2.1.1.1 Initial Guess Field

Options existing with CALMET to create an initial guess field either by interpolating observation data or by using output from a prognostic meteorological model, such as the NCAR/PSU Mesoscale Modelling System (MM4/MM5). The prognostic model data is usually run over a very large domain with much coarser resolution than that applied with CALMET. CALMET will interpolate the prognostic data to develop a 3-D (three-dimensional) fine scale first guess field of wind speeds and directions.

2.1.1.2 Step 1 Wind Field

The step one wind field is adjusted for kinematic effects of terrain, slope flows, and blocking effects as follows:

Kinematic Effects of Terrain: The approach of Liu and Yocke (1980) is used to evaluate kinematic terrain effects. The domain-scale winds are used to compute a terrain-forced vertical velocity, subject to an exponential, stability-dependent decay function. The kinematic effects of terrain on the horizontal wind components are evaluated by applying a divergence-minimisation scheme to the initial guess wind field. The divergence minimisation scheme is applied iteratively until the three-dimensional divergence is less than a threshold value.

Slope Flows: An empirical scheme based on Allwine and Whiteman (1985) is used to estimate the magnitude of slope flows in complex terrain. The slope flow is parameterised in terms of the terrain slope, terrain height, domain-scale lapse rate, and time of day. The slope flow wind components are added to the wind field adjusted for kinematic effects.

Blocking Effects: The thermodynamic blocking effects of terrain on the wind flow are parameterised in terms of the local Froude number (Allwine and Whiteman, 1985). If the Froude number at a particular grid point is less than a critical value and the wind has an uphill component, the wind direction is adjusted to be tangent to the terrain.

2.1.1.3 Step 2 Wind Field

The wind field resulting from the adjustments of the initial-guess wind described above is the Step 1 wind field. The second step of the procedure involves the introduction of observational data into the Step 1 wind field through an objective analysis procedure. An inverse-distance squared interpolation scheme is used which weighs observational data heavily in the vicinity of the observational station, while the Step 1 wind field dominates the interpolated wind field in regions with no observational data. The resulting wind field is subject to smoothing, an optional adjustment of vertical velocities based on the O'Brien (1970) method, and divergence minimisation to produce a final Step 2 wind field.

2.1.2 Micrometeorology Modules

The CALMET model contains two boundary layer models for application to overland and overwater grid cells:

Overland Boundary Layer Model: Over land surfaces, the energy balance method of Holtslag and van Ulden (1983) is used to compute hourly gridded fields of the sensible heat flux, surface friction velocity, Monin-Obukhov length, and convective velocity scale. Mixing heights are determined from the computed hourly surface heat fluxes and observed temperature soundings using a modified Carson (1973) method based on Maul (1980). The model also determines gridded fields of PGT stability class and optional hourly precipitation rates.

Overwater Boundary Layer Model: The aerodynamic and thermal properties of water surfaces suggest that a different method is best suited for calculating the boundary layer parameters in the marine environment. A profile technique (Garratt, 1977; Hanna et al., 1985), using air-sea temperature differences, is used in CALMET to compute the micrometeorological parameters in the marine boundary layer.

2.2 Spatial and Temporal Boundaries

In CALPUFF, to consider the dispersion of air contaminants from modelled sources to receptor locations, the corresponding CALMET meteorological modelling domain must cover all relevant sources and receptors. The CALMET meteorological domain adopted for this project is larger than the Air Quality Study Area, covering a 50 by 40 km region centred approximately 5 km north of the site location. The CALMET modelling domain extends approximately 25 km to the west, north, and east of the proposed site location. The domain extends about 15 km to the south. A 250 m grid resolution was used for this application to better depict the variance in meteorological conditions created by the land-sea interface and the coastal marine environment. The specifications of the modelled CALMET grid are summarized below in Table D2-1. A graphical representation of the modelling domain relative to the proposed site location is provided in Figure D2-2.

Table D2-1 Map Projections and Horizontal Grid Parameters

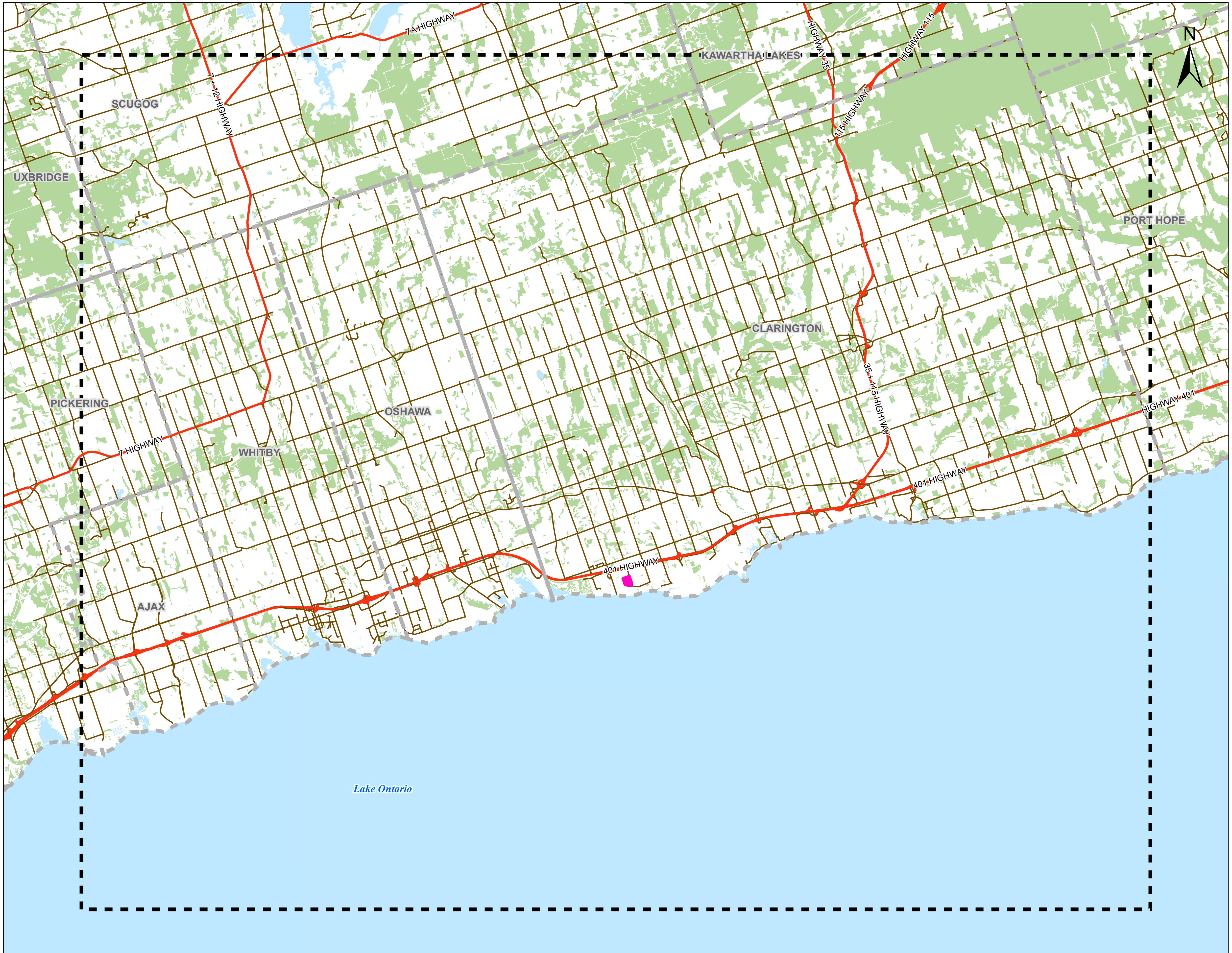
Map Grid Parameter		Values Selected for CALMET Modelling
Map Projection		UTM
UTM Zone		17N
Datum		WGS-84
Number of Grid Cells (nx,ny)		200, 160
SW Corner (x,y)	Easting (km)	655
	Northing (km)	4845
Grid Spacing (km)		0.25

Eight vertical levels were used to model the atmosphere up to a maximum cell face height of 3300 m above ground level. Cell mid-points were chosen at heights of 10, 25, 75, 150, 250, 750, 1500, and 2650 m above ground to allow for higher resolution in the layers nearest to the earth's surface than in the levels aloft. The vertical levels chosen are expected to be of a sufficient resolution to capture differences in advection and dispersion at different heights in the atmosphere.

The CALMET meteorological model was run for five years from January 2003 to December 2007. Five years of meteorological data were considered to depict a wide range of meteorological conditions and associated dispersion conditions as per the MOE guidance documentation (MOE 2009a). This time period was chosen such that the most recent five-year period of quality-assured meteorological data was considered.

2.3 Geophysical Input Data

To initialize the CALMET model, terrain elevation and land use data depicting the geophysical conditions in the selected modelling domain are required. Terrain elevation data are used in CALMET in various model algorithms to characterize meteorological phenomena such as up- and down-slope flows terrain steering of winds. In addition to the terrain elevation data, the CALMET model uses surface parameters such as surface roughness length, albedo, Bowen ratio, leaf area index, soil heat flux, and anthropogenic heat flux to estimate meteorological parameters such as surface heat flux and mechanical turbulence. In the model's geophysical pre-processor MAKEGEO, values for each of these surface parameters are specified based on input land use categories.



YORK REGION AND DURHAM REGION
RESIDUAL WASTE STUDY

CALMET Modelling Domain

Data Provided By: Ministry of Natural Resources, 2008
Produced by Jacques Whitford under Licence with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2004-2009

- Collector
- Highway
- CALMET Modeling Domain
- Proposed Site Location
- Wooded Area
- Waterbody
- Municipal Lower tier Boundaries

0 1.5 3 4.5
Kilometres

1009497-038

Jacques Whitford

FIGURE NO.
D2-2

Last Modified: May 5, 2009 By: S.Allen

2.3.1 Terrain Data

Terrain elevations in CALMET were initialized with data from the Shuttle Radar Topography Mission (SRTM). This data, a product from a joint project between the U.S. National Aeronautics and Space Administration (NASA) and the U.S. National Geospatial-Intelligence Agency (NGA), is available at 3 arc-second (approximately 90 m) horizontal resolution for the continent of North America (USGS, 2007). The SRTM data was processed by the CALPUFF pre-processor TERREL over the domain of interest to approximate terrain elevations at 250 m resolution.

After processing, the prepared terrain data were compared with local topography maps and satellite imagery to assure quality. Consistent agreement was found between these data sets.

The terrain elevations for the area, as processed for CALMET are shown in Figure D2-3. As shown in Figure D1-1, the Project will be located near the town of Clarington, approximately 2 km west of the Darlington nuclear power plant and within 1 km of the shore of Lake Ontario. The terrain in the immediate vicinity of the site location is predominantly flat and, for the purposes of dispersion modelling, is not considered complex. Elevations in the CALMET domain range from approximately 75 to 350 meters above sea level (masl) over a distance of 40 km. The base elevation at the proposed project site is about 100 masl.

2.3.2 Land Use Data

In addition to terrain elevation data, the CALMET model utilizes surface parameters such as surface roughness length, albedo, Bowen ratio, leaf area index, soil heat flux, and anthropogenic heat flux to provide input to subroutines estimate quantities such as surface heat flux and mechanical turbulence. In the model's geophysical pre-processor MAKEGEO, values for each of these surface parameters are specified based on input land use categories.

For this application, a high-resolution land use dataset developed specifically for input to dispersion models by the Ontario MOE (Liu, Personal communication, Feb 11 2009) was used to initialize the surface parameters in CALMET. This MOE dataset categorizes regional land use in terms of the U.S. EPA AERSURFACE categories (U.S. EPA 2008) such as 'Low Intensity Residential', 'Mixed Forest', 'Row Crops', and 'Open Water'. The AERSURFACE documentation defines seasonal surface parameter values for roughness length, Bowen ratio, and albedo for each of these land use categories.

The MOE dataset was rasterized at 250 m resolution to determine the dominant land use category for each cell in the CALMET modelling domain. The data was then converted into a text format and converted into the fractional land use format accepted by the CALMET MAKEGEO pre-processor. This conversion was accomplished by mapping the dominant land use category for each 250 m square grid cell into one of the United States Geological Survey (USGS) Level II categories typically used in the

CALMET model (Table D2-2). For surface parameters with U.S. EPA AERSURFACE-recommended values (albedo, Bowen ratio, surface roughness), the default summer CALMET surface parameter values in the mapped land use category were replaced with the summer AERSURFACE parameters. For all other surface parameters used in CALMET (soil heat flux, anthropogenic heat flux, leaf area index), the default CALMET land use categories were used.

Table D2-2 Mapping from AERSURFACE to CALMET Land Use Categories

AERSURFACE Land Use Category		USGS (CALMET) Land Use Category	
ID	Description	ID	Description
21	Low Intensity Residential	11	Residential
22	High Intensity Residential	12	Commercial and Services
23	Commercial/Industrial/Transportation (Not at Airport)	14	Transportation, Communications and Utilities
85	Urban/Recreational Grasses	17	Other Urban or Built-up Land
82	Row Crops	21	Cropland and Pasture
61	Orchards/Vineyards/Other	22	Orchards, Groves, and Vineyards
81,83	Pasture/Hay, Small Grains	23	Confined Feeding Operations
84	Fallow	24	Other Agricultural
71	Grasslands/Herbaceous	31	Herbaceous Rangeland
51	Shrub land (Non-arid Region)	32	Shrub and Brush Rangeland
41	Deciduous Forest	41	Deciduous Forest Land
42	Evergreen Forest	42	Evergreen Forest Land
43	Mixed Forest	43	Mixed Forest Land
11	Open Water	52	Lakes
91	Woody Wetlands	61	Forested Wetland
92	Emergent Herbaceous Wetlands	62	Non-forested Wetland
31	Bare Rock/Sand/Clay (Non-arid Region)	73	Sandy Area Other than Beaches
32	Quarries/Strip Mines/Gravel	75	Strip Mines, Quarries, and Gravel Pits
33	Transitional	76	Transitional Areas
12	Perennial Ice/Snow	91	Perennial Snowfields

To quality assure the gridded land use data, the processed dataset was superimposed onto satellite images and base maps covering the CALMET modelling domain. Consistent agreement was found between these datasets. A graphical representation of the 250 m square gridded land use data across the model domain is presented in Figure D2-4. Land use varies throughout the modelled domain, consisting primarily of agricultural zones, and water (Lake Ontario). Urban and forested areas are also important land use categories in the CALMET modelling domain.

To consider the case of snow and ice on the ground, a winter scenario was considered by assuming a proportion of the ground will be covered by snow depending on the land use category. This parameterization was applied to the months of January, February, March, November, and December, as these are months where there may be snow on the ground in the study area (EC, 2008). Note that, as increased snow cover generally decreases model mixing heights, and as such, reduces dispersion of pollution in CALPUFF, the assumption that snow covers the ground for all five months is conservative with respect to the estimation of maximum ground level concentrations and deposition.

For each month specified as 'winter', the default CALMET land use parameters was altered to account for the fact that a portion of each 250 m square cell might be under snow cover. The condition of being covered with snow was approximated by the CALMET Snow/Ice land use parameters. A weighted average was then performed between the proportion of the cell covered by the default 'summer' land use parameter and the proportion assumed to be snow/ice, for each land use category. The exception to this was the treatment of major water bodies such as Lake Ontario which were assumed, for the purposes of the modelling, to remain unfrozen during the winter months (which is conservative as the presence of an unfrozen water body will lower convective mixing heights in the model).

The proportions used for this calculation, as well as the final CALMET surface parameterizations used, for each land use category, are specified in Table D2-3. The surface properties calculated in Table D2-3 have been benchmarked against previous CALMET modelling studies as well as values published in the AERMET User's Manual (U.S. EPA 2004b).

2.4 Meteorological Input Data

The CALMET model requires the input of surface and upper air meteorological fields. As there are no long-term reliable sources of meteorological data in the immediate vicinity of the proposed site location, a high-resolution prognostic meteorological model dataset was generated to initialize the 'first-guess' wind field in CALMET. The Weather Research and Forecasting (WRF) meteorological model (UCAR 2008a) was used to generate a gridded 3-D meteorological dataset covering the five-year period of interest. As requested by the MOE (Liu, personal communication, March 7 2009), this dataset was used to create four 'model-generated' stations which were used to input surface wind and upper level meteorological data into CALMET. Each model-generated station consisted of meteorological data extracted from the WRF model at locations specified by the MOE. The use of model-generated stations to bring the WRF model output into CALMET was considered favourable by the MOE for this application (Liu, personal communication, March 7 2009) and was therefore used in this study. More information regarding the model-generated station processing is provided in the sections below.

In addition to the WRF model meteorological data, observed meteorological data from six surface weather stations and one overwater buoy station were used to initialize other required meteorological fields (e.g., temperature, cloud cover, precipitation) required as input into CALMET.

Finally, remote sensing data (MSU, 2009) was used to estimate daily lake temperatures near the site location. As requested by the MOE (Liu, personal communication, February 6 2009), this dataset was used, along with the hourly surface temperature data from a nearby surface weather station (Cobourg), to create two ‘supplementary buoy’ stations which were used to input air-lake temperature differences near the site location into CALMET. These supplementary buoy stations were created to try and better parameterize surface and lake temperatures in the vicinity of the site location. The use of supplementary buoy stations to initialize CALMET was considered favourable by the MOE for this application (Liu, personal communication, February 6 2009).

A summary of the meteorological inputs considered in this application is provided in Table D2-4. The relative locations of these inputs are provided in Figure D2-5. The following subsections provide details concerning the data sources, assumptions, and data processing used to prepare the meteorological data for this study.

Table D2-3 Land Use Parameterization for Winter Scenario

CALMET Land Use Category		Proportion Without Snow Cover	Surface Roughness (Z_0)		Albedo		Bowen Ratio (Average Moisture)		Soil Heat Flux		Leaf Area Index	
ID	Description		Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
11	Residential	80%	0.43	0.54	0.25	0.16	0.74	0.80	0.19	0.20	0.80	1.00
12	commercial and Services	80%	0.80	1.00	0.26	0.18	1.30	1.50	0.23	0.25	0.16	0.20
14	Transportation, Communications, and Utilities	80%	0.64	0.80	0.26	0.18	1.30	1.50	0.23	0.25	0.16	0.20
17	Other Urban and Built-up Land	80%	0.02	0.02	0.24	0.15	0.50	0.50	0.23	0.25	0.16	0.20
21	Cropland and Pasture	20%	0.04	0.20	0.52	0.20	0.50	0.50	0.15	0.15	0.60	3.00
22	Orchards. Groves, Vineyards …	20%	0.06	0.30	0.52	0.18	0.50	0.50	0.15	0.15	0.60	3.00
23	Confined Feeding Operations	20%	0.03	0.15	0.52	0.20	0.50	0.50	0.15	0.15	0.60	3.00
24	Other Agricultural	20%	0.01	0.05	0.52	0.18	0.50	0.50	0.15	0.15	0.60	3.00
31	Herbaceous Rangeland	40%	0.04	0.10	0.43	0.18	0.62	0.80	0.15	0.15	0.20	0.50
32	Shrub and Brush Rangeland	40%	0.12	0.30	0.43	0.18	0.70	1.00	0.15	0.15	0.20	0.50
41	Deciduous Forest Land	50%	0.65	1.30	0.38	0.16	0.40	0.30	0.15	0.15	3.50	7.00
42	Evergreen Forest Land	90%	1.17	1.30	0.17	0.12	0.32	0.30	0.15	0.15	6.30	7.00
43	Mixed Forest Land	70%	0.91	1.30	0.28	0.14	0.36	0.30	0.15	0.15	4.90	7.00
52	Lakes	100%	0.001	0.001	0.10	0.10	0.10	0.10	1.00	1.00	0	0.0
61	Forested Wetland	70%	0.49	0.70	0.28	0.14	0.29	0.20	0.22	0.25	1.40	2.00
62	Non-forested Wetland	40%	0.08	0.20	0.42	0.14	0.34	0.10	0.19	0.25	0.40	1.00
73	Sandy Area Other Beaches	0%	0.002	0.05	0.60	0.20	0.50	1.50	0.15	0.15	0.00	0.05
75	Strip Mines, Quarries, and Gravel Pits	0%	0.002	0.30	0.60	0.20	0.50	1.50	0.15	0.15	0.00	0.05
76	Transitional Areas	0%	0.002	0.20	0.60	0.18	0.50	1.00	0.15	0.15	0.00	0.05
91	Perennial Snowfields	0%	0.002	0.002	0.60	0.60	0.50	0.50	0.15	0.15	0.00	0.00

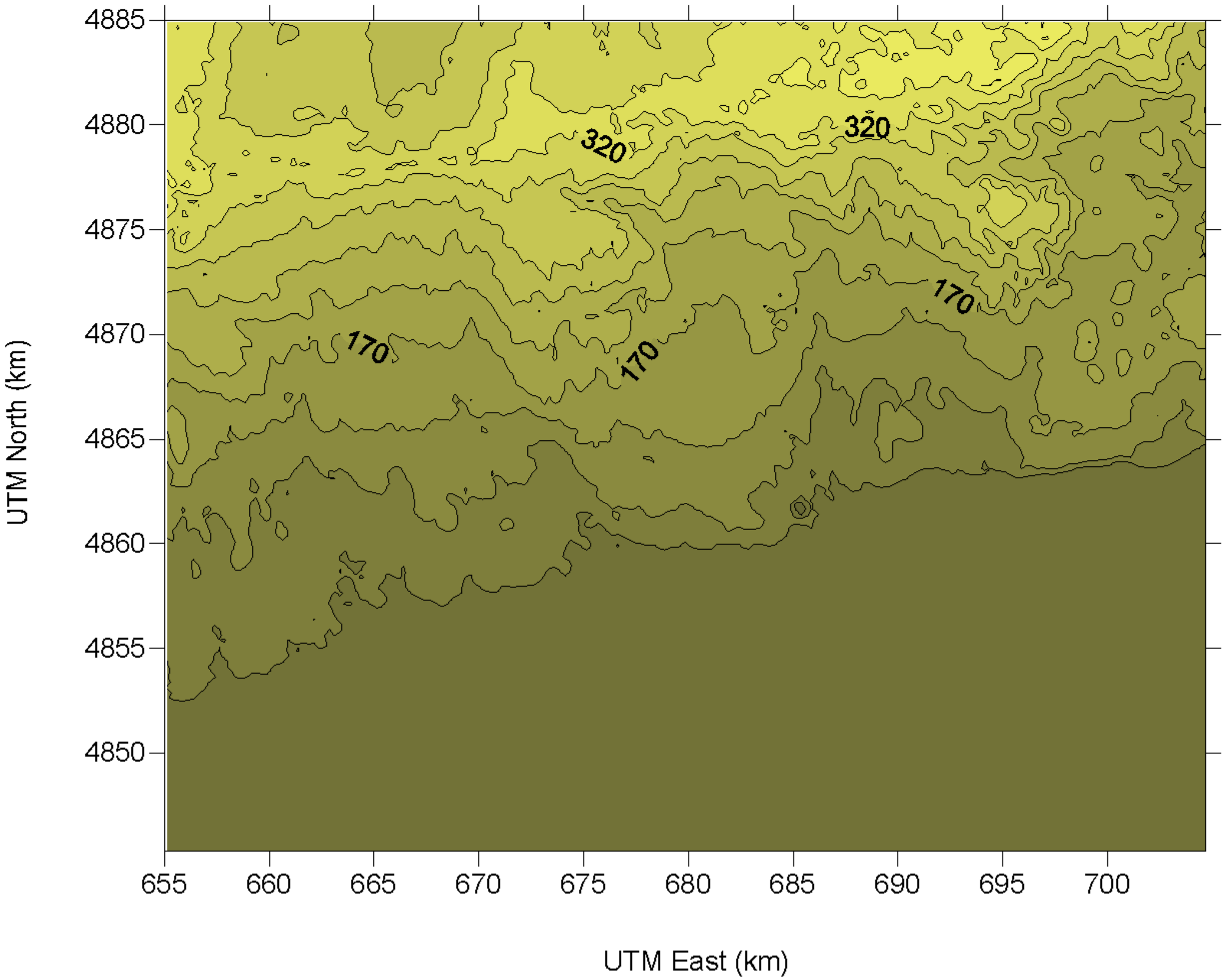


FIGURE D2-3

Terrain Elevations Used as Input into CALMET

Map Parameters
Projection: UTM
Datum: NAD 83
Zone: 17
Map Units: m
DATE: 12/8/2009
PROJECT: 1009497

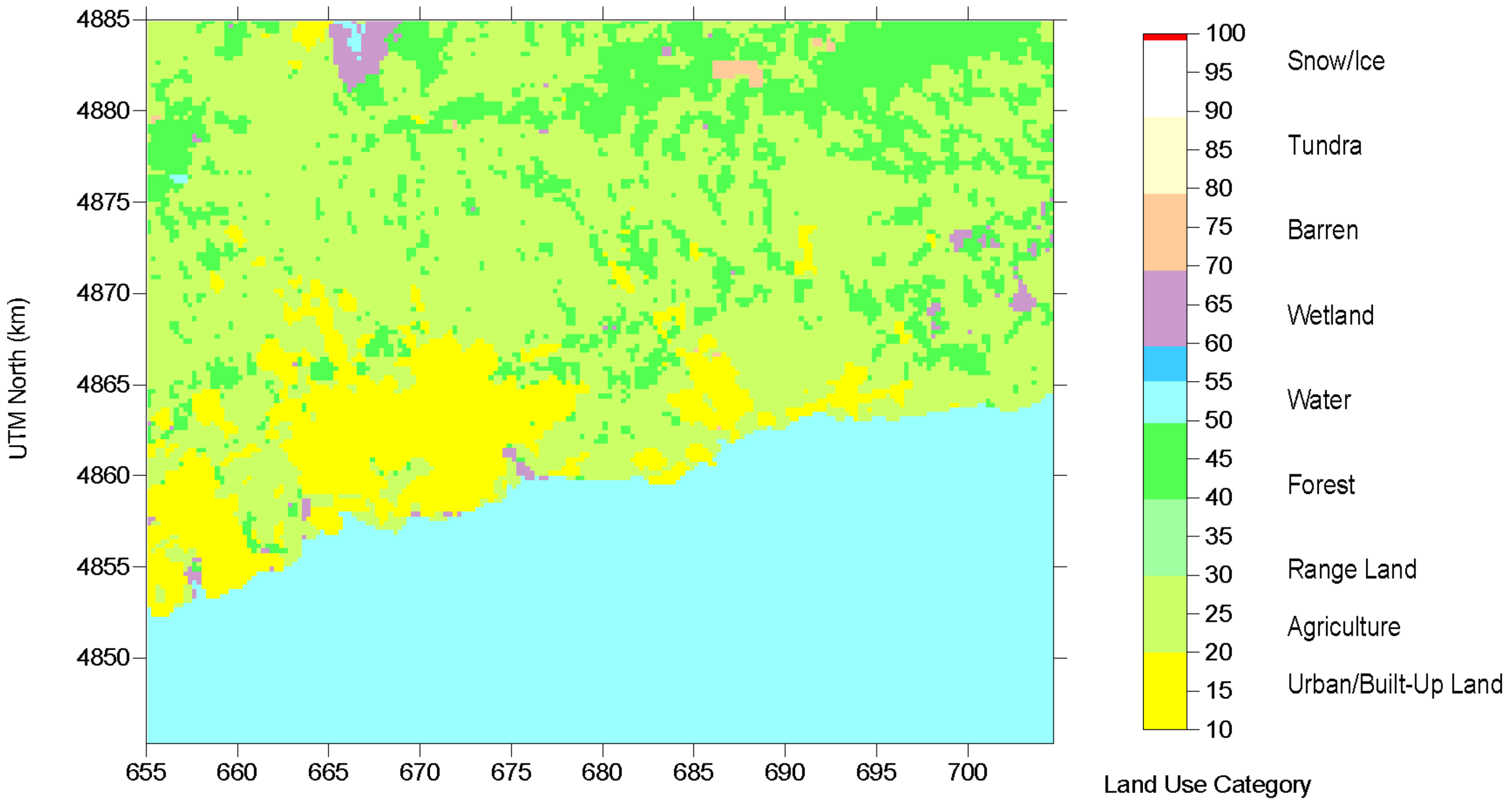


FIGURE D2-4

Dominant Land Use Categories Used as Input into CALMET

Map Parameters
Projection: UTM
Datum: NAD 83
Zone: 17
Map Units: m
DATE: 12/8/2009
PROJECT: 1009497

Table D2-4 Summary of CALMET Meteorological Inputs

Station Name	ID	Type	CALMET Pathway	UTM Easting (km)	UTM Northing (km)	Input Meteorological Data Fields
Buttonville	71639	EC	Surface	630.991	4857.615	Air Temperature, Wind Speed & Direction, Cloud Cover & Ceiling Height, Station Pressure, Relative Humidity, Present Weather, Daily Precipitation
Cobourg	71431	EC	Surface	727.087	4870.214	Air Temperature, Wind Speed & Direction, Station Pressure, Relative Humidity
Toronto Pearson Airport	71624	EC	Surface	610.428	4837.244	Air Temperature, Wind Speed & Direction, Cloud Cover & Ceiling Height, Station Pressure, Relative Humidity, Present Weather, Daily Precipitation
Peterborough	71629	EC	Surface	710.044	4900.783	Air Temperature, Wind Speed & Direction, Station Pressure, Relative Humidity, Present Weather, Daily Precipitation
Toronto Island Airport	71265	EC	Surface	629.074	4832.023	Air Temperature, Wind Speed & Direction, Station Pressure, Relative Humidity, Present Weather, Daily Precipitation
Trenton Airport	71621	EC	Surface	777.648	4891.058	Air Temperature, Wind Speed & Direction, Cloud Cover & Ceiling Height, Station Pressure, Relative Humidity, Present Weather, Daily Precipitation
Lake Ontario Buoy	45012	NDBC	Buoy	789.665	4835.933	Air Temperature, Wind Speed & Direction, Air-Lake Temperature Difference
Supplementary Buoy I	-	SOW	Buoy	680.650	4858.640	Air Temperature, Air-Lake Temperature Difference
Supplementary Buoy II	-	SOW	Buoy	679.410	4858.050	Air Temperature, Air-Lake Temperature Difference
Model-generated Station I	-	MGSU	Surface & Upper Air	680.273	4837.863	Surface - Wind Speed & Direction Upper Air - Wind Speed & Direction, Pressure, Temperature
Model-generated Station II	-	MGSU	Surface & Upper Air	670.896	4869.614	Surface - Wind Speed & Direction Upper Air - Wind Speed & Direction, Pressure, Temperature
Model-generated Station III	-	MGSU	Surface & Upper Air	678.861	4871.947	Surface - Wind Speed & Direction Upper Air - Wind Speed & Direction, Pressure, Temperature
Model-generated Station IV	-	MGSU	Surface & Upper Air	686.830	4874.291	Surface - Wind Speed & Direction Upper Air - Wind Speed & Direction, Pressure, Temperature

Notes:
1. EC = Observed Meteorological Data from Environment Canada Surface Station
2. NDBC = Observed Meteorological Data from National Buoy Data Center Overwater Station
3. SOW = Supplementary Overwater Buoy Station with Air Temperatures taken from Cobourg and Lake Temperatures extracted from remote sensing data
4. MGSU = Model-Generated Surface & Upper Air Stations extracted from WRF model output fields

YORK REGION AND DURHAM REGION
RESIDUAL WASTE STUDY

Meterological Inputs into CALMET

Data Provided By: Ministry of Natural Resources, 2008
Produced by Jacques Whitford under Licence with the Ontario
Ministry of Natural Resources © Queen's Printer for Ontario, 2004-2009

- Overwater Meteorological Station
- Pseudo Buoy Meteorological Station
- Surface Meteorological Station
- Pseudo Surface and Upper Air Meteorological Station
- Collector
- Highway
- Proposed Site Location
- Waterbody

0 5 10 15
Kilometres

1009497-039

Jacques Whitford

FIGURE NO.
D2-5

Last Modified: May 5, 2009 By: S.Allen

2.4.1 Prognostic Meteorological Model Input

Meteorological data from the WRF model were used to initialize surface winds and upper level meteorological fields in CALMET. The preparation of these meteorological inputs involved three key steps:

- The WRF model was initialized and run over the five year modelling period (2003 to 2007);
- The fields required for CALMET were extracted from the WRF model using the CALWRF pre-processor; and,
- Surface and upper-level meteorological data were extracted from the CALWRF fields at four 'model-generated' stations whose locations were determined based on pre-consultation with the MOE (Liu, personal communication, March 7 2009).

The resultant model-generated surface and upper air stations were used to input the prognostic meteorological data into the CALMET model. The following subsections provide an overview of the WRF modelling, CALWRF processing and model-generated-station extraction.

2.4.1.1 Summary of WRF Modelling

To initialize the WRF model, North American Mesoscale (NAM) gridded meteorological data on a 40 km grid were obtained from CISL Research Data Archive (UCAR 2008b) for the five year simulation period (2003 to 2007). This data, along with the default WRF model terrain and land use datasets were used as input into the WRF Pre-processing System (WPS), which is used to prepare the geophysical and meteorological data required to run WRF. The most recent versions of WRF-ARW (v. 3.0) and WPS (v. 3.0) were used.

A two-way nesting strategy was used in the WRF modelling to create a high resolution 4 km dataset from the 40 km input NAM data. To accomplish this, three nested grids at 36 km, 12 km, and 4 km spacing were considered. Figure D2-6 shows the relative location and area covered by each of these grids. The smallest grid had 4 km spacing, with 80 grid points in the east-west direction by 72 grid points in the north-south direction.

The primary WRF dynamics and physics parameterizations specified for the modelling are provided in Table D2-5. These model options were selected based on the U.S. National Center for Atmospheric Research (NCAR) real-time WRF model input configuration (UCAR 2008c). Forty eight (48) vertical sigma levers were considered in the modelling. The lowest layer (sigma=0.9990) corresponding to a height of approximately 10 m above ground. Each WRF simulation was run for a simulation period spanning 30 hours from 0 UTC to 6 UTC on the next day to give 24 hours of output meteorological data (the first 6 hours of each simulation were discarded to account for the model spin-up period). A sample WRF input file is provided in Attachment D-2.

Table D2-5 Primary Dynamics and Physics Parameterizations Used in WRF Modelling

Option	Nested Grid	36 km	12 km	4 km
Dynamics	Time step (s)	180	60	20
	Run Days	1	1	1
	Run Hours	6	6	6
	Grid points	74*61	82*70	82*70
	Vertical levels	48	48	48
Physics	Microphysics	WSM 3-class simple ice scheme	WSM 3-class simple ice scheme	WSM 3-class simple ice scheme
	Boundary Layer	YSU scheme	YSU scheme	YSU scheme
	Long Wave Radiation	RRTM scheme	RRTM scheme	RRTM scheme
	Short Wave Radiation	Dudhia scheme	Dudhia scheme	Dudhia scheme
	Surface Layer	Monin-Obukhov scheme	Monin-Obukhov scheme	Monin-Obukhov scheme
	Land Surface	Thermal diffusion scheme	Thermal diffusion scheme	Thermal diffusion scheme
	Cumulus	Kain-Fritsch (new Eta) scheme	Kain-Fritsch (new Eta) scheme	None

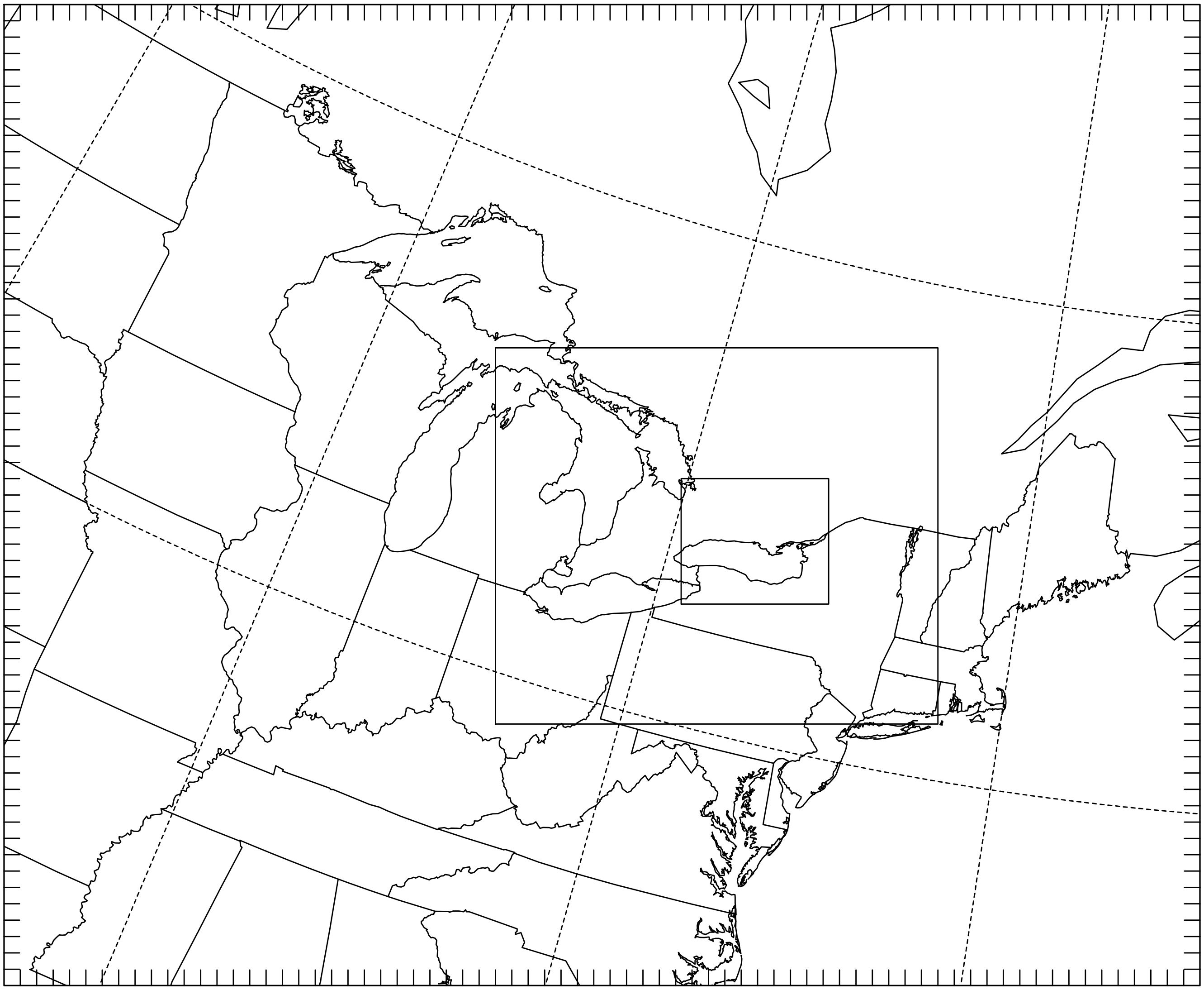
2.4.1.2 CALWRF Processing

The CALMET pre-processer CALWRF (version 1.1) was used to convert the WRF model standard output NETCDF files into CALMET readable files for each modelled period. For each 30 hour WRF simulation period, hours 7 though 30 were processed using CALWRF with the first 6 hours discarded to account for the model spin-up period. The 32 lowest sigma levels of WRF output data were extracted.

2.4.1.3 Model-generated Station Extraction

As requested by the MOE (Liu, personal communication, March 7 2009), surface and upper air meteorological data was extracted from the CALWRF output files at four model-generated station locations. Four model-generated stations were selected with three located approximately 8 km north of the Lake Ontario shoreline and one located about 20 km south of the site location. Model-generated station locations were determined in conjunction with the MOE (Bloxam, personal communication, March 10, 2009). The specific locations of the model-generated stations are shown in Figure D2-5.

Figure D2-6 Nested Grids Used in WRF Modelling



Based on the MOE pre-consultation, it was determined that only surface winds from WRF would be extracted for input into CALMET (Bloxam, personal communication, March 10, 2009). Thus, all other input surface meteorological data for the CALMET simulations came from the observed surface weather stations. On the other hand, all upper air data input into CALMET (winds, temperature, and pressure) was extracted from the CALWRF output files.

2.4.2 Observed Surface Weather Station Input

In addition to the WRF output, observed meteorological data from surface weather stations during the modelling period from Environment Canada (EC) were used as input into CALMET. The observed weather station data was used exclusively to initialize CALMET inputs such as cloud cover, ceiling height, surface temperatures, and precipitation. Based on consultation with the MOE it was determined that initializing CALMET using observed data instead of the WRF-output fields was preferential for these meteorological variables (Bloxam, personal communication, March 10, 2009).

A summary of regional surface weather stations used and the meteorological data available from each station is shown in Table D2-4. While certain EC weather stations (i.e., Toronto Pearson Airport) contained all fields necessary to initialize CALMET over the period of interest, for other stations (i.e., Cobourg) fewer meteorological fields were available for input into CALMET. Nevertheless, the complete data set required to initialize CALPUFF was easily obtained by considering data from six surface meteorological stations. The observed EC surface weather stations used as input into CALMET were reviewed and approved by the MOE (Liu, personal communication, February 6, 2009).

Although meteorological data are available from the Darlington Power Plant station near to the site location, the MOE has advised this information is not reliable and was not used in the assessment (Liu, personal communication, September 10, 2008). Therefore, although it is noted that this weather station is very close to the site location, data from this station was not used in the assessment.

As shown in Figure D2-5, all observed surface meteorological stations are outside the CALMET domain, with Cobourg, Buttonville, Peterborough, and the Toronto Island Airport located nearest to the model domain. As such, the observed surface stations were less influential than the WRF-based model-generated stations in determining CALMET winds near the site location. For surface temperatures, since the two supplementary buoy stations were initialized with observed temperature data from Cobourg, CALMET surface temperatures near the site location were most influenced by this weather station. For other meteorological variables, the CALMET meteorological fields near the site location were most influenced by the observed weather data from Cobourg, Buttonville, Peterborough, and the Toronto Island Airport.

2.4.2.1 Observed Station Data Processing

For all input surface station data received, quality analysis of the data was performed. The observed EC wind directions, which are reported in 10s of degrees, were randomized within each directional sector to better depict the variance in actual wind directions.

For periods with calm winds or missing data, the following protocols were followed:

- For periods with winds below the threshold of the anemometer, wind directions and speeds were marked as missing. Wind speeds and directions during such periods were thus calculated within CALMET using data from other nearby surface stations.
- No data fills were required for periods with missing hourly data or missing fields for non-missing records. This is because CALMET requires only one non-missing value for each mandatory input surface meteorological field. In other words, the required surface input data was available from at least one station for each hour of the 5-year data set.

Precipitation data for 24-hour accumulation periods was obtained from Environment Canada for all EC surface stations with available precipitation data, as outlined in Table D2-4. These daily totals were partitioned into hourly amounts as follows:

- If the precipitation amount was zero for the 24-hour accumulation period, each hour over the 24-hour period received 0 mm of precipitation.
- Otherwise, if at least one of the precipitation codes over the 24-hour period reported precipitation, the total 24-hour accumulated amount was partitioned over each hour with an observed precipitation event in the period.
- Otherwise, if at least one of the opaque cloud cover measurements during the 24 hour period was greater than or equal to 7/10, the total 24-hour accumulated amount was partitioned over each of the hours with at least this much cloud cover in the period.
- Otherwise, the total 24-hour precipitation amount was evenly distributed over all hours in the period (*i.e.,* divided by twenty four).

The resultant hourly precipitation amounts were used, along with the hourly present weather data as input into CALMET so that wet deposition could be considered for the CALPUFF modelling.

2.4.2.2 Summary of Regional Observed Surface Winds

Wind direction and wind speed play an important role in determining the overall transport of airborne pollutants. Wind roses summarizing hourly model-input winds (2003-2007) at all six input EC surface stations are shown in Figures D2-7 and D2-8. Wind roses are an efficient and convenient means of presenting wind data. The length of the radial barbs gives the total percent frequency of winds from the indicated direction, while portions of the barbs of different widths indicate the frequency of associated wind speed categories. Note that periods with calm winds (less than 1 m/s) cannot be included in these diagrams as such periods do not have valid measurements for wind direction.

As can be seen in Figures D2-7 and D2-8, regional wind patterns can vary considerably due to differences in factors such as synoptic meteorology (large-scale weather trends), proximity to water bodies as well as local surface characteristics. For example, the influence of Lake Ontario can be seen at meteorological stations such as Toronto Island Airport, and Trenton. In general, most of the meteorological stations in the region show a relatively higher proportion of winds from the west to south-westerly directions, which is indicative of the prevailing wind direction in the region.

Note that as all observed surface stations are much further from the site location than the modelled model-generated stations, the wind data from the EC surface stations had relatively less influence in providing the initialization data for CALMET.

2.4.3 Overwater Station Input

To allow for better parameterization of the marine boundary layer in CALMET, overwater station inputs were also considered as input into the model. This supplementary information was included to better allow CALMET to parameterize the marine boundary layer. As previously mentioned, both observed and supplementary buoy data were used to initialize CALMET through the overwater station input pathway.

The nearest reliable long-term source of overwater meteorological and sea temperature data is the U.S. National Data Buoy Center (NDBC) Lake Ontario buoy weather station. All available data from this buoy station was used as input into CALMET.

Since the Lake Ontario buoy station does not operate during the winter months, and since the location is over 100 km from the site location, the MOE recommended a procedure to augment the observed buoy data with supplementary buoy data (Liu, personal communication, February 6 2009). Only air and lake temperatures were considered in creating the supplementary buoy stations. Remote sensing data from Michigan State University (MSU, 2009), a data source recommended by the MOE (Liu, personal communication, February 6 2009) was used to estimate daily lake temperatures near the site location. Hourly surface temperatures from the EC Cobourg surface station (which is located near the lake and therefore reflects the air temperature over the lake) were used in conjunction with the lake temperature data to estimate the air-lake temperature difference.

The air temperature and air-lake temperature differences were input into CALMET at two supplementary buoy locations near the site location. As requested by the MOE (Liu, personal communication, February 6 2009), one supplementary buoy station was placed 1 km offshore and the other placed 2 km offshore in the CALMET model inputs. The locations of the two supplementary buoy stations are shown in Figure D2-5.

Figure D2-7 Hourly Surface Winds from Regional Environment Canada Stations (2003-2007)

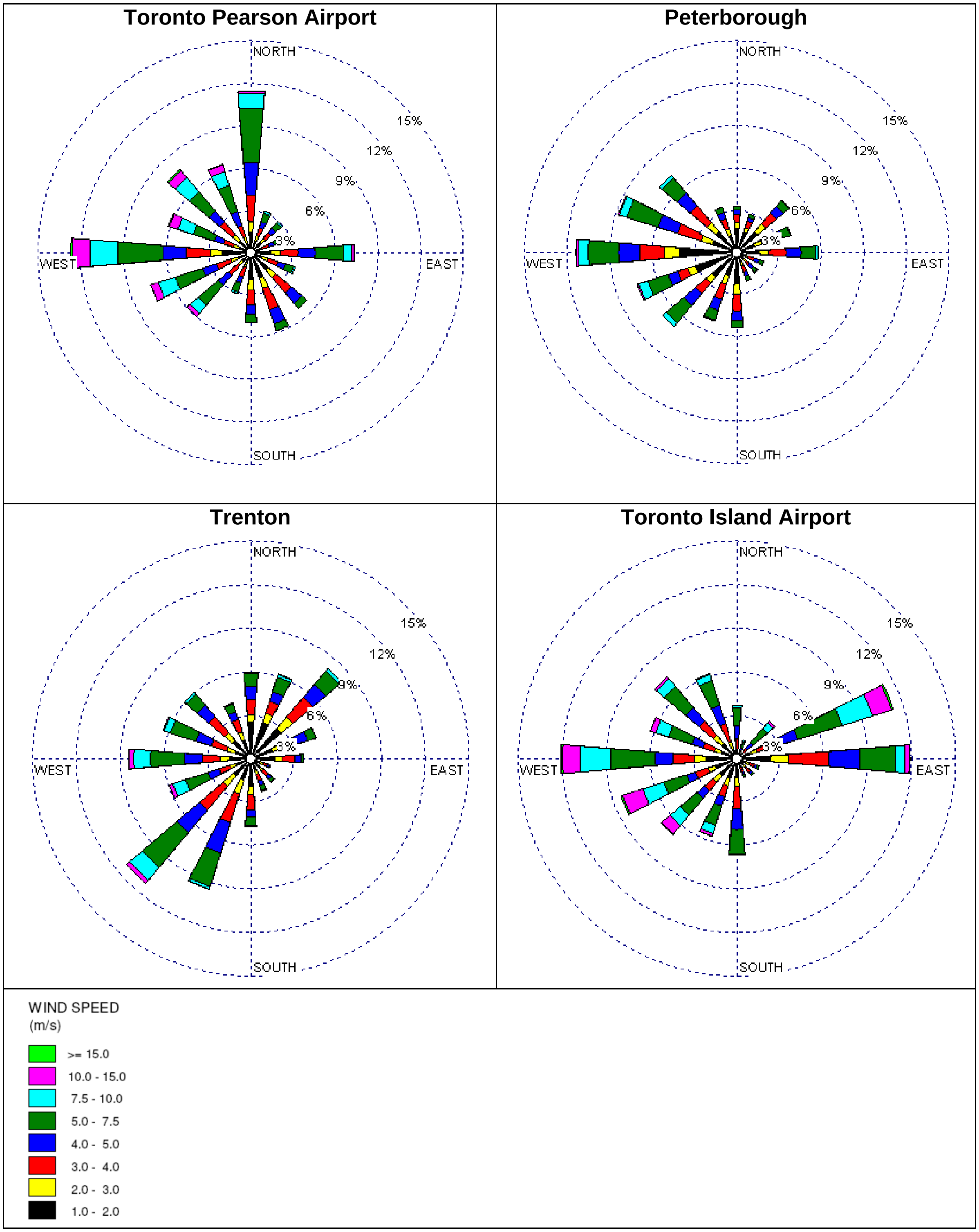
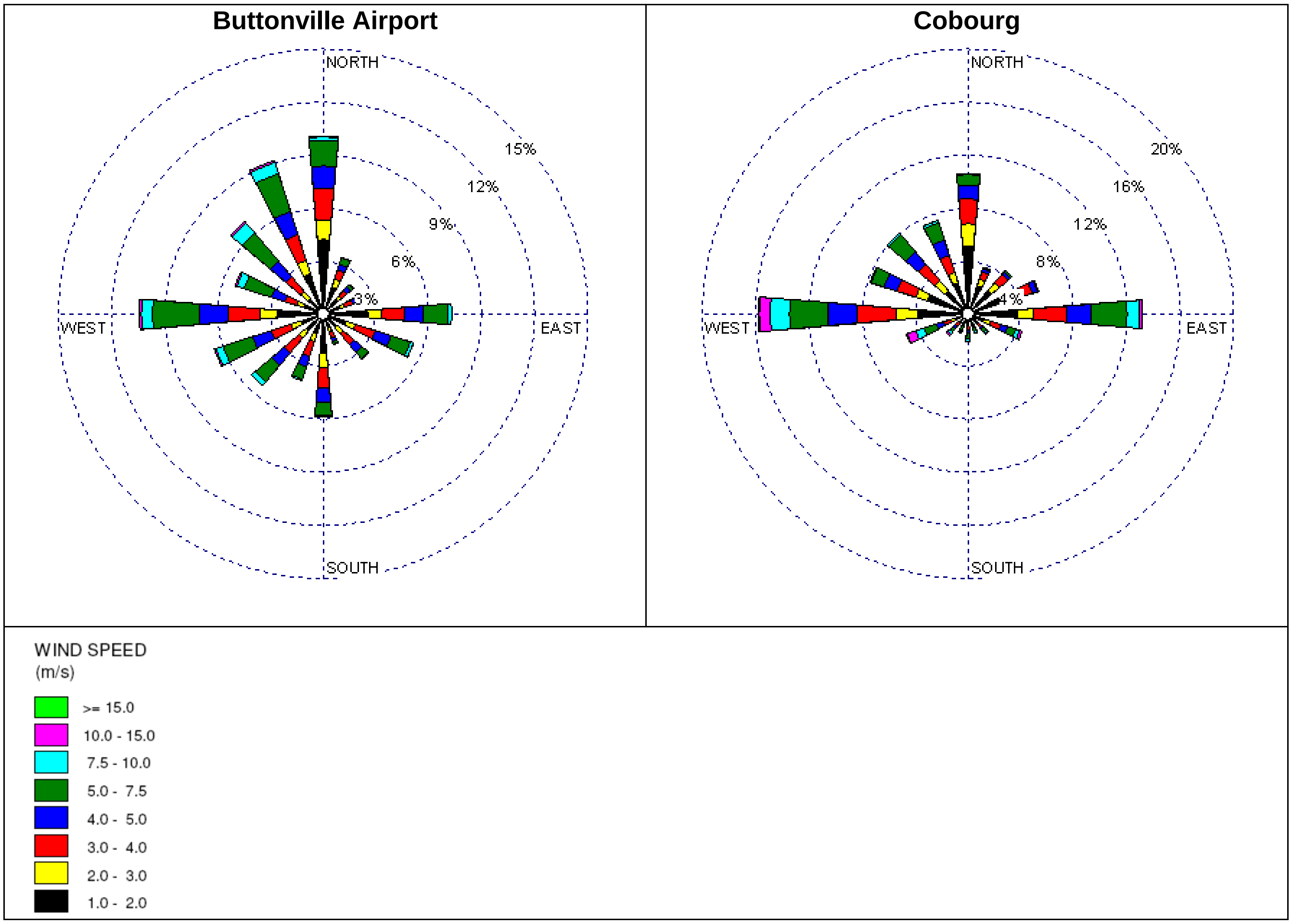


Figure D2-8 Hourly Surface Winds from Regional Environment Canada Stations (2003-2007)



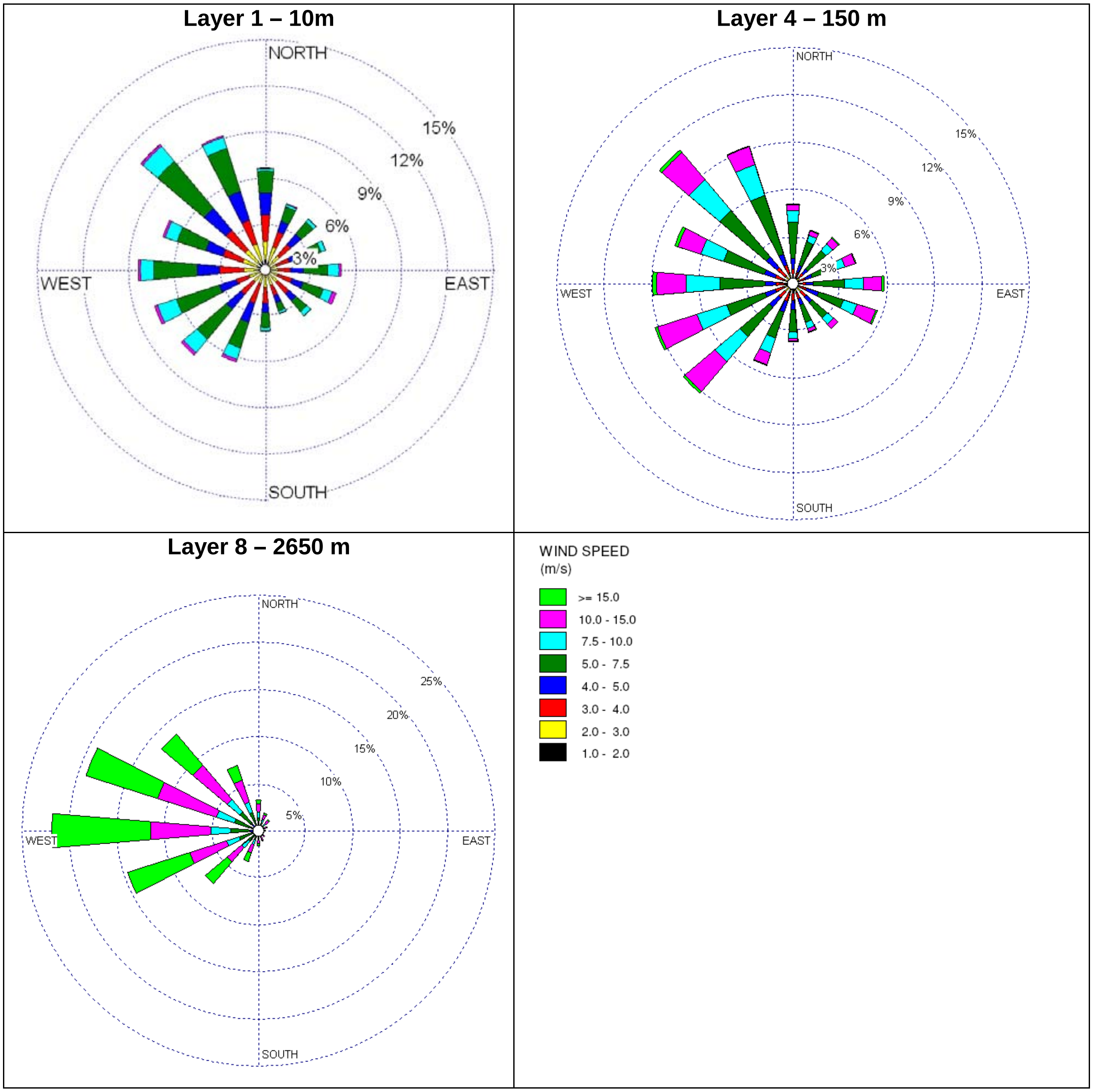
2.5 CALMET Output

The following subsections present a summary of the CALMET modelling predictions at both the site location as well as over the CALMET model domain.

2.5.1 Winds at the Site Location

In Figure D2-9, wind rose diagrams summarizing of the hourly CALMET-output winds at the model grid cell nearest to the site location are presented. The wind data presented has been extracted from CALMET model levels 1, 4, and 8 (which correspond to 10-m, 150-m and 2650-m above ground) and spans all hours in the modelling period (2003-2007).

Figure D2-9 CALMET Model-Output Winds at the Site Location (2003-2007)



Both upper air and surface wind characteristics are important to dispersion modelling. The wind rose plots show a transition from near-surface winds more influenced by local terrain and land use features to mid-tropospheric winds more influenced by prevailing synoptic conditions. As expected, wind speeds increase and wind direction becomes more consistent with increasing height above ground.

To help gauge model performance, CALMET model output winds from the grid cell nearest the site location were compared with available on-site meteorological data (April 2007 - December 2007). Zephyr North installed a 60 m, multi-level meteorological tower on the same site as the proposed facility in April 2007, as part of a wind resource evaluation. A summary of this on-site monitoring program is provided in Attachment D-3.

Wind rose diagrams showing both model-predicted and observed winds over the 9 month period of overlap (April - December 2007) are presented in Figure D2-10. The observed winds were measured at a heights of 47 m and 57 m above ground, while the CALMET winds are presented for Levels 2 and 3 (cell midpoints of 35-m and 75-m). Since the observed and predicted wind data are at different heights, exact agreement between the data sets would not be expected. For ease of comparison, the wind roses have been plotted with eight wind directions, with each barb on the rose representing winds blowing from ±22.5^{o} from the barb direction.

The comparison shows that the WRF/CALMET modelling does a reasonable job in capturing the dominant wind directions, as influenced by both synoptic and boundary layer (lake breeze) influences, over the test period. Prevailing daytime winds during the summertime in the study area are primarily from the south-west, while daytime lake breeze influence may occur from the south-west to south-east. During the evening and night, winds occur more frequently from the north and north-west. The modelling tends to under predict the frequency of winds from the east and over predict the frequency of winds from the north-west. The percentage of on-shore winds (winds blowing from south-west to south-easterly directions) is similar for both datasets (approximately 18% of the time for the model results and approximately 19% for observed values). On an overall basis, model-predicted wind speeds are slightly lower than the observed values, which would be expected as the model-predicted values are at a lower height than the measured wind speeds.

It is important to note that this comparison is for a limited time (less than one year) and therefore greater variability between the predicted and measured wind frequencies would be expected relative to comparisons over a longer data set. A comparison of the 2007 observations to the predicted directionality of winds during the same period (April to December) for each year in the five year CALMET data set is presented in Table D2-1. This comparison shows that for most wind directions, within the 5-year period the percentage of time that the predicted winds blew from a particular sector was greater for at least one-year in the CALMET data than that measured in 2007. Only for south-westerly winds was the maximum frequency of CALMET predicted winds slightly less than that of the 2007 observations (maximum predicted frequency of 16% versus an observed percentage of 19%). Since the CALPUFF dispersion modelling utilized the full five-year CALMET data set to predict maximum ground level concentrations, the predicted annual average concentration reported at each receptor would be the highest of the individual years in the five year data set, and would therefore reflect these variations in wind directionality.

Figure D2-10 Model-Predicted and Observed Winds at the Site Location (April – December 2007)

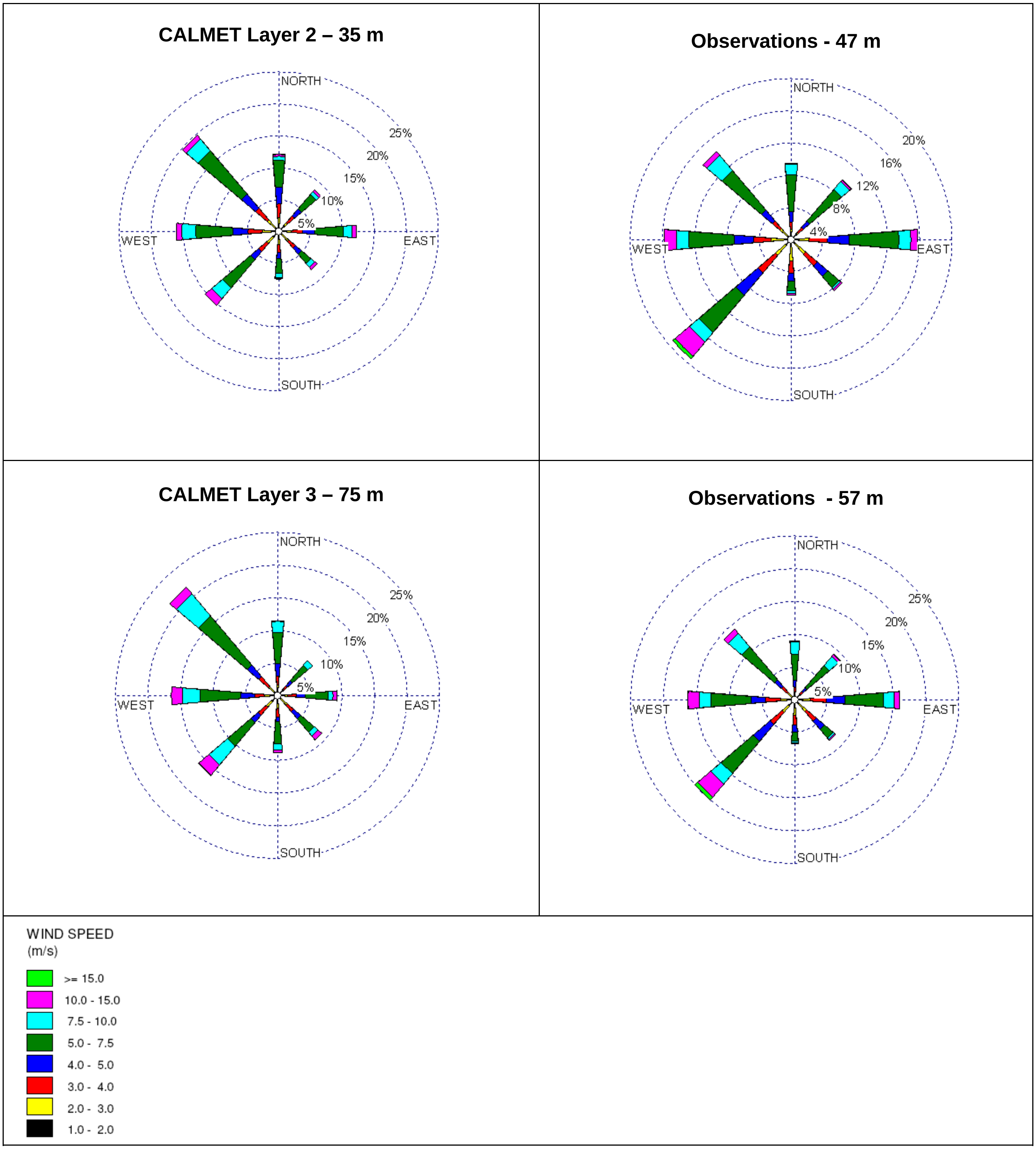
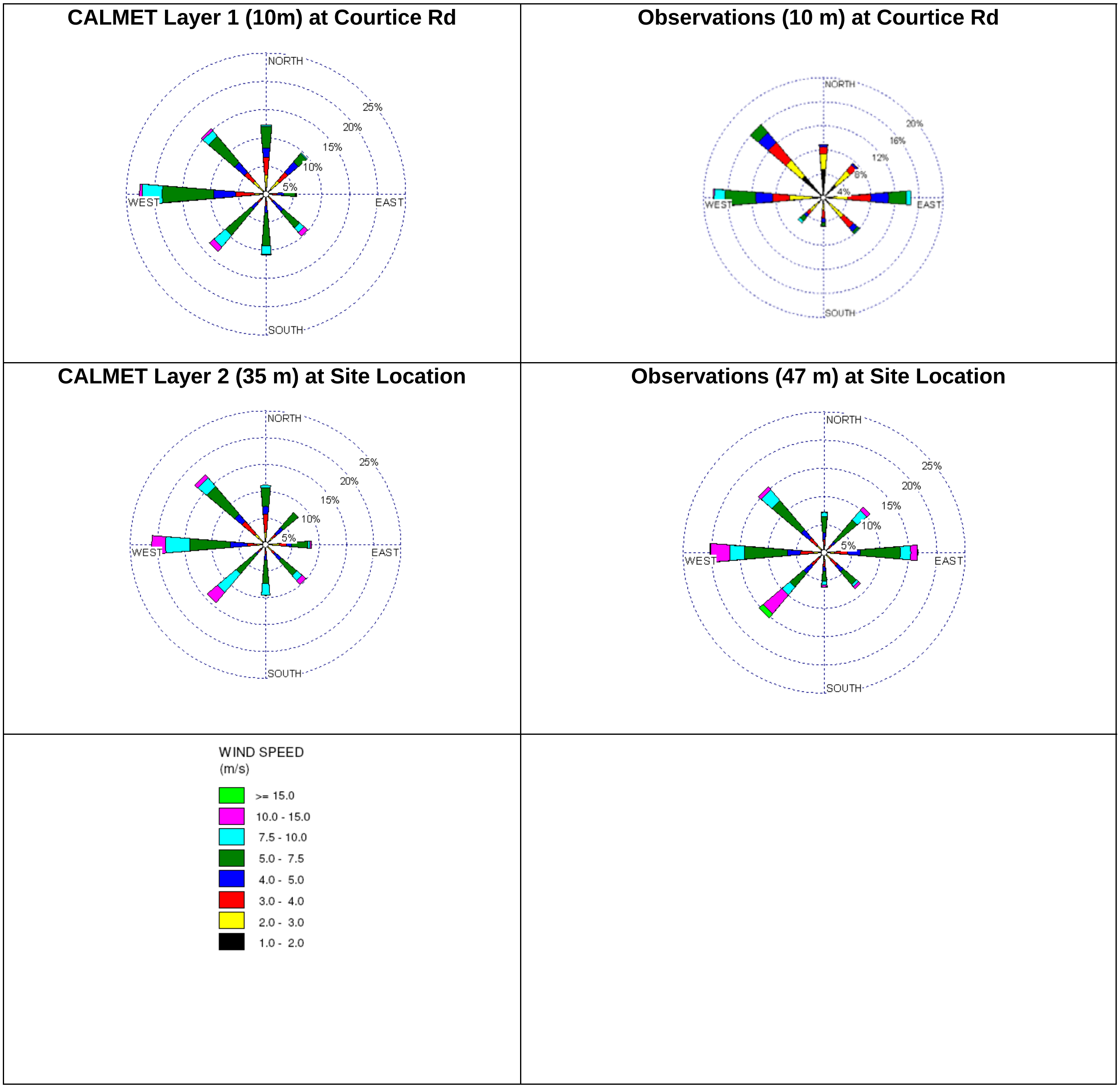


Table D2-1 Comparison of Wind Frequency with Direction from April to December of Each Year in the Five-Year Meteorological Data Set

Wind Direction	CALMET Predictions at 35-m							Observed (2007) at 47-m
	2003	2004	2005	2006	2007	Max	Min	
N	11%	13%	12%	10%	13%	13%	10%	9%
NE	6%	9%	10%	9%	7%	10%	6%	10%
E	17%	13%	10%	11%	9%	17%	9%	16%
SE	9%	9%	9%	6%	8%	9%	6%	8%
SE	6%	8%	9%	8%	8%	9%	6%	7%
SW	14%	15%	16%	16%	16%	16%	14%	19%
W	16%	13%	16%	21%	16%	21%	13%	16%
NW	20%	19%	18%	19%	21%	21%	18%	14%

Additional comparisons of model-predicted and observed winds are over a shorter 3 ½ month period (Sep 13 – Dec 31 2007) are presented in Figure D2-11. During this time interval, measured wind data was available from the Zephyr North meteorological tower located on the proposed site, as well as from the ambient monitoring station located at Courtice Road (approximately 2 km west of the site). More information on the ambient monitoring conducted at the Courtice Road location is provided in Appendix A of this report. As the observed winds at the Courtice Road monitoring station were measured at a height of 10 m above ground, these values are compared to the Level 1 CALMET winds (cell midpoint of 10 m) at the Courtice road location. The 47 m observations from the Zephyr North tower in Figure D2-11 are compared to the Level 2 CALMET winds at the site location for the 3 ½ month period. Similarly to the data shown in Figure D2-10, the CALMET model tends to under predict the frequency of winds from the east during this 3 ½ month period. However, the model predictions of north-westerly and south-westerly winds are very similar to the observed data at the proposed Facility site (Zephyr North tower). The Courtice Road measurements show a lower percentage of winds blowing from the south-west than do the Zephyr North tower measurements at the site, and the CALMET predictions at the Courtice Road station over-predict the measured frequency of south-westerly winds. The CALMET model at the Courtice site predicts a higher occurrence of winds blowing on-shore than that measured at the Courtice Road station, which would be expected to be conservative.

Figure D2-11 Model-Predicted and Observed Winds near the Proposed Site (September 13 – December 30, 2007)



2.5.2 Wind Vector Diagrams

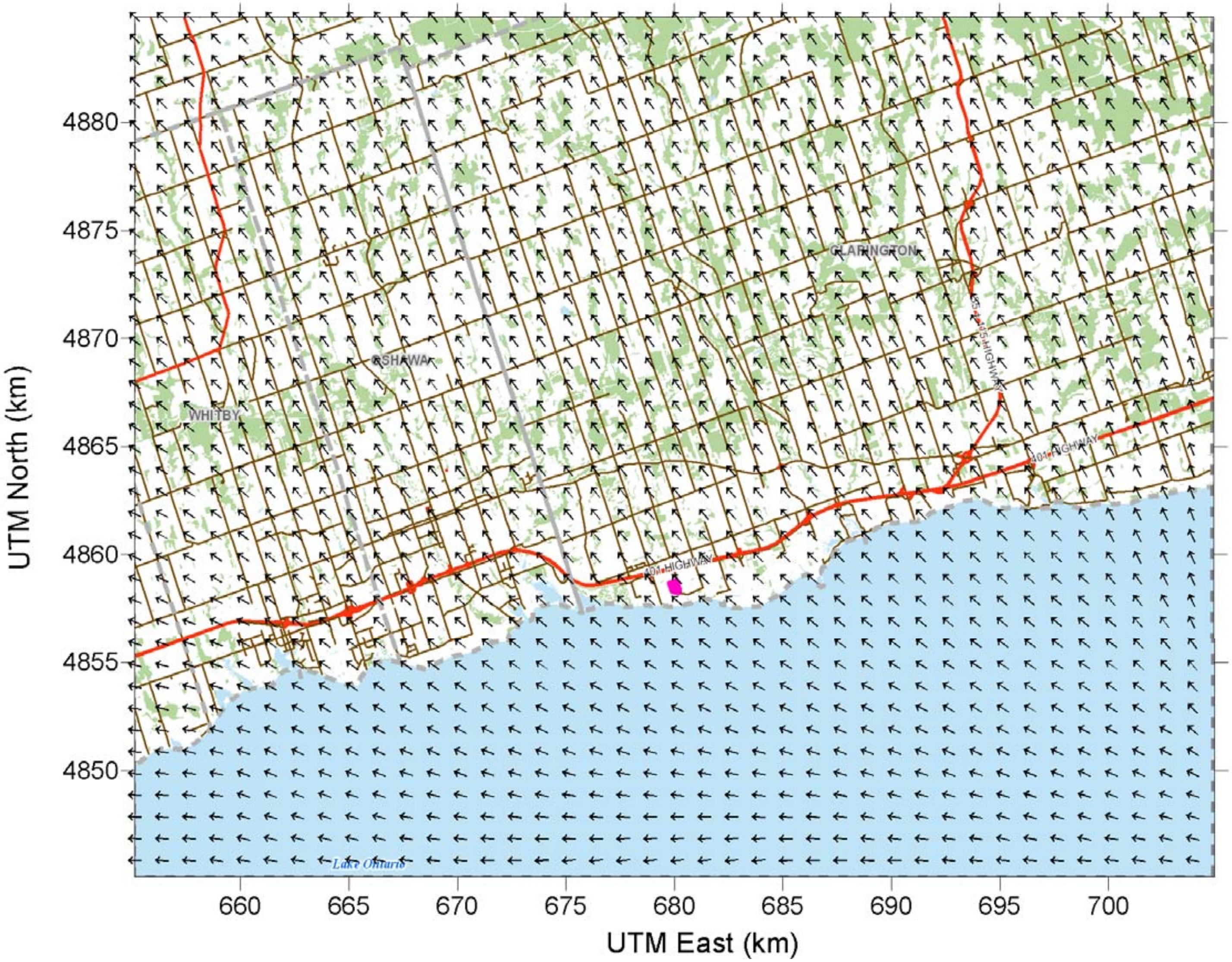
Surface wind vector plots are displayed to provide an overview of how the wind fields predicted by CALMET vary across the model domain. The vector plots were not selected to illustrate representative conditions, but rather were selected at random to demonstrate the wind variation that can occur across the study domain during a given hour. In these diagrams, an arrow is shown to represent the direction and velocity of the wind for each meteorological grid cell. The direction of the arrow indicates the direction that the wind is blowing towards and the length of the arrow indicates the relative wind speed.

Figure D2-12 shows surface winds on a warm summer afternoon on July 6, 2005 at 14:00 Eastern Standard Time (EST). Winds are moderate in magnitude during this period, ranging from 1 to 2.7 m/s across the model domain. This combination of lower wind speeds and the differential in surface heating between the land and water can cause the formation of a local pressure gradient along the coastline which can give rise to a lake breeze onto the shore. During this particular time, the wind orientation is predominantly from the east over the lake, becoming more south-easterly as it nears the coastline. This shift in wind orientation suggests a combination of synoptic as well as mesoscale forcing (due to a localized pressure gradient) are affecting the meteorological conditions over the CALMET domain during this period.

Figure D2-13 presents a wind vector diagram of the surface layer over the CALMET domain for February 11, 2005 at 01:00 EST. Atmospheric conditions in the boundary layer are neutral during this period due to higher wind speeds (4.9 to 8 m/s) across the CALMET domain. Wind directions exhibit less variance across the domain, with higher wind speeds inhibiting the action of CALMET's Diagnostic Wind Module.

2.5.3 Precipitation at the Site

The CALMET model spatially interpolates the input precipitation data over the modelled grid. Figure D2-14 shows the predicted average monthly precipitation amount at the CALMET grid point nearest to the site location versus the data from the five EC surface stations that were as input into the model. The figure shows that the precipitation amounts interpolated to the site location are typically near the middle of the range of precipitation amounts measured at the input surface stations considered in this study. This is because none of the input EC station locations are located substantively nearer to the facility than the others (see Figure D2-5). As such, all were given a similar weighting in the precipitation interpolation to the site location in CALMET.



Map Parameters
Projection: UTM
Datum: NAD 83
Zone: 17
Map Units: m
DATE: 12/8/2009
PROJECT: 1009497

FIGURE D2-12

Output CALMET Level 1 Winds: July 6, 2005 at 14:00 LST

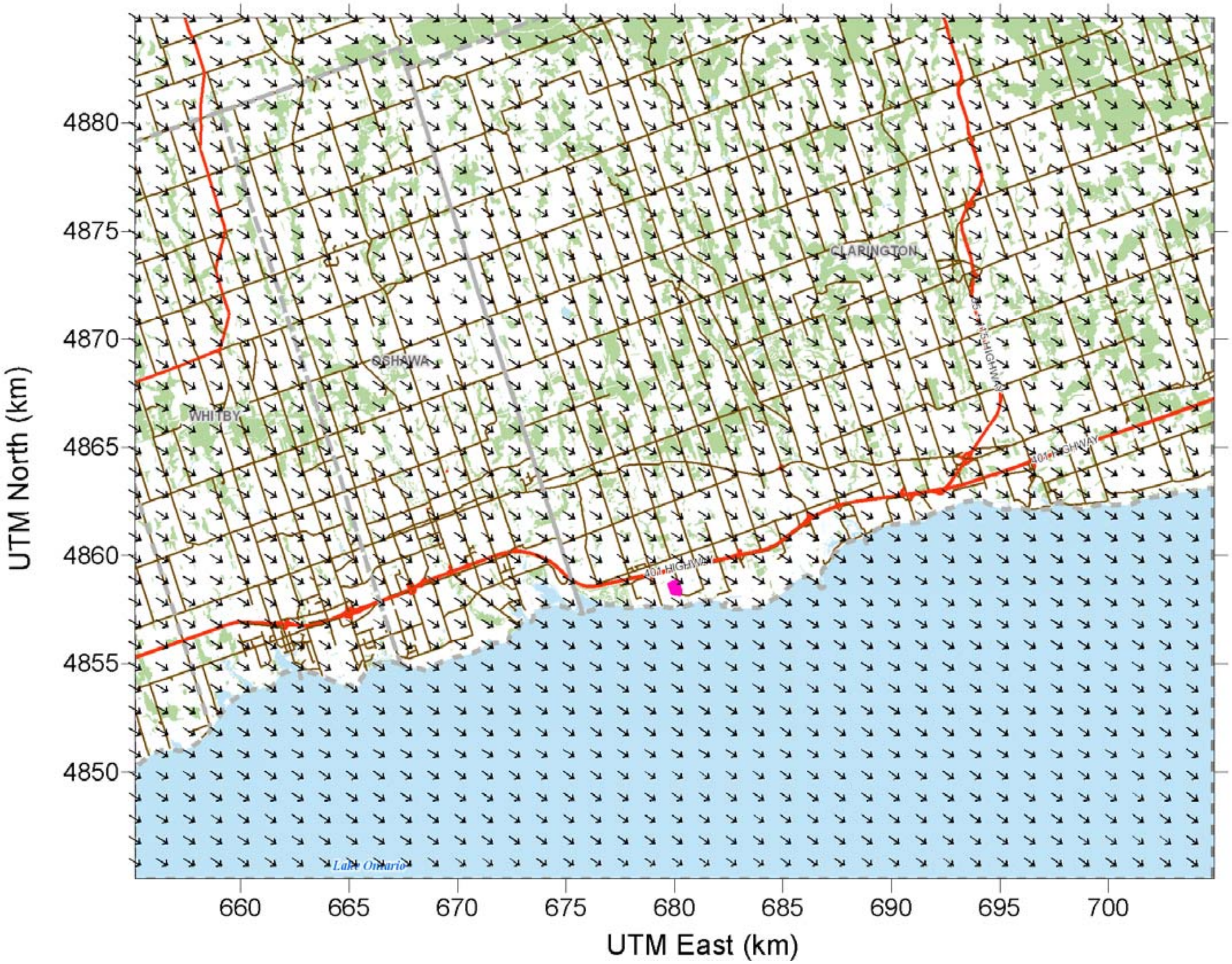
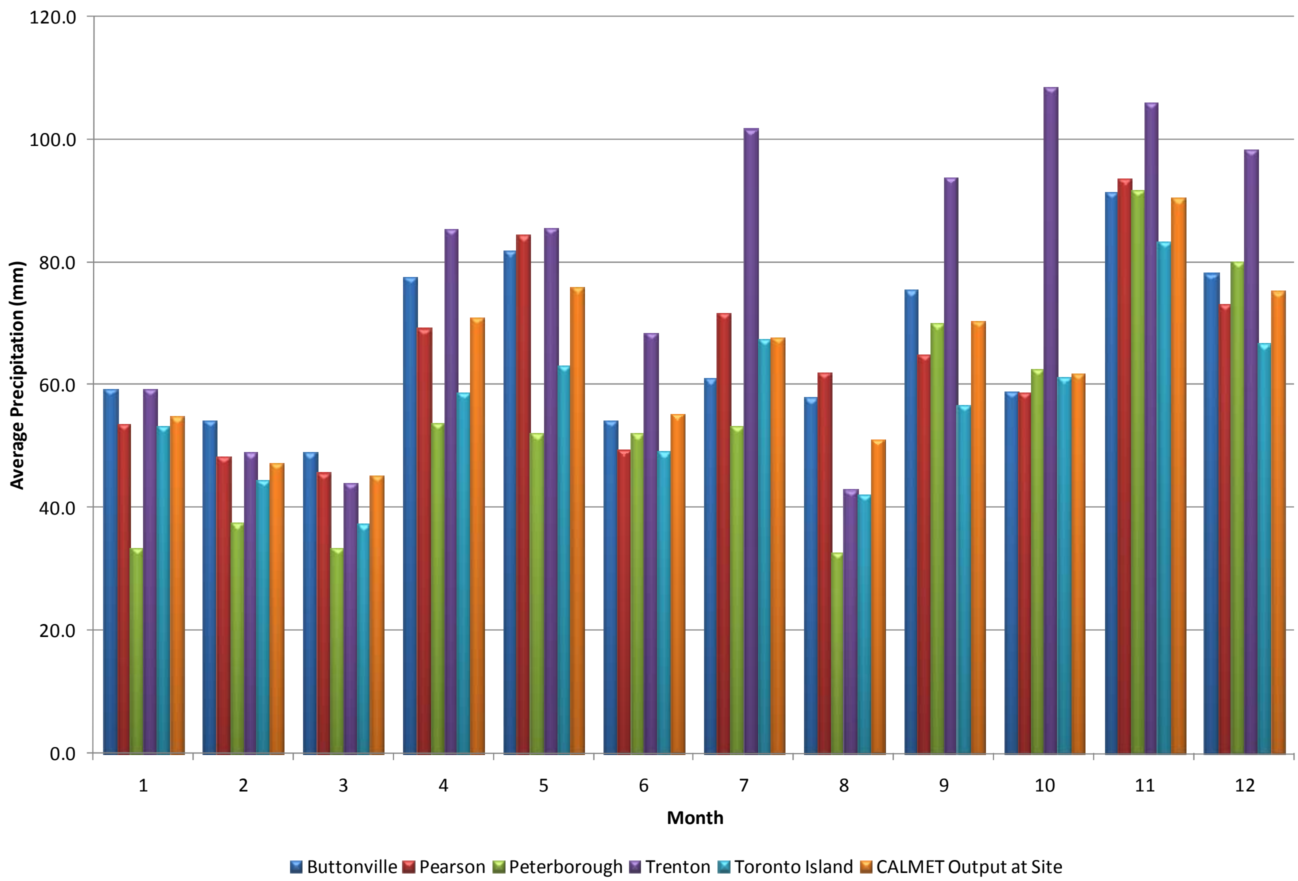


FIGURE D2-13

Output CALMET Level 1 Winds: February 11, 2005 at 1:00 L

Map Parameters
Projection: UTM
Datum: NAD 83
Zone: 17
Map Units: m
DATE: 12/8/2009
PROJECT: 1009497

Figure D2-14 Average Monthly Precipitation from EC Surface Stations and CALMET Output at Site Location (2003-2007)



2.5.4 Stability and Mixing Heights at the Site Location

Atmospheric turbulence near the earth's surface is often described in terms of atmospheric stability, which is governed by both thermal and mechanical factors. Atmospheric stability can, very broadly, be classified as stable, neutral, or unstable.

Stable atmospheric conditions occur when vertical motion in the atmosphere is suppressed. With respect to air quality, this means contaminants released near ground-level are not well-dispersed and are believed to have a larger incremental effect on local ambient levels. This type of situation frequently occurs at night, when the Earth's surface emits thermal radiation and cools. Air in contact with the ground thus becomes cooler and denser than the air aloft. This phenomenon is referred to as a ground-based temperature inversion and is often associated with poor air quality conditions.

Unstable atmospheric conditions are also highly dependent on radiation at the earth's surface, and most frequently occur during daytime hours. During such times, as short-wave energy from the sun heats the ground, air in contact with the ground becomes warmer and less dense than the air aloft. Subsequently, vertical motion in the atmosphere is enhanced and the atmosphere is said to be unstable.

When a balance exists between incoming and outgoing radiation, there is no net heating or cooling of the air in contact with the ground, and vertical motions of the atmosphere are neither enhanced nor suppressed. Such an atmosphere is described as neutral and exists during overcast skies or during transition from unstable to stable conditions.

Mechanical mixing, which is mostly a function of lower level wind speeds (and surface roughness), can also influence atmospheric stability. Higher wind speeds (and a greater surface roughness) promote higher levels of turbulence in the region of discussion. This, in turn, leads to more mechanical mixing, which means that the atmosphere becomes more unstable. Mechanical mixing plays a more important role in determining stability when wind speeds are very high and at night, when convective vertical motion is suppressed.

The relative stability of the Earth's boundary layer is often expressed in terms of the Pasquill-Gifford-Turner (PGT) Stability Classes (Pasquill, 1961). These classes range from Unstable (i.e., Classes A, B and C), through Neutral (i.e., Class D) to Stable (i.e., Classes E and F). Normally, unstable conditions are associated with daytime ground-level heating, which produces thermal turbulence in the boundary layer. Stable conditions are primarily associated with night time cooling which suppresses the turbulence levels and produces temperature inversions at lower levels. Neutral conditions are mostly associated with high wind speeds and overcast sky conditions.

The CALMET predictions of atmospheric stability at the grid cell closest to the site location are shown in Table D2-6. Atmospheric conditions near the site location are shown to be unstable, neutral and stable 18%, 59.3% and 22.7% of the time, respectively. The relatively high proportion of neutral conditions can be attributed to the moderating influence of Lake Ontario.

Table D2-6 CALMET-Predicted Atmospheric Stability at the Site Location (2003-2007)

PG Class	A	B	C	D	E	F
	Very Unstable	Moderately Unstable	Slightly Unstable	Neutral	Slightly Stable	Moderately Stable
Frequency (%)	0.4	6.5	11.1	59.3	13.0	9.7

The CALMET model calculates a maximum mixing height, as determined by either convective or mechanical forces. The convective mixing height is the height to which an air package will rise under the buoyant forces created by the heating of the Earth's surface. The convective mixing height is dependent on solar radiation amount, wind speed, as well as the vertical temperature structure of the atmosphere. Mechanical mixing heights are, similarly, the height to which an air package will rise under the influence of mechanical-invoked turbulence. The mechanical mixing height is proportional to low-level wind speeds and surface roughness.

The height of the mixing layer is an extremely important factor in determining the dispersion of pollution in the atmosphere. The mixing heights under different stability conditions are estimated through different methods based on either surface heat flux (i.e., thermal turbulence) and vertical temperature profile, or friction velocity (i.e., mechanical turbulence) (Scire et al., 2000a).

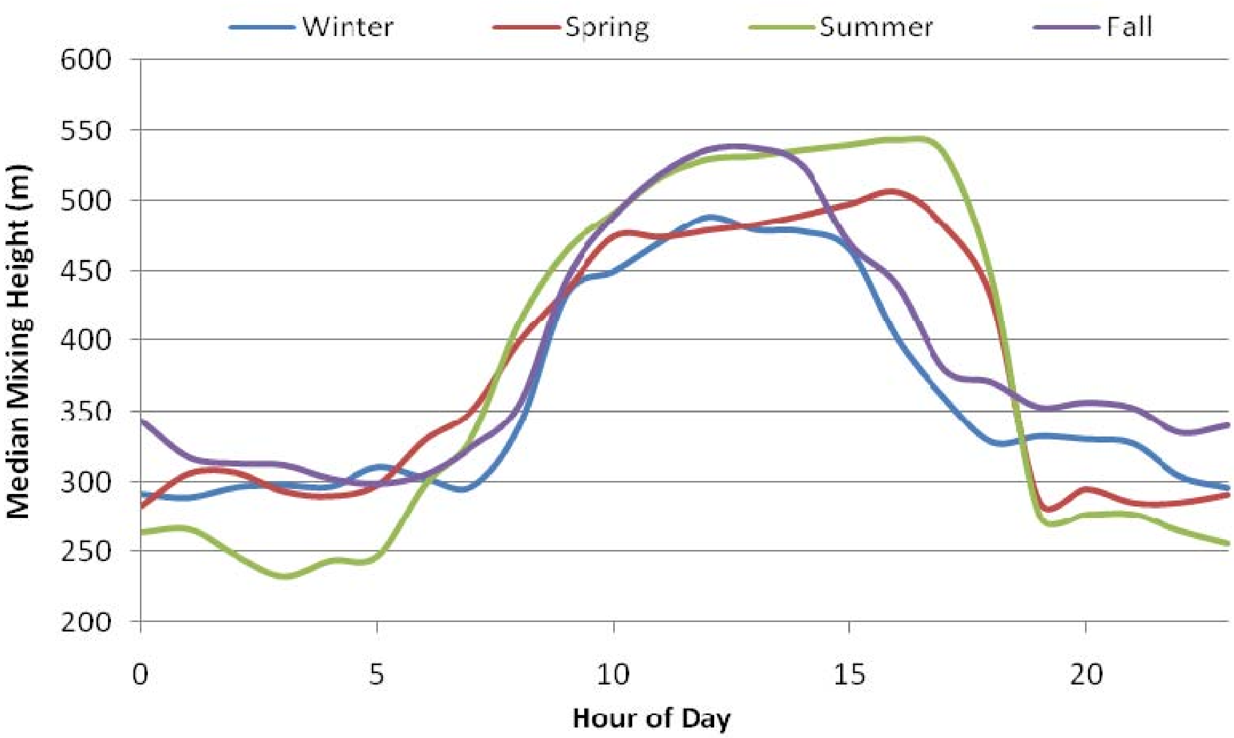
Diurnal variations of median mixing height, as estimated by the CALMET model near the site location are shown for each season in Figure D2-15. Model mixing heights can vary from several meters to several thousand meters, depending on the intensity of solar radiation and wind speed. Daytime mixing heights are generally greater during the summer and fall than during the winter and spring due to different surface radiation budgets. Night time mixing heights are shown to be slightly higher in winter, which is probably due to the influence of stronger winds associated with stronger weather systems, which increase mechanical mixing heights in the model. As expected, maximum mixing heights are seen to occur during mid-afternoon hours when the effects of solar heating are greatest; while minimum mixing heights occur most frequently at night. On an overall basis, the model-predicted mixing heights are relatively low due to the moderating influence of Lake Ontario. Lower mixing heights tend to inhibit dispersion of air contaminants and higher predicted ground-level concentrations (conservative).

2.6 CALMET Model Options

The CALMET model (Version 5.8, Level 070623) was used to predict the meteorological parameters required by the CALPUFF model. The U.S. Environmental Protection Agency has published recommended values for CALMET (US EPA, 1998b). Where possible, the US EPA-recommended values were used. For model options with no US EPA-recommended values, the CALMET model default parameters were chosen, were applicable. All CALMET model options and input data sources were reviewed by the MOE (Liu, personal communication, March 13 2009) prior to the final CALMET model runs.

A sample CALMET input file (for October 2003), showing the values selected for this application, is provided in Attachment D-4. All other CALMET input files are identical to this version, except for the reference file and date parameters.

Figure D2-15 Median CALMET-Predicted Diurnal Mixing Heights by Season near the Site Location (2003-2007)



3.0 CALPUFF MODELLING

3.1 Model Description

The following description of the CALPUFF model's major model algorithms and options are all excerpts from the CALPUFF model's user manual (Scire et al., 2000b).

The CALPUFF model is a non-steady-state Gaussian puff dispersion model which incorporates simple chemical transformation mechanisms, wet and dry deposition, complex terrain algorithms and building downwash. The CALPUFF model is suitable for estimating ground-level air quality concentrations on both local and regional scales, from tens of meters to hundreds of kilometres. It can accommodate arbitrarily varying point sources and gridded area source emissions. Most of the algorithms contain options to treat the physical processes at different levels of detail depending on the model application.

The major features and options of the CALPUFF model are summarized are briefly described below.

- Chemical Transformation CALPUFF includes options for parameterizing chemical transformation effects using the five species scheme (SO_2, SO, NO_x, HNO_3, and NO) employed in the MESOPUFF II model, the six species RIVAD/ARM3 scheme, or a set of user-specified, diurnally-varying transformation rates. The RIVAD/ARM3 reactions separately model NO and NO_2 rather than NO_x. Calculations of chemical transformations require, among other information, a knowledge of background concentrations of ozone and ammonia.

- Subgrid Scale Complex Terrain The complex terrain module in CALPUFF is based on the approach used in the Complex Terrain Dispersion Model (CTDMPLUS) (Perry *et al,.* 1989). Plume impingement on subgrid scale hills is evaluated using a dividing streamline (H_d) to determine which pollutant material is deflected around the sides of a hill (below H_d) and which material is advected over the hill (above H_d). Individual puffs are split into up to three sections for these calculations.

- Puff Sampling Functions A set of accurate and computationally efficient puff sampling routines are included in CALPUFF which solve many of the computational difficulties with applying a puff model to near-field releases. For near-field applications during rapidly varying meteorological conditions, an elongated puff (slug) sampling function can be used. An integrated puff approached is used during less demanding conditions. Both techniques reproduce continuous plume results exactly under the appropriate steady state conditions.

- Wind Shear Effects CALPUFF contains an optional puff splitting algorithm that allows vertical wind shear effects across individual puffs to be simulated. Differential rates of dispersion and transport occur on the puffs generated from the original puff, which under some conditions can substantially increase the effective rate of horizontal growth of the plume.

- Building Downwash The Huber-Snyder and Schulman-Scire downwash models are both incorporated into CALPUFF. An option is provided to use either model for all stacks, or make the choice on a stack-by-stack and wind sector-by-wind sector basis. Both algorithms have been implemented in such a way as to allow the use of wind direction specific building dimensions.

- Over water and Coastal Interaction Effects Because the CALMET meteorological model contains both over water and over land boundary layer algorithms, the effects of water bodies on plume transport, dispersion, and deposition can be simulated with CALPUFF. The puff formulation of CALPUFF is designed to handle spatial changes in meteorological and dispersion conditions, including the abrupt changes that occur at the coastline of a major body of water.

- Dispersion Coefficients Several options are provided in CALPUFF for the computation of dispersion coefficients, including the use of turbulence measurements (σ_v and σ_w), the use of similarity theory to estimate σ_v and σ_w from modelled surface heat and momentum fluxes, or the use of Pasquill-Gifford (PG) or McElroy-Pooler (MP) dispersion coefficients, or dispersion equations based on the Complex Terrain Dispersion Model (CTDM). Options are provided to apply an averaging time correction or surface roughness length adjustment to the PG coefficients.

- Dry Deposition A full resistance model is provided in CALPUFF for the computation of dry deposition rates of gases and particulate matter as a function of geophysical parameters, meteorological conditions, and pollutant species. Options are provided to allow user-specified, diurnally varying deposition velocities to be used for one or more pollutants instead of the resistance model (*e.g.*, for sensitivity testing) or to by-pass the dry deposition model completely.

- Wet Deposition An empirical scavenging coefficient approach is used in CALPUFF to compute the depletion and wet deposition fluxes due to precipitation scavenging. The scavenging coefficients are specified as a function of the pollutant and precipitation type (*i.e.*, frozen vs. liquid precipitation).

3.2 Model Initialization

3.2.1 Computational Domain

The CALPUFF computational domain is the area in which the transport and dispersion of puffs are considered for the calculation of ground level concentrations. Dispersion modelling was conducted using CALPUFF over a computational domain equal to the CALMET meteorological grid defined in Section D2 of this appendix (see Figure D2-2.) As previously mentioned, the CALMET modelling domain (and CALPUFF computation domain) extends beyond the Air Quality Study Area (which covers a 40 km by 30 km area centered approximately 5 km north of the proposed site location). This was done to ensure that plumes were tracked beyond the furthest receptor locations and ensure the worst case ground-level concentrations are considered at all receptors.

3.2.2 Meteorological Data

Meteorological data such as mixing heights, stability and winds determine the transport and dispersion of pollutants within the CALPUFF model. To capture puff behaviour under a variety of meteorological conditions, five years of meteorological data were considered for this application. Hourly three-dimensional meteorological fields for the years spanning 2003-2007 were prepared using the CALMET model, as described in Section D2 of this appendix and used with the CALPUFF model.

3.2.3 Emissions and Source Characteristics

CALPUFF was used to model the dispersion of emissions from Project for a variety of modelling scenarios for all applicable CoPCs to assess potential changes in air quality. For details regarding emission rates and other sources characteristics considered in the modelling, refer to Appendix B and Section 4 of the report.

3.2.4 Building Downwash Effects

For stacks located in the wake region of buildings, enhanced plume dispersion due to turbulent wake and reduced plume rise caused by a combination of descending streamlines in the lee of the building and increased entrainment in the wake may occur. Building wake effects are generally expected to affect a stack if:

1) The stack is located a distance less than 5 times the greater of the building height or width from the building; and,

2) The height of the stack is less than 1.5 times the building height

Since the main stack (or stacks for the 400,000 tpy Facility) exhausts at a height of 87.6 m while the highest buildings on-site are approximately 35 m tall, it is not expected that the resultant plume will interact with the surrounding buildings. However, to be conservative, and to account for downwash in modelling emissions from the emergency generator (which exhausts 2 m above ground), the U.S. EPA Building Profile Input Program (BPIP) Model (US EPA 1997b) was used.

BPIP estimates downwash effects based on the relative locations of emission sources and building configurations. Building heights and source locations were input into the model based on preliminary facility design data. CALPUFF uses the output from the BPIP model to account for the potential influence of building downwash in determining plume dispersion during different meteorological conditions. A three-dimensional rendering of the BPIP inputs (source locations and buildings) is shown in Figure D3-1 for the 140,000 tpy Facility and in Figure D3-2 for the 400,000 tpy Facility. The BPIP input and output files for both the 140,000 tpy and 400,000 tpy Facilities are provided in Attachments D-5 and D-6, respectively.

Figure D3-1 Three-Dimensional Rendering of the BPIP Input for the 140,000 tpy Facility

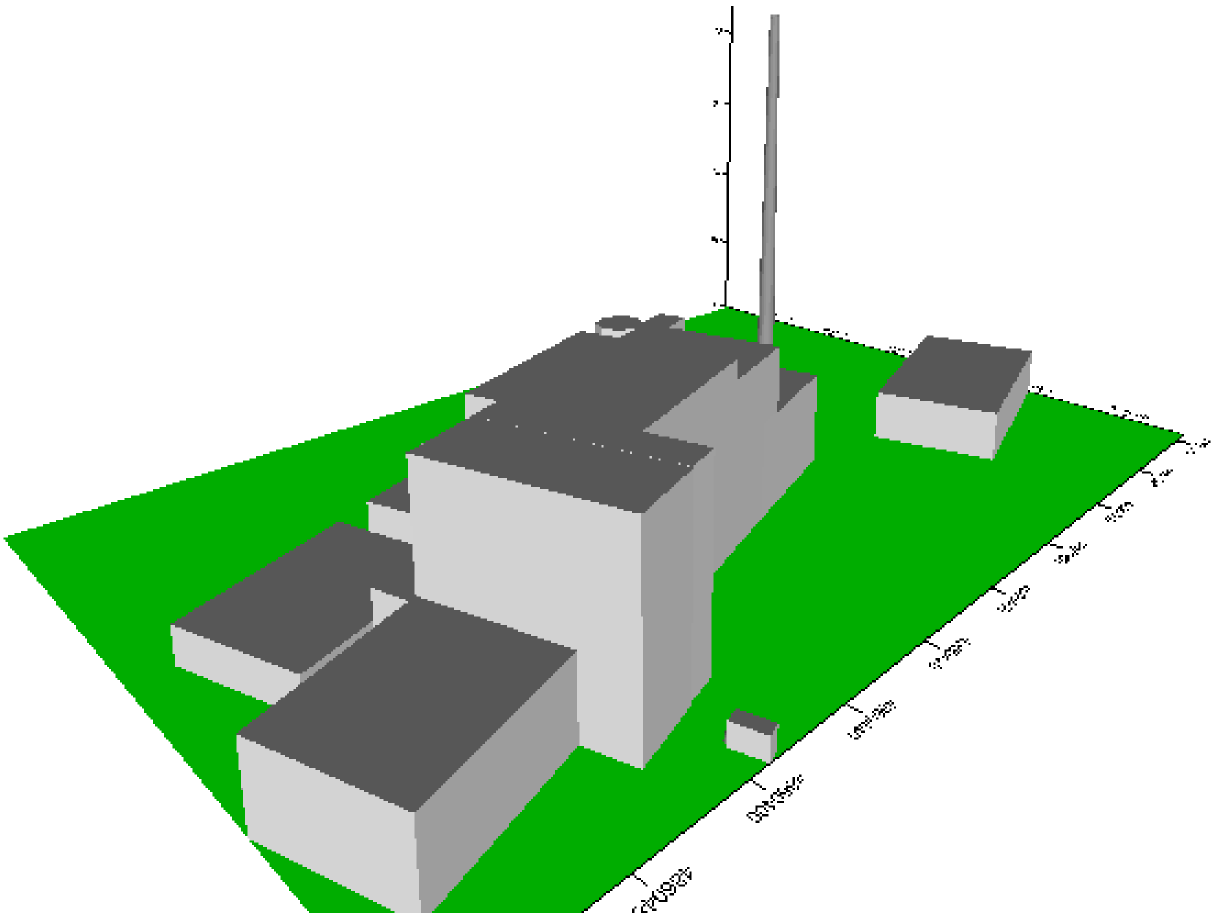
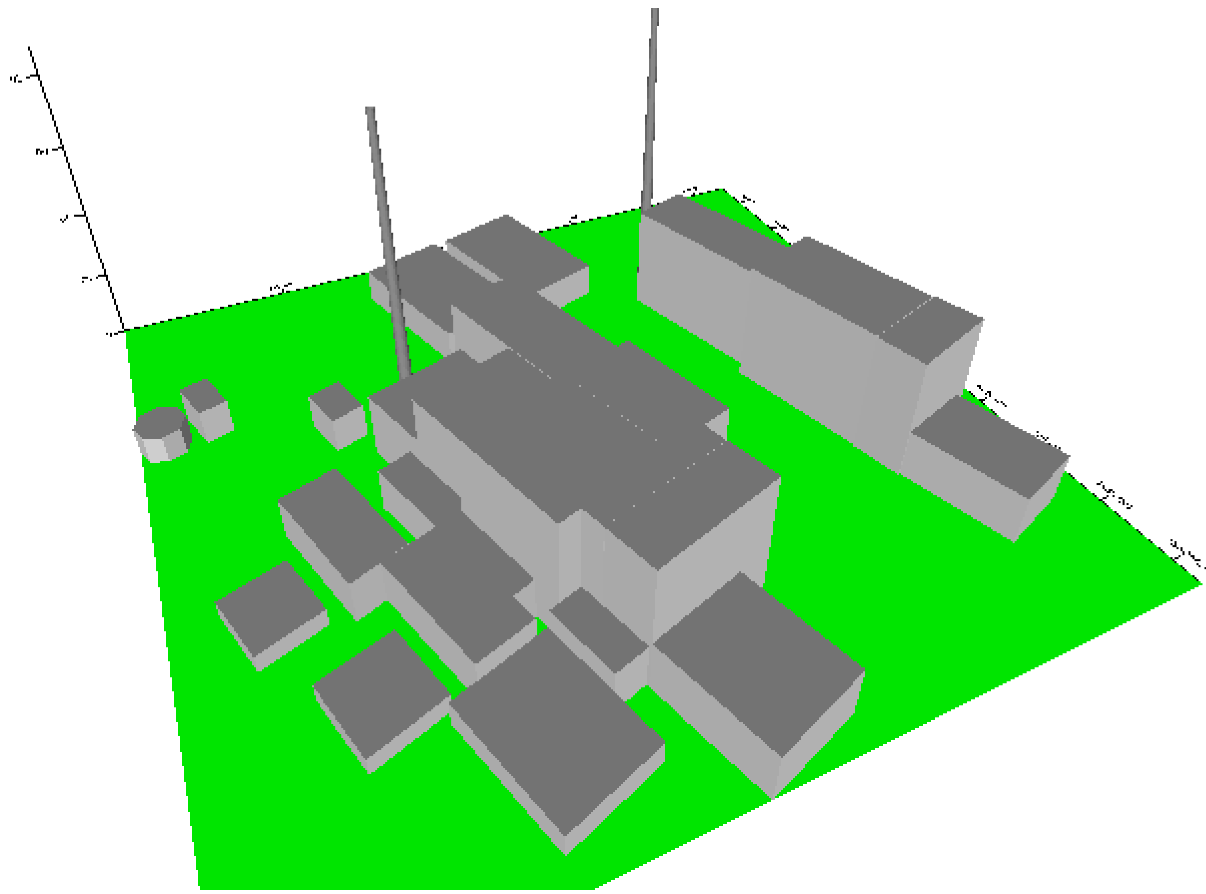


Figure D3-2 Three-Dimensional Rendering of the BPIP Input for the 400,000 tpy Facility



CALPUFF has two model options for downwash calculations (Scire et al. 2000b): the ISC downwash method, and the newer PRIME algorithm. The PRIME method was chosen because it is more up-to-date and recommended for most regulatory applications.

3.2.5 Model Receptors

Two different types of receptors, or points of computation for model-output values over different averaging periods, were considered for the CALPUFF modelling: a nested series of gridded receptors and discrete receptors at specific locations of interest.

A nested series of gridded receptors were used to determine the maximum predicted GLC over the modelling domain due to Project-related emissions. The same receptor grid was used for both the 140,000 tpy and 400,000 tpy Facilities. As shown in Figure D3-3, this grid consists of more densely spaced receptors near the proposed site location, gradually becoming sparser with distance from site. The nested gridded receptors cover the 40 by 30 km Air Quality Study Area and were designed in accordance with the specifications laid out in the Ontario MOE Dispersion Modelling Guideline A-11 (MOE 2009a). The specifications used to select the nested gridded receptors were:

- 10 m receptor spacing along the property boundary;
- 20 m receptor spacing within 0.2 km of the sources;
- 50 m receptor spacing within 0.5 km of the sources;
- 100 m receptor spacing within 1.0 km of the sources;
- 200 m receptor spacing within 2.0 km of the sources;
- 500 m receptor spacing within 5.0 km of the sources; and,
- 1,000 m spacing beyond 5.0 km (out to 20 km in the north, east, and west directions; and out to 10 km to the south).

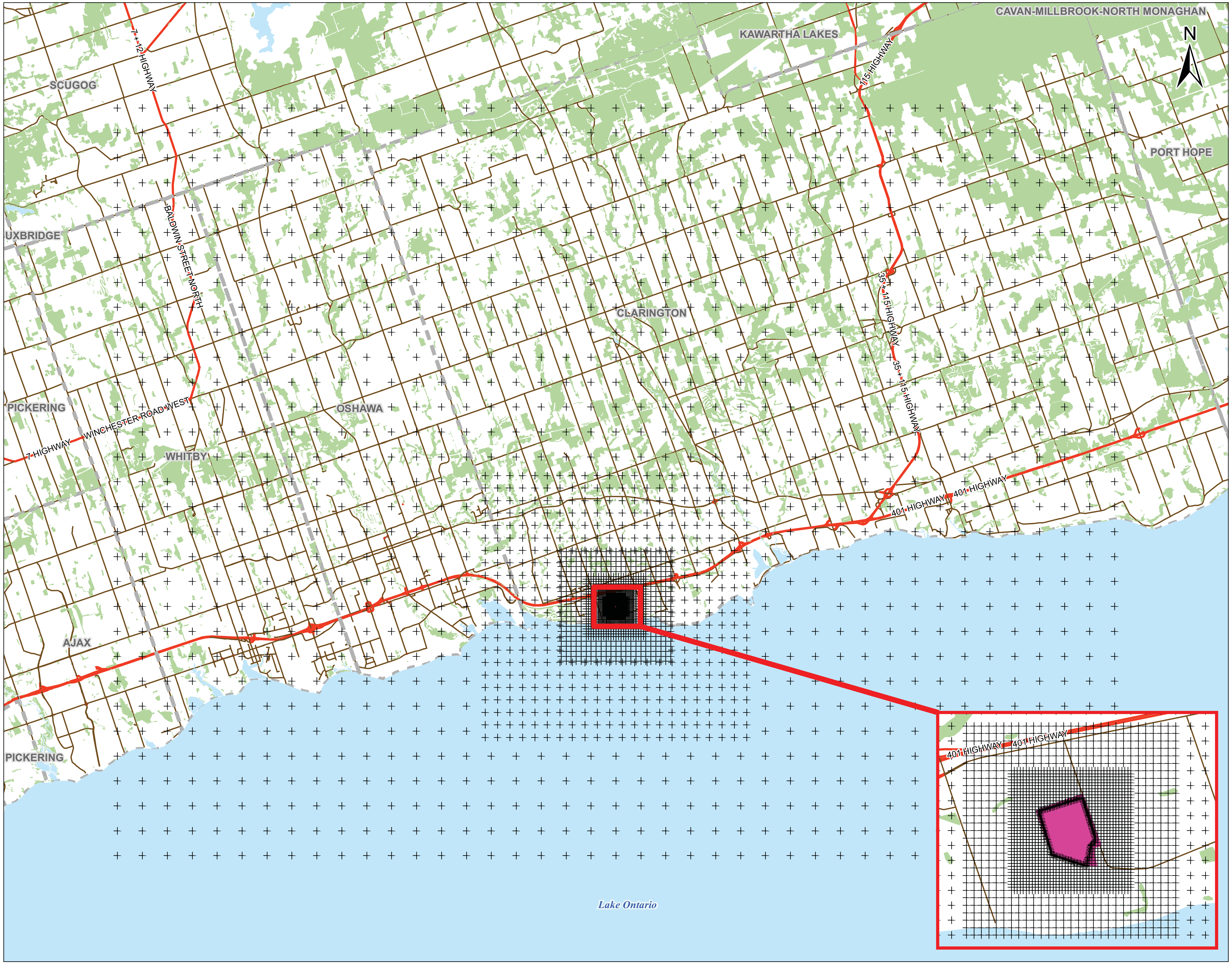
Model predictions were also made at approximately 400 discrete receptors chosen to represent locations of interest within the model domain including:

- Hospitals;
- Nursing homes;
- Schools;
- Daycares;
- Senior citizen’s centers;
- Nearest residential receptors;
- Specific watersheds and water bodies; and,
- Parks.

YORK REGION AND DURHAM REGION
RESIDUAL WASTE STUDY

Nested Cartesian Gridded Receptors

Data Provided By: Ministry of Natural Resources, 2008
Produced by Jacques Whitford under Licence with the Ontario
Ministry of Natural Resources © Queen's Printer for Ontario, 2004-2009



- \+ Nested Cartesian Gridded Receptor
- Collector
- Highway
- Proposed EFW Facility Site
- Waterbody
- Wooded Area
- Municipal Lower tier Boundaries

0 1.5 3 4.5
Kilometres

Inset Map
0 250 500 750
Metres

1009497-043

Jacques Whitford

FIGURE NO.
D3-3

Last Modified: May 5, 2009 By: S.Allen

CALPUFF was used to predict maximum short-term and annual average ground-level concentrations and deposition fluxes at these receptor locations for input into the human health and ecological risk assessment. In addition, the predicted air contaminant concentrations at these receptor locations were analyzed as part of the Air Quality Study. A listing of the sensitive receptors selected and the relative location of each point are provided in Table 3-9, Figure 3-1, and Figure 3-2 in the main body of this report.

3.2.6 Terrain Effects

Although the study area is relatively flat, terrain effects were still considered in the modelling exercise. To account for possible changes in plume trajectory over elevated terrain, the CALPUFF model's Partial Plume Path Adjustment Method (PPPAM) was used to modify the height of the plume.

The PPPAM employs a plume path coefficient (PPC) to adjust the height of the plume above the ground. Default PPC values of 0.5, 0.5, 0.5, 0.5, 0.35, and 0.35 for PG stability classes A, B, C, D, E, and F, respectively are recommended by the CALPUFF authors and were used in this study.

3.2.7 Dispersion Coefficients

A fundamental parameter controlling plume dispersion in a Gaussian model such as CALPUFF are the dispersion coefficients. These values, which must be specified for both the horizontal as well as the vertical directions in the model, can be computed using several different methods in CALPUFF. The two U.S. EPA-approved methods are:

- From internally calculated turbulence values using micrometeorological variables (MDISP=2; MPDF=1)
- By using the PG dispersion coefficients for RURAL areas and the MP coefficients for urban areas (MDISP=1,MPDF=0)

The first method is similar to that used in the AERMOD regulatory dispersion model, while the second is similar to that used in the now-outdated ISC dispersion model. Method 1 was chosen for this assessment.

3.2.8 Chemical Transformation

For the purposes of assessing Project contributions to Secondary Particulate Matter (SPM) formation, chemical transformation was considered in the CALPUFF modelling.

To model the chemical transformation of emitted NO, NO_2 and SO_2 into HNO_3, NO_3, and SO_4, CALPUFF's RIVAD/ARM3 chemical mechanism was used. This scheme is one of two recommended by the U.S. EPA (U.S. EPA, 1998b). The model's authors recommend using the RIVAD/ARM3 scheme in non-urban areas (Scire et al., 2000b). As the majority of the Air Quality Study Area is rural, this mechanism was considered preferable for this application. A sensitivity analysis using the alternative MESOPUFF II mechanism showed the SPM concentrations predicted by the RIVAD/ARM3 mechanism to be more conservative.

Both the MESOPUFF II and RIVAD/ARM3 chemical mechanisms in CALPUFF require estimates of ground level ozone and ammonia concentrations. For this application, monthly average ozone concentrations collected as part of the onsite sampling program (see Appendix A) were used. As no background ammonia data was available, the suggested model default average monthly concentration (10 ppb) was used.

3.2.9 Model Deposition Parameters

The consideration of deposition in CALPUFF means that contaminant mass will also be depleted from the transporting plume (resulting in lower predicted maximum ground-level concentrations). Therefore, to be conservative, deposition and plume depletion were not considered when predicting ground level CoPC concentrations for comparison to regulatory criteria. Deposition (and associated plume depletion) was considered in separate model runs to determine deposition fluxes at the special receptors for use in the human health and ecological risk assessment.

For the CALPUFF model, there is only limited deposition parameter data available in the model's species library (Scire, personal communication, May 23, 2007). In the absence of any extensive list of CALPUFF deposition parameters for the CoPCs considered in this study, guidance for the selection of model deposition parameters was taken from the US EPA's Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (U.S. EPA, 2005b), and Volume II of the ISC User's Guide (U.S. EPA, 1995b). From these guidance documents, the following assumptions and methods were used.

- All metals (except mercury) and dioxins/furans were assumed to be emitted as very small particles.
- All VOC and PAH were assumed to be emitted as vapours.
- All emitted mercury was assumed to be divalent and was assumed to be emitted as a vapour.
- To estimate the dry deposition of vapours, the CALPUFF dry deposition resistance model was by-passed due to uncertainty in the parameterization of the required input parameters to run the resistance model. Instead, the following constant deposition velocities, as recommended in the US EPA HHRAP document were considered (U.S. EPA, 2005b):
  - For organics, a deposition velocity of 0.5 cm/s was used; and
  - For divalent mercury, a deposition velocity of 2.9 cm/s was used.

- To estimate the wet deposition of vapours, Figure 1-11 in Volume II of the ISC User's Guide (US EPA, 1995b) was used to determine a wet scavenging rate coefficient, based an assumed particle diameter size of 0.1 microns (U.S. EPA, 2005b).
- To estimate the dry deposition of particles, a mean particle size of 2.5 microns was conservatively chosen based on expected particle sizes of emissions from the facility and consultation with the MOE (Liu, personal communication, February 6, 2009). A standard deviation of 0 was assumed.
- To estimate the wet deposition of particles, based on the rationale above, a conservative mean particle size of 1.0 microns was chosen. Figure 1-11 in Volume II of the ISC User's Guide (U.S. EPA, 1995b) was used to determine the corresponding wet scavenging rate coefficient.

3.2.10 Thermal Internal Boundary Layer

CALPUFF contains an option to account for sub-grid scale coastal influences on plume dispersion such as the development of a thermal internal boundary layer (TIBL). Given the proximity of the proposed facility to Lake Ontario (approximately 500 m) and the grid size (250 m), variations in coastline location within the grid cells near the proposed facility were accounted for in the dispersion modelling. To achieve this, a digitized sub-grid coastline, extending to the boundaries of the Air Quality Study Area, was included as an additional source of input into CALPUFF.

To examine the influence the CALPUFF sub-grid TIBL module had on model results, additional simulations were conducted with this model option turned off. The results of this sensitivity analysis showed changes in maximum predicted concentrations that varied greatly depending on the relative proximity of the receptor to the coastline and the site. Approximately 27% of special receptors had maximum hourly average concentrations that, with TIBL effects included, increased between 1% to 56% of their maximum concentrations when TIBL effects were not included, while 29% of special receptors had decreases of between -1% to -29% , and 44% showed changes of less than ±1%. Thus, for certain receptors, TIBL effects caused increases in maximum predicted ground level concentrations, while for others the TIBL effects resulted in decreases in maximum ground level concentrations. These predictions are consistent with expectations as the TIBL effect can, in some instances, cause rapid fumigation of a plume to ground causing higher ground level concentrations in the vicinity of the plume "touch-down" relative to a non-TIBL case, but with greater dispersion (and therefore lower concentrations) at distances farther afield due to higher turbulence. TIBL effects would not be expected to occur at all receptors due to their locations relative to the site and the shoreline, and this was seen in the results of the sensitivity study.

3.3 Model Options

The CALPUFF dispersion model (Version 5.8, Level 070623) was used for all dispersion modelling conducted in this study. Where possible, the US EPA-recommended values (U.S. EPA, 1998b) were used. For model options with no US EPA-recommended values, the CALPUFF model default parameters were chosen, where applicable. CALPUFF model options and input data sources were reviewed by the MOE (Liu, personal communication, April 3 2009).

A sample CALPUFF input file, showing the model options selected for this study, is provided in Attachment D-7. Note that the parameterization provided in this sample file represents a specific emissions scenario used to model specific air contaminants over a particular receptor grid (in this case a unit emission rate from the main stack assuming MCR operating conditions, without deposition, and at sensitive receptor locations). Therefore, case-specific model parameters (*i.e.*, the number of sources modelled, number of receptors, species considered, chemical transformation and deposition options) would have different values for different model runs.

3.4 CALPUFF Post-processing

3.4.1 Secondary Particulate Matter Formation Calculation

Secondary Particulate Matter (SPM) formation results from a series of chemical reactions from precursor gases, and can be an important constituent of particulate matter (PM). In some cases, compounds such as ammonium nitrate have be shown to make up more than 50% of $PM_{2.5}$ in urban areas, and even more in non-urban areas (Watson and Chow 2002). As concentrations for both nitrates and sulphates can be estimated by CALPUFF's RIVAD/ARM3 Chemical Mechanism (see Section 3.2.8), this model output was used to estimate the potential effect the Project might have on SPM formation.

For the purposes of this report, SPM formation was conservatively considered by assuming that sufficient ammonium was present in the atmosphere to react with all the sulphate and nitrate in the atmosphere. The resulting products (ammonium sulphate and ammonium nitrate) were assumed to constitute all SPM in the region. This is a conservative assumption as in reality, a fraction of either the sulphate and nitrate aerosols may not combine with the ammonium ion to form SPM, and thus the relative concentration could be much smaller. The model-predicted ground-level concentrations of sulphate and nitrate were used to estimate Secondary Particulate Matter as follows:

$$[SPM]_{conc} = 1.376\,[SO_4]_{conc} + 1.291[NO_3]_{conc}$$

where the concentrations in the equations above are expressed in units of $\mu g/m^3$, and the leading constants are the respective ratios of the molecular mass of ammonium to those of sulphate/nitrate (Malm 2000).

Concentrations of SPM were predicted in separate model runs so that NO_X and SO_2 would not be depleted in predicting maximum ground-level concentrations. The model-predicted SPM was added to the primary (emitted directly from Project operations) for each hour of the modelling period (2003-2007). Then, maximum ground-level concentrations for PM, PM_{10}, and $PM_{2.5}$ were calculated for pertinent averaging periods for comparison with the regulatory standards. Thus, all model-predicted PM, PM_{10}, and $PM_{2.5}$ concentrations include both primary and secondary particulate matter due to facility operations.

4.0 MODEL PREDICTION CONFIDENCE

In the US Guideline on Air Quality Models (U.S. EPA, 2005a), the need to address the uncertainties associated with dispersion modelling is acknowledged as an important issue that should be considered. The US Guideline divides the uncertainty associated with dispersion model predictions into two main types (U.S. EPA, 2005a), as follows.

- Reducible uncertainty, which results from uncertainties associated with the input values and with the limitations of the model physics and formulations. Reducible uncertainty can be minimized by improved (*i.e.*, more accurate and representative) measurements and improved model physics.
- Inherent uncertainty is associated with the stochastic (turbulent) nature of the atmosphere and its representation (approximation) by numerical models. Models predict concentrations that represent an ensemble average of numerous repetitions for the same nominal event. An individual observed value can deviate significantly from the ensemble value. This uncertainty may be responsible for a ± 50% deviation from the measured value.

There is no disputing that models are inherently uncertain. Both reducible and inherent uncertainties mean that dispersion modelling results may over- or under-estimate measured ground-level concentrations at a specific time or place. However, the US Guideline on Air Quality Models (U.S. EPA, 2005a) also states the following, which summarizes quite well what is accepted by the dispersion modelling community for regulatory applications:

> *"Models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of +/- 10 to 40 percent are found to be typical, i.e., certainly well within the often-quoted factor of two accuracy that has long been recognized for these models. However, estimates of concentrations that occur at a specific time and site, are poorly correlated with actually observed concentrations and are much less reliable."*

Thus, although model uncertainty is important to consider, when dispersion models such as CALPUFF are used for regulatory applications to assess maximum ground-level concentration and when a sufficiently large number of meteorological conditions are considered, the modelling results should fall well within the often quoted "factor of two" accuracy for these modelled (U.S. EPA, 2005a).

The US Guideline on Air Quality Models also provides pragmatic advice regarding what is to be done about the uncertainties associated with dispersion modelling in a regulatory context:

> *" … (W)hile (information regarding uncertainty) can be provided by the modeller to the decision-maker, it is unclear how this information should be used to make an air pollution control decision. Given a range of possible outcomes, it is easiest and tends to ensure consistency if the decision-maker confines his judgement to the use of the "best guess" estimate provided by the modeler … This is an indication of the practical limitations imposed by current abilities of the technical community."*

Thus, from a regulatory perspective, and given that there remains uncertainty surrounding model accuracy, it is standard practice to accept the modeller's best estimate as to what the maximum change in air quality will be as the main piece of evidence in the final decision. Thus, although the existence of model uncertainty is well-accepted, it does not mean that important environmental decisions cannot be made based on dispersion modelling results – it should simply be acknowledged and understood that given their inherent uncertainty, models are a best case approximation of what are otherwise very complex physical processes in the atmosphere, and should be used as one of many tools in the regulatory decision-making "toolbox".

It should be noted that for the modelling done in this study, emission rates were estimated based on a combination of emission factors, engineering estimates based on preliminary design, and maximum emission levels based on manufacturer's specifications. Actual emissions vary from hour to hour and day to day. Emissions from the Project employed a conservative maximum hourly emissions approach consistent with the requirements of the Ontario MOE (MOE, 2009b), which is expected to over-estimate longer-term averaging periods. Because of the nature of this approach, there is a high degree of confidence that emissions are over-estimated and include considerable conservatism.

In addition, air quality dispersion models such as CALPUFF also employ assumptions to simplify the random behaviour of the atmosphere into short periods of average behaviour. These assumptions limit the capability of the model to replicate every individual meteorological event. To compensate for these simplifications, five years of meteorological data are applied to evaluate a wide range of possible conditions. Furthermore, regulatory models, such as CALPUFF, are designed to have a bias toward over estimation of contaminant concentrations (*i.e.*, to be conservative under most conditions).

Therefore, on an overall basis, it is expected that the CALPUFF modelling provides conservative estimates of maximum ground-level concentrations during adverse meteorological conditions.

ATTACHMENT D-1

MOE Form 5352 – Request for Use of Alternate Model

Ministry of the Environment | Ministère de l'Environnement

Ontario

REQUEST UNDER s.7(1) OF REGULATION 419/05 FOR USE OF A SPECIFIED DISPERSION MODEL

General Information

Information requested in this form is collected under the authority of the *Environmental Protection Act*, R.S.O. 1990 (EPA) and the *Environmental Bill of Rights*, C. 28, Statutes of Ontario, 1993, (EBR) and will be used to evaluate requests for the use of a specified dispersion model under s.7 of O. Reg. 419/05. **INCOMPLETE FORMS WILL BE RETURNED TO THE REQUESTOR.** The Ministry of the Environment may request additional information during the review of this request of any form accepted as complete.

1. Technical questions regarding the suitability of specified models may be directed to the Environmental Monitoring and Reporting Branch (EMRB). Questions regarding completion and submission of this request should be directed to the Environmental Assessment and Approvals Branch (EAAB) of the Ministry of the Environment at the address below or to the local District Office which has jurisdiction over the area where the facility is located. A list of these District Offices is available on the Ministry of the Environment Internet site at http://www.ene.gov.on.ca/envision/org/op.htm#Reg/Dist.

2. Three copies of this form must be submitted to the Ministry of the Environment.

   The original should be sent to:

   Ministry of the Environment,
   Director, O. Reg. 419/05, s.7
   Environmental Assessment and Approvals Branch
   2 St. Clair Avenue West, Floor 12A
   Toronto, Ontario M4V 1L5
   Phone: 416-314-8001
   Toll Free: 1-800-461-6290
   Email: EAABGen@ene.gov.on.ca

   A copy should be sent to:

   Ministry of the Environment
   Director, O. Reg. 419/05, s.7
   Environmental Monitoring and Reporting Branch
   125 Resources Road
   Toronto (Etobicoke), Ontario M9P 3V6
   Phone: 416-235-6300

   A copy of this form should also be sent to the local District Office which has jurisdiction over the area where the facility is located.

3. Information contained in this request form is not considered confidential and will be made available to the public upon request. Information submitted as supporting information may be claimed as confidential but will be subject to the *Freedom of Information and Protection of Privacy Act* (FOIPPA) and the *EBR*. If you do not claim confidentiality at the time of submitting the information, the Ministry of the Environment may make the information available to the public without further notice to you.

Instructions

This form should be used to request the use of a specified dispersion model as required by the Air Pollution – Local Air Quality Regulation (O. Reg. 419/05), s. 7 (1) and should be accompanied by a description of the circumstances surrounding this request. In accordance with s. 7(1) a person who discharges or causes or permits the discharge of a contaminant from a property may also request the Director to consider issuing written notice under subsection 7 (1) of O. Reg. 419/05 indicating that a specified model, or combination of models and/or specified models, would assess concentrations of contaminants discharged from the property at least as accurately as an Approved Dispersion Model listed under s.6 (2) of O. Reg. 419/05. For more information about air dispersion modelling, please refer to the "Air Dispersion Modelling Guideline for Ontario". This document and other related publications are available on the Ministry of the Environment Internet site at http://www.ene.gov.on.ca/envision/gp/index.htm#PartAir.

Regulatory Authority

7. (1) Under this regulation the Director may give written notice to a person who discharges or causes or permits the discharge of contaminants from a property stating that the Director is of the opinion that, with respect to discharges of a contaminant from that property,

(a) one or more dispersion models specified in the notice would predict concentrations of the contaminant at least as accurately as an approved dispersion model;
(b) a combination specified in the notice of two or more dispersion models would predict concentrations of the contaminant at least as accurately as an approved dispersion model;
(c) a combination specified in the notice of one or more dispersion models and one or more sampling and measuring techniques would predict concentrations of the contaminant at least as accurately as an approved dispersion model; or
(d) one or more approved dispersion models specified in the notice would predict concentrations of the contaminant less accurately than,
(i) a dispersion model or combination specified under clause (a), (b) or (c), or
(ii) another approved dispersion model. O. Reg. 419/05, s. 7 (1).

1. Requestor Information *(Owner of works/facility)*

Requestor Name *(legal name of individual or organization as evidenced by legal documents)* Regional Municipalities of York and Durham	Business Identification Number N/A
Business Name *(the name under which the entity is operating or trading if different from the Requestor Name - also referred to as trade name)*.	
Requestor Type: ☐ Corporation ☐ Federal Government ☐ Individual ☒ Municipal Government ☐ Partnership ☐ Provincial Government ☐ Sole Proprietor ☐ Other *(describe)*:	North American Industry Classification System (NAICS) Code N/A
Business Activity Description *(a narrative description of the business endeavour, this may include products sold, services provided or machinery/equipment used, etc.)*	

2. Site Information

Site Name Clarington 01			MOE District Office York-Durham District Office		
Address Information: Site Address - Street information *(address that has civic numbering and street information includes street number, name, type and direction)* 72 Osborne Road				Unit Identifier *(i.e. suite or apartment number)*	
Survey Address *(used for a rural location specified for a subdivided township, an unsubdivided township or unsurveyed territory)*					
Lot and Conc.: used to indicate location within a subdivided township and consists of a lot number and a concession number Lot	Conc.	Part and Reference: used to indicate location within an unsubdivided township or unsurveyed territory, and consists of a part and a reference plan number indicating the location within that plan. Attach copy of the plan Part		Reference Plan	
Non Address Information *(includes any additional information to clarify the requestor's physical location)*					
Municipality/Unorganized Township Clarington		County/District Durham		Postal Code ON	
Geo Reference(mandatory)					
Map Datum NAD83	Zone 17N	Accuracy Estimate +/- 10 m	Geo Referencing Method	UTM Easting 680548	UTM Northing 48060353
Which of the following section of O. Reg. 419/05 currently applies to your facility? ☐ s.18 (Schedule 1) ☐ s.19 (Schedule 2) ☐ s.20 (Schedule 3)					

3. Project Technical Information Contact

Name Greg Crooks			Company Jacques Whitford Ltd	
Civic Address - Street information *(address that has civic numbering and street information includes street number, name, type and direction)* 7271 Warden Ave				Unit Identifier *(i.e. suite or apartment number)*
Delivery Designator: If signing authority mailing address is a Rural Route, Suburban Service, Mobile Route or General Delivery *(i.e., RR#3)*				
Municipality Markham	Postal Station	Province/State ON	Country Canada	Postal Code L3R 5X5
Telephone Number *(including area code & extension)* 905.474.7003		Fax Number *(including area code)* 905.479.9326	E-mail Address greg.crooks@jacqueswhitford.com	

4. Reason(s) for Request

The use of a specified model is being requested in regards to (check all that apply):

- ☐ An application for a Certificate of Approval
  (Please provide Certificate of Approval Number or Application Reference Number):
- ☐ A submission under s.23, s.24 or s.25 of O. Reg. 419/05 (to prepare an Emission Summary and Dispersion Modelling (ESDM) Report)
- ☐ An ESDM Report required by s.30 (exceedence of Upper Risk Thresholds)
- ☐ A request for approval of an alteration of a Schedule 3 standard under s. 32 of O. Reg. 419/05
- ☐ Abatement activity
- ☒ Other *(please indicate)*: Dispersion Modelling in Support of EA

5. Information about the Specified Model(s)

☐ This is a request to use a specified model in combination with a currently approved model

Are the following attached or submitted?

Name of Specified Model being requested for use in combination with currently approved model	☐ Yes	☐ No (if no, reason?)
Site Specific Circumstance that warrant the use of the specified model	☐ Yes	☐ No (if no, reason?)
Scenarios under which the combination of models would be used	☐ Yes	☐ No (if no, reason?)

☒ This is a request to use a specified model listed in the Air Dispersion Modelling Guideline for Ontario

Are the following attached or submitted?

Name of Specified Model being requested	☒ Yes	☐ No (if no, reason?)
Site Specific Circumstance that warrant the use of the specified model	☒ Yes	☐ No (if no, reason?)

☐ This is a request to use a specified model not listed in the Air Dispersion Modelling Guideline for Ontario

Are the following attached or submitted?

Name of Specified Model being requested	☐ Yes	☐ No (if no, reason?)
An executable copy of the specified model (or reference to where it can be obtained)	☐ Yes	☐ No (if no, reason?)
Site specific circumstance that warrant the use of the specified model	☐ Yes	☐ No (if no, reason?)
A copy of the user guide specific to the dispersion model named above	☐ Yes	☐ No (if no, reason?)
A copy of any technical guidance available on the dispersion model named above	☐ Yes	☐ No (if no, reason?)
A copy of any evaluation (e.g. comparison with monitoring studies, beta testing results) pertaining to the dispersion model named above	☐ Yes	☐ No (if no, reason?)

☐ This is a request to use a specified model in combination with monitoring

Contact the Environmental Monitoring and Reporting Branch for pre-submission consultation

6. Additional Facility Information

General Supporting Information Required	Attached or Submitted?		If No, reason?
Site Plan	☒ Yes	☐ No	
Location of Stacks & Buildings Identified	☐ Yes	☒ No	Info not currently available
Elevation Plan	☐ Yes	☒ No	Info not currently available
Physical Location Information	☐ Yes	☒ No	Info not currently available
Surrounding Building Information	☐ Yes	☒ No	Info not currently available
Local Terrain Information	☐ Yes	☒ No	Info not currently available
Downwash Effect Described (if applicable)	☐ Yes	☒ No	Info not currently available

7. Statement of Requestor

I, the undersigned hereby declare that, to the best of my knowledge:

- The information contained herein and the information submitted in support of this application is complete and accurate in every way and I am aware of the penalties against providing false information as per s.184(2) of the *Environmental Protection Act*.
- The Project Technical Information Contact identified this form is authorized to act on my behalf for the purpose of obtaining approval for use of a specified dispersion model under Section 7 of O. Reg. 419/05 for the equipment/processes identified herein.
- I have used the most recent request form (as obtained from the Ministry of the Environment Internet site at http://www.ene.gov.on.ca/envision/gp/index.htm#PartAir or the Environmental Assessment and Approvals Branch at 1-800-461-6290) and I have included all necessary information required by O. Reg. 419/05 or identified on this form.

Name of Signing Authority *(please print)*: Cliff Curtis

Title: Commissioner, Works Department, Durham Region

Telephone Number *(including area code & extension)*: 905.668.4113 x3417

Fax Number *(including area code)*: 905.668.2051

E-mail Address: works@region.durham.on.ca

Signature: [signature]

Date *(dd/mm/yyyy)*: 18/11/2008

Address Information:

Civic Address - Street information *(address that has civic numbering and street information includes street number, name, type and direction)*: 605 Rossland Rd. E.

Unit Identifier *(i.e. suite or apartment number)*:

Delivery Designator: If signing authority mailing address is a Rural Route, Suburban Service, Mobile Route or General Delivery *(i.e., RR#3)*

Municipality	Postal Station	Province/State	Country	Postal Code
Whitby	P.O. Box 623	ON	Canada	LIN 6A3

ATTACHMENT D-2

Sample WRF Input File

```
 &time_control
 run_days                            = 1,
 run_hours                           = 6,
 run_minutes                         = 0,
 run_seconds                         = 0,
 start_year                          = 2007, 2007, 2007,
 start_month                         = 05,   05,   05,
 start_day                           = 10,   10,  10,
 start_hour                          = 00,   00,  00,
 start_minute                        = 00,   00,  00,
 start_second                        = 00,   00, 00,
 end_year                            = 2007, 2007, 2007,
 end_month                           = 05,   05,  05,
 end_day                             = 11,   11,  11,
 end_hour                            = 06,   06,  06,
 end_minute                          = 00,   00,  00,
 end_second                          = 00,   00,  00,
 interval_seconds                    = 10800
 input_from_file                     = .true.,.false.,.false.,
 history_interval                    = 60,  60,  60,
 frames_per_outfile                  = 1000,  1000, 1000,
 restart                             = .false.,
 restart_interval                    = 2880,
 io_form_history                     = 2
 io_form_restart                     = 2
 io_form_input                       = 2
 io_form_boundary                    = 2
 debug_level                         = 0
 /

 &domains
 time_step                           = 180,
 time_step_fract_num                 = 0,
 time_step_fract_den                 = 1,
 max_dom                             = 3,
 s_we                                = 1,     1,    1,
 e_we                                = 74,    82,   82,
 s_sn                                = 1,     1,    1,
 e_sn                                = 61,    70,   70,
 s_vert                              = 1,     1,    1,
 e_vert                              = 48,    48,  48,
 eta_levels                          = 1.0000, 0.9976, 0.9948, 0.9920,
0.9890,
                                       0.9858, 0.9825, 0.9790, 0.9754,
0.9718,
                                       0.9679, 0.9637, 0.9590, 0.9538,
0.9480,
                                       0.9340, 0.9144, 0.9020, 0.8883,
0.8582,
                                       0.8253, 0.8079, 0.7714, 0.7523,
0.7124,
                                       0.6915, 0.6699, 0.6477, 0.6255,
0.6015,
                                       0.5779, 0.5540, 0.5300, 0.507,
0.444,
                                       0.380, 0.324, 0.273, 0.228,
0.188,
                                       0.152, 0.121, 0.093, 0.069,
0.048,
                                       0.029, 0.014, 0.000,
```

```
 num_metgrid_levels                  = 27
 dx                                  = 36000, 12000, 4000,
 dy                                  = 36000, 12000, 4000,
 grid_id                             = 1,     2,    3,
 parent_id                           = 0,     1,    2,
 i_parent_start                      = 0,     31,    35,
 j_parent_start                      = 0,     17,    23,
 parent_grid_ratio                   = 1,     3,    3,
 parent_time_step_ratio              = 1,     3,    3,
 feedback                            = 1,
 smooth_option                       = 0
 /

 &physics
 mp_physics                          = 3,     3,     3,
 ra_lw_physics                       = 1,     1,     1,
 ra_sw_physics                       = 1,     1,     1,
 radt                                = 30,    30,    30,
 sf_sfclay_physics                   = 1,     1,     1,
 sf_surface_physics                  = 1,     1,     1,
 bl_pbl_physics                      = 1,     1,     1,
 bldt                                = 0,     0,     0,
 cu_physics                          = 1,     1,     0,
 cudt                                = 5,     0,     0,
 isfflx                              = 1,
 ifsnow                              = 0,

 icloud                              = 1,
 surface_input_source                = 1,
 num_soil_layers                     = 5,
 ucmcall                             = 0,
 mp_zero_out                         = 0,
 maxiens                             = 1,
 maxens                              = 3,
 maxens2                             = 3,
 maxens3                             = 16,
 ensdim                              = 144,
 /

 &fdda
 /

 &dynamics
 w_damping                           = 0,
 diff_opt                            = 1,
 km_opt                              = 4,
 diff_6th_opt                        = 0,
 diff_6th_factor                     = 0.12,
 base_temp                           = 290.
 damp_opt                            = 0,
 zdamp                               = 5000.,  5000.,  5000.,
 dampcoef                            = 0.01,   0.01,   0.01,
 khdif                               = 0,      0,      0,
 kvdif                               = 0,      0,      0,
 non_hydrostatic                     = .true., .true., .true.,
 pd_moist                            = .false., .false.,.false.,
 pd_scalar                           = .false., .false., .false.,
/

 &bdy_control
```

```
spec_bdy_width                     = 5,
spec_zone                          = 1,
relax_zone                         = 4,
specified                          = .true., .false., .false.,
nested                             = .false., .true., .true.,
/

&grib2
/

&namelist_quilt
nio_tasks_per_group = 0,
nio_groups = 1,
/
```

ATTACHMENT D-3

On-site Meteorological Station Metadata

Appendix A — Station Metadata

Courtice 60 m WM

Station details

Name: Courtice 60 m WM
Short name: CrWM1
Type: 60 m guyed pole tower with wind speeds at 10.0, 36.9, 47.4, 57.2 m
Zephyr North network name: Crt06
Magnetic declination: 11°W
Geographic Coordinates (Datum: NAD83): Longitude: 78°45'14.03"W Latitude: 43°52'27.35"N
Decimal Geographic Coordinates (Datum: NAD83): Longitude: -78.75390°E Latitude: 43.87426°N
UTM Coordinates (Datum: NAD83; Zone 17N): Easting: 680,461 m Northing: 4,860,360 m
Altitude: 100 m
NTS 1:50,000 maps: 030-M-15 (Oshawa)
Data start: 2007/04/18 Data end: ongoing
Datalogger archiving interval: 10 min
Datalogger clock set to: Eastern Standard Time

Data parameters measured directly by datalogger

	Units	Sampling
At 1.5 m level:		
Air temperature	C	60 sec
At 10.0, 36.9, 47.4, 57.2 m levels:		
Wind speed	ms^{-1}	1 sec
At 47.4, 57.2 m levels:		
Wind direction	°(true)	1 sec

Data parameters calculated by datalogger

	Units	Interval
At 1.5 m level:		
Average air temperature	C	10 min
At 10.0, 36.9 m level		
Average wind speed	ms^{-1}	10 min
Standard deviation of wind speed	ms^{-1}	10 min
1-sec gust wind speed (in 10 min interval)	ms^{-1}	10 min
3-sec gust wind speed (in 10 min interval)	ms^{-1}	10 min
At 47.4, 57.2 m levels:		
Average wind speed	ms^{-1}	10 min
Standard deviation of wind speed	ms^{-1}	10 min
1-sec gust wind speed (in 10 min interval)	ms^{-1}	10 min
3-sec gust wind speed (in 10 min interval)	ms^{-1}	10 min
Average wind direction	°(true)	10 min
Standard deviation of wind direction	°	10 min

Mast
Type: 60 m guyed, tubular, steel mast; combinations of 2.2 m and 1.9 m sections with flare connections; gin-pole erection
Manufacturer: NRG Systems
Model: 60 m Heavy Duty (HD) TallTower
Height 58.3 m
Mast diameter: 25.4 cm (bottom sections, 0.0 to 30.9 m), 20.3 cm (top sections, 30.9 to 58.3 m)
Guying levels: 11.8, 23.0, 30.9, 38.7, 46.6, 56.4 m a.g.l.
Guying radii: 40.0, 45.0, 50.0 m from base
Number of guying directions: 4 (90° apart): WSW, NNW, ENE, SSE (WSW is 236° true)

Anchoring
Type: screw anchors (15)
Deployment: 12 guy anchors (3 in each of 4 directions); 3 winch anchors
Deployment: all anchors hand-screwed

Anemometer booms (all levels)
Type: Round aluminum tube with round aluminum stub mast
Manufacturer: Local manufacture using Zephyr North design
Model: n/a
Boom cross-section dimensions: 4.83 cm Ø
Stub mast cross-section dimensions: 3.34 cm Ø

10.0 m wind speed
Instrument Type: propeller-vane anemometer
Manufacturer: R.M. Young
Model: 05103-10A "Wind Monitor"
Body Serial No.: 43108
Propeller Model: 08234
Propeller Serial No.: n/a
Speed calibration: $U(ms^{-1}) = (0.0980 \times Hz) + 0.0$ (manufacturer series calibration)
Speed calibration certificate: not calibrated (proposed for use for shear calculation for turbine noise estimates only)
Anemometer boom azimuth (from sensor end to tower end): 100° true
Minimum horizontal distance (mid-propeller to mid-mast): 172 cm
Maximum horizontal distance (mid-propeller to mid-mast): 203 cm
Vertical distance: mid-boom arm to mid-propeller: 56 cm

36.9 m wind speed
Instrument Type: propeller-vane anemometer
Manufacturer: R.M. Young
Model: 05103-10A "Wind Monitor"
Body Serial No.: 50579
Propeller Model: 08234
Propeller Serial No.: 78157
Speed calibration: $U(ms^{-1}) = (0.09765 \times Hz) + 0.14$

Speed calibration certificate: R.M. Young Test Number 66196 (2006/06/19)
Anemometer boom azimuth (from sensor end to tower end): 101° true
Minimum horizontal distance (mid-propeller to mid-mast): 175.5 cm
Maximum horizontal distance (mid-propeller to mid-mast): 207 cm
Vertical distance: mid-boom arm to mid-propeller: 57.5 cm

47.4 m wind speed and direction
Instrument Type: propeller-vane anemometer
Manufacturer: R.M. Young
Model: 05103-10A "Wind Monitor"
Body Serial No.: 50580
Propeller Model: 08234
Propeller Serial No.: 78182
Speed calibration: $U(ms^{-1})$ = (0.09787 x Hz)+0.11
Speed calibration certificate: R.M. Young Test Number 66195 (2006/06/19)
Direction calibration offset (adjusted at time of installation; offset set in datalogger): 101° (yields direction true)
Direction calibration multiplier: 0.142 °/mV with 2500 mV excitation (manufacturer series calibration)
Anemometer boom azimuth (from sensor end to tower end): 101° true
Minimum horizontal distance: mid-propeller to mid-mast: 173.5 cm
Maximum horizontal distance (mid-propeller to mid-mast): 204.5 cm
Vertical distance: mid-boom arm to mid-propeller: 57.5 cm

57.2 m wind speed and direction
Instrument Type: propeller-vane anemometer
Manufacturer: R.M. Young
Model: 05103-10A "Wind Monitor"
Body Serial No.: 75401
Propeller Model: 08234
Propeller Serial No.: 03402
Speed calibration: $U(ms^{-1})$ = (0.09736 x Hz)+0.12
Speed calibration certificate: R.M. Young Test Number 60176 (2006/10/17)
Direction calibration offset (adjusted at time of installation; offset set in datalogger): 101° (yields direction true)
Direction calibration multiplier: 0.142 °/mV with 2500 mV excitation (manufacturer series calibration)
Anemometer boom azimuth (from sensor end to tower end): 101° true
Minimum horizontal distance: mid-propeller to mid-mast: 175.5 cm
Maximum horizontal distance (mid-propeller to mid-mast): 207 cm
Vertical distance: mid-boom arm to mid-propeller: 58 cm

Anemometer Cabling
Type 22AWG 3-pair separately shielded
Manufacturer Belden
Model 8777-60

Temperature (1.5 m a.g.l.)
Instrument Type: Linearized thermistor
Manufacturer: Campbell Scientific

Model: 107F
Serial No.: C1283
Calibration offset: linearization carried out by datalogger
Calibration multiplier: linearization carried out by datalogger
Mounting: mounted in Gill radiation shield
Aspiration: self-aspirated 6-plate radiation shield

Temperature radiation shield
Instrument Type: 6-plate, natural ventilation
Manufacturer: R.M. Young
Model: 6-plate Gill radiation shield
Mounting: horizontally offset from mast wall 14cm; on south side of mast (to avoid shadow effects)

Datalogger
Manufacturer: Campbell Scientific
Model: CR800
Serial No.: 1641
PakBus address: 478
Peripherals: LLAC4 (s/n: 1241) — expansion to 4 pulse-counting channels
Programming: Programmed by Zephyr North
Datalogger archiving interval: 10 min
Clock set to: Eastern Standard Time
Power: 12V sealed lead-acid battery with solar panel recharging

Communications
Type: analogue cellular transceiver and modem telecommunications; initiated by Zephyr North calling computer
Modem: COM210 (S/N: 1768)
Transceiver: COM100 S/N: (DF9CAF03AUY)
Antenna: 6 dB YAGI (3 element)
Power: from datalogger
Calling interval: daily (initiated from Zephyr North calling computer)

Power storage and conditioning
Type: gelled lead-acid battery with regulator; additional external battery for cellular communications
Regulator manufacturer: Campbell Scientific
Model: PS12LA
Serial no: 20075
Internal battery: manufacturer: EnerSys
Model: NPX-35
Serial no: C1074
External battery: manufacturer: n/a
Model: n/a
Serial no: n/a

Power generation
Type: 20W solar photovoltaic panel

Manufacturer: BP Solar
Model: SX 20U
Serial no:C10507152888350
Connection: through PS12LA regulator to power storage batteries

Electrostatic protection
Type: lightning rod mounted at top of mast
Manufacturer: Dominion Lightning Rod Co.
Model: n/a
Mounting: mounted at top of mast in a position to avoid interference with top anemometer; top anemometer located within 45° cone of protection
Electrostatic path: 8 AWG uninsulated copper wire runs from lightning rod to grounding rod
Ground: copper wire grounded to two 1.5 m copper clad 1.91 cm Ø steel grounding rods inserted through mast base plate, and to buried grounding plate

Aircraft Obstruction Lighting
Type: none
Manufacturer: n/a
Model: n/a
Mounting: n/a
Power: n/a

Aircraft Obstruction Painting
none

Safety marking
Type: Yellow guy guards: on all guys, on vertical T-posts around outer anchors, on vertical T-posts around base, on vertical T-posts around winch anchors

Anemometer Calibration Certificates
Speed calibration certificates are available for all anemometers except 10 m level. If required, they can be supplied as a separate PDF document. Please request them from Info@ZephyrNorth.com.

Site Photographs
The following site photographs are taken from the site of the Courtice 60 m WM station in the direction shown on each photograph.

Crt06: Courtice Wind Energy Project: Courtice 60 m WM (CrWM1) Station

Courtice 60 m WM — Station Maintenance Log

2007/07/18

Purpose: Tower check-up.

Adjusted all guy levels for sag. Straightened tower in SSE-NNW direction. Replaced the desiccant.

ATTACHMENT D-4

Sample CALMET Input File

```
Summer Oct. 2007 - Y/D WT Facility - March 2009


---------------- 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=../../../INPUT/GEO-SUM.DAT       !
SURF.DAT      input    ! SRFDAT=../../../INPUT/SURF-FINAL.DAT      !
CLOUD.DAT     input    * CLDDAT=            *
PRECIP.DAT    input    ! PRCDAT=../../../INPUT/PRECIP.DAT !
WT.DAT        input    * WTDAT=             *

CALMET.LST    output   ! METLST=CMET.LST     !
CALMET.DAT    output   ! METDAT=CMET.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 = T !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

    Number of upper air stations (NUSTA)  No default     ! NUSTA =  4  !
    Number of overwater met stations
                             (NOWSTA) No default     ! NOWSTA =  3
!

NUMBER OF PROGNOSTIC and IGF-CALMET FILEs:
OB
    Number of MM4/MM5/3D.DAT files
                             (NM3D) No default       ! NM3D =  0  !

    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
------------  ----       ---------
UP1.DAT       input     1  ! UPDAT=../../../INPUT/UP1.DAT!    !END!
UP1.DAT       input     2  ! UPDAT=../../../INPUT/UP2.DAT!    !END!
```

```
UP1.DAT       input     3  ! UPDAT=../../../INPUT/UP3.DAT!    !END!
UP1.DAT       input     4  ! UPDAT=../../../INPUT/UP4.DAT!    !END!
-------------------------------------------------------------------------
--------
Subgroup (c)
-----------------------------------------
Overwater station files (one per station)
-----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
SEA1.DAT       input     1  ! SEADAT=../../../INPUT/SEA.DAT!    !END!
SEA1.DAT       input     2  ! SEADAT=../../../INPUT/SEA2007-1km.DAT!
!END!
SEA1.DAT       input     3  ! SEADAT=../../../INPUT/SEA2007-2km.DAT!
!END!

-------------------------------------------------------------------------
--------
Subgroup (d)
------------------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
MM51.DAT       input     1  *
M3DDAT=../../../wrf4km/calwrf/2007/may/wrf_4km_070509.m3d  *    *END*
MM51.DAT       input     2  *
M3DDAT=../../../wrf4km/calwrf/2007/may/wrf_4km_070510.m3d  *    *END*
MM51.DAT       input     3  *
M3DDAT=../../../wrf4km/calwrf/2007/may/wrf_4km_070511.m3d  *    *END*

-------------------------------------------------------------------------
--------
Subgroup (e)
-------------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
-------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
IGFn.DAT       input     1  * IGFDAT=CALMET0.DAT *    *END*
-------------------------------------------------------------------------
--------
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=  2007  !
                     Month (IBMO) -- No default       ! IBMO=  10  !
                       Day (IBDY) -- No default       ! IBDY=  1  !
                      Hour (IBHR) -- No default       ! IBHR=  1  !


     Note: IBHR is the time at the END of the first hour of the
simulation
           (IBHR=1, the first hour of a day, runs from 00:00 to 01:00)

     Base time zone        (IBTZ) -- No default       ! IBTZ=  5  !
        PST = 08, MST = 07
        CST = 06, EST = 05

     Length of run (hours) (IRLG) -- No default       ! IRLG= 744  !

     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 =   1   !

        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

!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  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  17   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = N  !
         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 =  40N  !
     (RLON0)                    No Default      ! RLON0 =  90E  !

         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 =  30N  !
     (XLAT2)                   No Default      ! XLAT2 =  60N  !

         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 =   200  !
            No. Y grid cells (NY)      No default     ! NY =   160  !

     Grid spacing (DGRIDKM)            No default     ! DGRIDKM = 0.25 !
                                       Units: km

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

        X coordinate (XORIGKM)         No default     ! XORIGKM =
655.000 !
        Y coordinate (YORIGKM)         No default     ! YORIGKM =
4845.000 !
                                       Units: km


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

        No. of vertical layers (NZ)    No default     ! NZ =  8  !

        Cell face height in arbitrary
        vertical grid (ZFACE(NZ+1))    No defaults
                                       Units: m
        ! ZFACE = 0.,20.,50.,100.,200.,500.,1000.,2000.,3300. !

!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  1  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 =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !
        -----------------------


        Specify which levels of the W wind component to print
        (NOTE: W defined at TOP cell face --  8  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 =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !


        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 =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !

        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 =  0
!
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air
observations)
              Use MM4/MM5/3D.DAT for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM4/MM5/3D.DAT for surface, overwater, and upper air
data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA =
10  !

       Number of precipitation stations
       (NPSTA=-1: flag for use of MM5/3D.DAT precip data)
                                    (NPSTA)  No default     ! NPSTA =  5
!

    CLOUD DATA OPTIONS
       Gridded cloud fields:
                                   (ICLOUD)  Default: 0     ! ICLOUD =
0  !
       ICLOUD = 0 - Gridded clouds not used
       ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT
       ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT
       ICLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity
                    at 850mb (Teixera)

    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 =
2  !
       (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 =
-4  !
       (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 = -1,-0.8,-.5,0,.5,1,1,1  !

       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 =
0  !
       (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 (hours) of the prognostic
       model input data   (ISTEPPG)          Default: 1      ! ISTEPPG =
1   !

       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 =
30. !
                                             Units: km

       Maximum radius of influence over land
       aloft (RMAX2)                         No default      ! RMAX2 =
30. !
                                             Units: km
       Maximum radius of influence over water
       (RMAX3)                               No default      ! RMAX3 =
30. !
                                             Units: km


    OTHER WIND FIELD INPUT PARAMETERS

       Minimum radius of influence used in
       the wind field interpolation (RMIN)   Default: 0.1    ! RMIN =
0.1 !
                                             Units: km
       Radius of influence of terrain
       features (TERRAD)                     No default      ! TERRAD =
10. !

                                             Units: km
       Relative weighting of the first
       guess field and observations in the
       SURFACE layer (R1)                    No default      ! R1 = 12.
!
       (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 = 12.
!
       (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=
5.0E-06 !

       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 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  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 =
 99, 99 ,  99 , 99 ,  99 ,  99 ,  99 ,  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 = 0., 0., 0., 0., 0., 0., 0., 0. !
       (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 =  8
!

       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 = 0. !
          Y coordinate of BEGINNING
          of each barrier (YBBAR(NBAR))      ! YBBAR = 0. !

          X coordinate of ENDING
          of each barrier (XEBAR(NBAR))      ! XEBAR = 0. !
          Y coordinate of ENDING
          of each barrier (YEBAR(NBAR))      ! YEBAR = 0. !


    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)   No default     ! ISURFT =
1  !
            (Must be a value from 1 to NSSTA)
            (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) No default     ! IUPT   =
1  !
            (Must be a value from 1 to NUSTA)
            (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)
            --------------------------

            Bottom and top of layer through
            which the domain-scale winds
            are computed
            (ZUPWND(1), ZUPWND(2))        Defaults: 1., 1000. ! ZUPWND=
1., 1000. !
            (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 = 0. !
         X Grid line 2 defining the region of interest
                                                         ! XG2 = 0. !
         Y Grid line 1 defining the region of interest
                                                         ! YG1 = 0. !
         Y Grid line 2 defining the region of interest
                                                         ! YG2 = 0. !

          X Point defining the coastline (Straight line)
                    (XBCST)  (KM)   Default: none    ! XBCST = 0. !

          Y Point defining the coastline (Straight line)
                    (YBCST)  (KM)   Default: none    ! YBCST = 0. !

          X Point defining the coastline (Straight line)
                    (XECST)  (KM)   Default: none    ! XECST = 0. !

          Y Point defining the coastline (Straight line)
                    (YECST)  (KM)   Default: none    ! YECST = 0. !


        Number of stations in the region     Default: none ! NLB =  0 !
        (Surface stations + upper air stations)

        Station ID's  in the region   (METBXID(NLB))
        (Surface stations first, then upper air stations)
          ! METBXID =  0 !

!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 =
1.0E-04!
                                             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: 0.05   ! 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 =
0   !
          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)

            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

    TEMPERATURE PARAMETERS

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

          0 = Use Surface and upper air stations
              (only if NOOBS = 0)
          1 = Use Surface stations (no upper air observations)
              Use MM5/3D.DAT for upper air data
              (only if NOOBS = 0,1)
          2 = No surface or upper air observations
              Use MM5/3D.DAT 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 =
99  !
       interpolation over water -- Make                       ! JWAT2 =
99  !
       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 --  5  records in all)


             1     2
         Name   ID            X coord.   Y coord.   Time   Anem.
                               (km)       (km)      zone   Ht.(m)
       ----------------------------------------------------------
! SS1  ='SUF1'      106       680.2726   4837.8626   5    10  !
! SS2  ='SUF3'      107       670.8957   4869.6138   5    10  !
! SS3  ='SUF4'      108       678.8614   4871.9473   5    10  !
! SS4  ='SUF5'      109       686.8299   4874.2907   5    10  !
! SS5  ='butt'      100       630.9912   4857.6150   5    10  !
! SS6  ='cobo'      101       727.0867   4870.2136   5    10  !
! SS7  ='pear'      102       610.4279   4837.2440   5    10  !
! SS8  ='pete'      103       710.0435   4900.7830   5    10  !
! SS9  ='toro'      104       629.074    4832.023    5    10  !
! SS10 ='Tren'      105       777.6484   4891.0579   5    10  !
-------------------
      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 --  1  records in all)

              1     2
         Name    ID      X coord.   Y coord.  Time zone
                           (km)       (km)
        -----------------------------------------------
! US1  ='UAI1'   10006     680.2726   4837.8626   5    10  !
! US3  ='UAI3'   10007     670.8957   4869.6138   5    10  !
! US4  ='UAI4'   10008     678.8614   4871.9473   5    10  !
! US5  ='UAI5'   10009     686.8299   4874.2907   5    10  !
-------------------
      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 --  5  records in all)
     (NOT INCLUDED IF NPSTA = 0)

             1          2
         Name   Station    X coord.  Y coord.
                  Code       (km)      (km)
         ------------------------------------
! PS1  ='Butt'   100      630.9912   4857.6150  !
! PS2  ='Pear'   102      610.4279   4837.2440  !
! PS3  ='Pete'   103      710.0435   4900.7830  !
! PS4  ='Tren'   105      777.6484   4891.0579  !
! PS5  ='Toro'   104      629.074    4832.023   !

-------------------
      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!

ATTACHMENT D-5

BPIP Input and Output Files (140,000 tpy Facility)

```
'\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP'
'P'
'Meters'  1.00000000
'UTMY'  0.0000
13
'1 TIP'  1           0.000  'Tipping Floor'
    4          13.900
           680477.340     4860499.950
           680486.090     4860470.700
           680510.680     4860478.250
           680501.230     4860507.480
'2 REFUSE'  1           0.000  'Refuse Bldg'
    4          34.900
           680477.190     4860468.110
           680481.260     4860454.830
           680514.660     4860465.060
           680510.620     4860478.210
'3 ADMIN'  1           0.000  'Administration Bldg'
    4           6.700
           680515.520     4860493.050
           680525.220     4860461.440
           680548.920     4860468.940
           680538.980     4860500.620
'4 BOILER'  1           0.000  'Boiler bldg'
    8          34.900
           680481.560     4860454.830
           680483.270     4860448.720
           680493.780     4860451.660
           680503.470     4860420.540
           680532.060     4860429.260
           680522.230     4860460.790
           680516.570     4860459.040
           680514.690     4860465.040
'19 ELEC'  1           0.000  'Control and Electrical Bldg'
    4          12.100
           680510.760     4860477.460
           680516.620     4860459.080
           680525.060     4860461.710
           680519.360     4860480.040
'5 TURBIN'  1           0.000  'Turbine bldg'
    6          12.100
           680524.530     4860453.450
           680532.100     4860429.260
           680552.190     4860435.670
           680542.410     4860467.010
           680528.060     4860462.370
           680530.190     4860455.470
'18 APC'  2           0.000  'FDG PAC Bldg / Baghouse Bldg'
    4          18.440
           680503.560     4860420.620
           680515.310     4860382.040
           680542.070     4860390.270
           680529.860     4860428.590
    4          31.000
           680503.550     4860420.550
           680509.210     4860402.120
           680535.670     4860410.230
           680529.910     4860428.550
'26 MAINT'  1           0.000  'Maintenance and Storage Bldg'
    4          12.100
```

```
           680529.810     4860428.520
           680536.820     4860406.320
           680545.620     4860409.550
           680538.480     4860431.310
'15 WATER'  1           0.000  'Fire Water Storage Tank'
    8           8.000
           680590.400     4860358.940
           680594.870     4860360.790
           680596.720     4860365.260
           680594.870     4860369.720
           680590.400     4860371.570
           680585.940     4860369.720
           680584.090     4860365.260
           680585.940     4860360.790
'16 PUMP'  1           0.000  'Fire Water Pump House'
    4          10.000
           680573.780     4860366.360
           680577.260     4860354.610
           680584.300     4860356.870
           680580.830     4860368.460
'40 FAN'  1           0.000  'ID Fan VFD Bldg'
    4          10.000
           680542.410     4860382.840
           680545.960     4860371.000
           680554.600     4860373.640
           680550.910     4860385.630
'11 RESID'  1           0.000  'Residue Storage Bldg'
    4          10.100
           680489.660     4860356.230
           680501.880     4860316.000
           680525.390     4860323.210
           680513.060     4860363.440
'GENSET'  1           0.000  'Emergency Diesel Generator Enclosure'
    4           4.000
           680466.720     4860456.140
           680467.560     4860453.580
           680473.250     4860455.160
           680472.490     4860457.740
2
'ST1'           0.000          87.600      680530.080     4860380.200
'Stack'
'ST2'           0.000           2.000      680472.920     4860456.430
'Emergency Diesel Generator stack (horizontal)'
```

BPIP (Dated: 04274)
DATE : 4/16/2009
TIME : 10:37: 7
\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

============================
BPIP PROCESSING INFORMATION:
============================

The P flag has been set for preparing downwash related data for a model run utilizing the PRIME algorithm.

Inputs entered in Meters will be converted to meters using a conversion factor of 1.0000. Output will be in meters.

The UTMP variable is set to UTMY. The input is assumed to be in UTM coordinates. BPIP will move the UTM origin to the first pair of UTM coordinates read. The UTM coordinates of the new origin will be subtracted from all the other UTM coordinates entered to form this new local coordinate system.

Plant north is set to 0.00 degrees with respect to True North.

\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

PRELIMINARY* GEP STACK HEIGHT RESULTS TABLE
(Output Units: meters)

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
ST1	87.60	0.00	87.25	87.25
ST2	2.00	0.00	87.25	87.25

* Results are based on Determinants 1 & 2 on pages 1 & 2 of the GEP Technical Support Document. Determinant 3 may be investigated for additional stack height credit. Final values result after Determinant 3 has been taken into consideration.

** Results were derived from Equation 1 on page 6 of GEP Technical Support Document. Values have been adjusted for any stack-building base elevation differences.

Note: Criteria for determining stack heights for modeling emission limitations for a source can be found in Table 3.1 of the GEP Technical Support Document.

TIME : 10:37: 7

\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

BPIP output is in meters

```
     SO BUILDHGT ST1        34.90   34.90   31.00   31.00   18.44
18.44
     SO BUILDHGT ST1        18.44   18.44   18.44   18.44   31.00
31.00
     SO BUILDHGT ST1        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST1        34.90   34.90   31.00   31.00   18.44
18.44
     SO BUILDHGT ST1        18.44   18.44   18.44   18.44   31.00
31.00
     SO BUILDHGT ST1        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDWID ST1        54.17   56.20   32.98   31.24   48.00
45.54
     SO BUILDWID ST1        41.69   43.32   46.55   48.37   31.92
33.24
     SO BUILDWID ST1        42.89   37.52   37.12   35.59   36.37
37.47
     SO BUILDWID ST1        54.17   56.20   32.98   31.24   48.00
45.54
     SO BUILDWID ST1        41.69   43.32   46.55   48.37   31.92
33.24
     SO BUILDWID ST1        42.89   40.24   39.78   40.74   45.29
50.50
     SO BUILDLEN ST1        45.77   45.65   33.24   33.55   41.07
35.88
     SO BUILDLEN ST1        29.59   32.65   38.51   43.20   33.71
32.98
     SO BUILDLEN ST1        55.12   26.42   21.38   15.68   17.93
23.38
     SO BUILDLEN ST1        45.77   45.65   33.24   33.55   41.07
35.88
     SO BUILDLEN ST1        29.59   32.65   38.51   43.20   33.71
32.98
     SO BUILDLEN ST1        55.12   52.05   47.39   41.30   41.88
44.50
     SO XBADJ    ST1        35.11   28.81    8.55    3.38  -10.13  -
11.87
     SO XBADJ    ST1       -13.25  -19.10  -26.52  -33.14  -38.73  -
43.15
     SO XBADJ    ST1       -85.14 -101.34 -102.58 -100.70  -99.90  -
98.01
     SO XBADJ    ST1       -80.88  -74.46  -41.79  -36.93  -30.94  -
24.00
     SO XBADJ    ST1       -16.34  -13.56  -11.99  -10.06    5.02
10.17
     SO XBADJ    ST1        30.02   36.31   41.50   45.42   44.35
40.34
     SO YBADJ    ST1        33.66   43.02   26.66   30.64   24.01
25.50
     SO YBADJ    ST1        26.21   26.03   25.11   23.43   29.42
25.17
```

```
     SO YBADJ    ST1        35.24   29.33   13.59   -2.56  -18.64  -
34.16
     SO YBADJ    ST1       -33.66  -43.02  -26.66  -30.64  -24.01  -
25.50
     SO YBADJ    ST1       -26.21  -26.03  -25.11  -23.43  -29.42  -
25.17
     SO YBADJ    ST1       -35.24  -25.67  -13.61    0.18   12.18
23.27


     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT ST2        34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDWID ST2        37.43   36.25   56.52   55.12   52.05
47.39
     SO BUILDWID ST2        41.30   41.88   44.50   45.77   45.65
34.93
     SO BUILDWID ST2        36.78   37.52   37.12   35.59   36.37
37.47
     SO BUILDWID ST2        37.43   36.25   56.52   55.12   52.05
47.39
     SO BUILDWID ST2        41.30   41.88   44.50   45.77   45.65
34.93
     SO BUILDWID ST2        36.78   37.52   37.12   35.59   36.37
37.47
     SO BUILDLEN ST2        28.12   32.01   44.24   42.89   40.24
39.78
     SO BUILDLEN ST2        40.74   45.29   50.50   54.17   56.20
33.97
     SO BUILDLEN ST2        30.66   26.42   21.38   15.68   17.93
23.38
     SO BUILDLEN ST2        28.12   32.01   44.24   42.89   40.24
39.78
     SO BUILDLEN ST2        40.74   45.29   50.50   54.17   56.20
33.97
     SO BUILDLEN ST2        30.66   26.42   21.38   15.68   17.93
23.38
     SO XBADJ    ST2        -0.13    1.35  -15.81   -7.86    0.33
5.11
     SO XBADJ    ST2         7.09    8.23    8.64    8.79    8.67   -
2.14
     SO XBADJ    ST2        -4.24   -6.20   -7.98   -9.52  -14.90  -
21.78
     SO XBADJ    ST2       -28.00  -33.36  -28.43  -35.04  -40.58  -
44.88
     SO XBADJ    ST2       -47.83  -53.52  -59.14  -62.96  -64.87  -
31.83
     SO XBADJ    ST2       -26.43  -20.22  -13.40   -6.17   -3.02   -
1.60
     SO YBADJ    ST2       -20.89  -18.14  -36.54  -35.21  -32.80  -
29.40
```

```
     SO YBADJ    ST2        -25.11  -19.71  -13.64   -7.15   -0.45
20.25
     SO YBADJ    ST2         22.53   24.12   24.98   25.08   24.42
23.00
     SO YBADJ    ST2         20.89   18.14   36.54   35.21   32.80
29.40
     SO YBADJ    ST2         25.11   19.71   13.64    7.15    0.45  -
20.25
     SO YBADJ    ST2        -22.53  -24.12  -24.98  -25.08  -24.42  -
23.00
```

ATTACHMENT D-6

BPIP Input and Output Files (400,000 tpy Facility)

```
'\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP'
'P'
'Meters'  1.00000000
'UTMY'  0.0000
26
'1 TIP'  1           0.000  'Tipping Floor'
    4          13.900
           680477.340     4860499.950
           680486.090     4860470.700
           680510.680     4860478.250
           680501.230     4860507.480
'2 REFUSE'  1           0.000  'Refuse Bldg'
    4          34.900
           680477.190     4860468.110
           680481.260     4860454.830
           680514.660     4860465.060
           680510.620     4860478.210
'3 ADMIN'  1           0.000  'Administration Bldg'
    4           6.700
           680515.520     4860493.050
           680525.220     4860461.440
           680548.920     4860468.940
           680538.980     4860500.620
'4 BOILER'  1           0.000  'Boiler bldg'
    8          34.900
           680481.560     4860454.830
           680483.270     4860448.720
           680493.780     4860451.660
           680503.470     4860420.540
           680532.060     4860429.260
           680522.230     4860460.790
           680516.570     4860459.040
           680514.690     4860465.040
'19 ELEC'  1           0.000  'Control and Electrical Bldg'
    4          12.100
           680510.760     4860477.460
           680516.620     4860459.080
           680525.060     4860461.710
           680519.360     4860480.040
'5 TURBIN'  1           0.000  'Turbine bldg'
    6          12.100
           680524.530     4860453.450
           680532.100     4860429.260
           680552.190     4860435.670
           680542.410     4860467.010
           680528.060     4860462.370
           680530.190     4860455.470
'18 APC'  2           0.000  'FDG PAC Bldg / Baghouse Bldg'
    4          18.440
           680503.560     4860420.620
           680515.310     4860382.040
           680542.070     4860390.270
           680529.860     4860428.590
    4          31.000
           680503.550     4860420.550
           680509.210     4860402.120
           680535.670     4860410.230
           680529.910     4860428.550
'26 MAINT'  1           0.000  'Maintenance and Storage Bldg'
    4          12.100
```

```
           680529.810     4860428.520
           680536.820     4860406.320
           680545.620     4860409.550
           680538.480     4860431.310
'15 WATER'  1           0.000  'Fire Water Storage Tank'
    8           8.000
           680590.400     4860358.940
           680594.870     4860360.790
           680596.720     4860365.260
           680594.870     4860369.720
           680590.400     4860371.570
           680585.940     4860369.720
           680584.090     4860365.260
           680585.940     4860360.790
'16 PUMP'  1           0.000  'Fire Water Pump House'
    4          10.000
           680573.780     4860366.360
           680577.260     4860354.610
           680584.300     4860356.870
           680580.830     4860368.460
'40 FAN'  1           0.000  'ID Fan VFD Bldg'
    4          10.000
           680542.410     4860382.840
           680545.960     4860371.000
           680554.600     4860373.640
           680550.910     4860385.630
'11 RESID'  1           0.000  'Residue Storage Bldg'
    4          10.100
           680489.660     4860356.230
           680501.880     4860316.000
           680525.390     4860323.210
           680513.060     4860363.440
'GENSET'  1           0.000  'Emergency Diesel Generator Enclosure'
    4           4.000
           680466.720     4860456.140
           680467.560     4860453.580
           680473.250     4860455.160
           680472.490     4860457.740
'1 FTIP'  1           0.000  'Future Tipping'
    4          13.900
           680417.270     4860481.130
           680398.030     4860474.720
           680406.580     4860446.560
           680426.540     4860452.620
'2 FREFUS'  1           0.000  'Future Refuse Bld'
    4          34.900
           680427.030     4860452.850
           680402.370     4860444.830
           680406.580     4860432.400
           680430.640     4860439.620
'4 FBOILE'  1           0.000  'Future Boiler'
    4          34.900
           680430.240     4860439.420
           680441.060     4860402.130
           680418.210     4860394.710
           680407.180     4860432.200
'5 F TURB'  1           0.000  'Future Turbine Bld'
    4          12.100
           680409.190     4860425.990
           680388.540     4860419.370
```

```
           680397.960     4860388.300
           680418.210     4860394.910
'18 F ACP'  1           0.000  'Future ACP Bld'
    4          31.000
           680437.650     4860401.330
           680450.690     4860358.430
           680434.450     4860353.010
           680421.420     4860395.920
'40 F FAN'  1           0.000  'Future FAN VFD Bld'
    4          10.000
           680423.620     4860349.800
           680412.590     4860346.000
           680415.400     4860336.970
           680426.630     4860340.780
'11 FRESI'  1           0.000  'Future Reside Storahe Bld'
    4          10.100
           680486.170     4860356.020
           680462.310     4860348.600
           680474.140     4860308.310
           680498.000     4860315.720
'4 FBOILE'  1           0.000  'Future Boiler'
    4          34.900
           680493.620     4860451.840
           680475.550     4860446.470
           680484.490     4860415.880
           680502.960     4860422.040
'18 F ACP'  1           0.000  'Future ACP Bld'
    4          31.000
           680502.910     4860422.050
           680484.440     4860416.090
           680497.180     4860373.190
           680515.880     4860378.920
'5 FTURB'  1           0.000  'Future Turbine Bld'
    4          12.100
           680559.470     4860438.590
           680545.390     4860433.240
           680554.310     4860404.290
           680568.590     4860408.650
'9 AIRC2'  1           0.000  'Future Air Cooled Condenser'
    4           5.000
           680580.690     4860442.000
           680564.850     4860436.720
           680569.950     4860420.150
           680585.790     4860425.070
'9 AIRC1'  1           0.000  'Air Cool Condenser'
    4           5.000
           680565.760     4860472.220
           680547.560     4860466.390
           680553.200     4860447.640
           680571.410     4860453.100
'9 FAIR C'  1           0.000  'Future Air Cool Condensir'
    4           5.000
           680417.940     4860390.100
           680399.690     4860384.470
           680405.860     4860363.660
           680424.380     4860369.570
3
'STCK1'          0.000          87.600      680530.080     4860380.200
'Stack'
'STCK2'          0.000           2.000      680472.920     4860456.430
```

```
'Emergency Diesel Generator stack (horizontal)'
'STCK3'           0.000          87.600      680443.860     4860349.750
'Future Stack'
```

\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

BPIP (Dated: 04274)

DATE : 5/28/2009
TIME : 10:29:21

\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

============================
BPIP PROCESSING INFORMATION:
============================

The P flag has been set for preparing downwash related data for a model run utilizing the PRIME algorithm.

Inputs entered in Meters will be converted to meters using a conversion factor of 1.0000. Output will be in meters.

The UTMP variable is set to UTMY. The input is assumed to be in UTM coordinates. BPIP will move the UTM origin to the first pair of UTM coordinates read. The UTM coordinates of the new origin will be subtracted from all the other UTM coordinates entered to form this new local coordinate system.

Plant north is set to 0.00 degrees with respect to True North.

\\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

PRELIMINARY* GEP STACK HEIGHT RESULTS TABLE
(Output Units: meters)

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
STCK1	87.60	0.00	87.25	87.25
STCK2	2.00	0.00	87.25	87.25
STCK3	87.60	0.00	87.25	87.25

* Results are based on Determinants 1 & 2 on pages 1 & 2 of the GEP Technical Support Document. Determinant 3 may be investigated for additional stack height credit. Final values result after Determinant 3 has been taken into consideration.

** Results were derived from Equation 1 on page 6 of GEP Technical Support Document. Values have been adjusted for any stack-building base elevation differences.

Note: Criteria for determining stack heights for modeling emission limitations for a source can be found in Table 3.1 of the GEP Technical Support Document.

BPIP (Dated: 04274)

```
 DATE :  5/28/2009
 TIME : 10:29:21


 \\Markppfs04\1005xxx$\1009497\Air Quality Assessment\Background\BPIP

  BPIP output is in meters


     SO BUILDHGT STCK1      34.90   34.90   31.00   31.00   31.00
31.00
     SO BUILDHGT STCK1      31.00   31.00   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK1      34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK1      34.90   34.90   31.00   31.00   31.00
31.00
     SO BUILDHGT STCK1      31.00   31.00   31.00   31.00   31.00
34.90
     SO BUILDHGT STCK1      34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDWID STCK1      54.17   56.20   32.98   31.24   48.68
47.91
     SO BUILDWID STCK1      45.24   47.03   44.71   46.12   46.13
35.71
     SO BUILDWID STCK1      42.89   37.52   37.12   35.59   36.37
37.47
     SO BUILDWID STCK1      54.17   56.20   32.98   31.24   48.68
47.91
     SO BUILDWID STCK1      45.68   47.12   48.86   49.11   31.92
35.71
     SO BUILDWID STCK1      42.89   40.24   39.78   40.74   45.29
50.50
     SO BUILDLEN STCK1      45.77   45.65   33.24   33.55   35.80
29.39
     SO BUILDLEN STCK1      19.53   22.32   33.88   38.59   42.12
35.95
     SO BUILDLEN STCK1      55.12   26.42   21.38   15.68   17.93
23.38
     SO BUILDLEN STCK1      45.77   45.65   33.24   33.55   35.80
29.39
     SO BUILDLEN STCK1      22.10   24.51   31.44   37.42   33.71
35.95
     SO BUILDLEN STCK1      55.12   52.05   47.39   41.30   41.88
44.50
     SO XBADJ    STCK1      35.11   28.81    8.55    3.38  -29.71  -
32.00
     SO XBADJ    STCK1     -99.16 -104.28 -122.90 -130.06 -133.27  -
80.36
     SO XBADJ    STCK1     -85.14 -101.34 -102.58 -100.70  -99.90  -
98.01
     SO XBADJ    STCK1     -80.88  -74.46  -41.79  -36.93   -6.09
2.60
     SO XBADJ    STCK1      11.22   14.21   14.20   13.76    5.02
44.41
     SO XBADJ    STCK1      30.02   36.31   41.50   45.42   44.35
40.34
     SO YBADJ    STCK1      33.66   43.02   26.66   30.64   32.49
29.95
     SO YBADJ    STCK1      29.32   13.34   36.86   17.92   -1.56
```

```
25.96
     SO YBADJ    STCK1       35.24   29.33   13.59   -2.56  -18.64  -
34.16
     SO YBADJ    STCK1      -33.66  -43.02  -26.66  -30.64  -32.49  -
29.95
     SO YBADJ    STCK1      -26.49  -22.37  -17.42  -11.94  -29.42  -
25.96
     SO YBADJ    STCK1      -35.24  -25.67  -13.61    0.18   12.18
23.27


     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK2       34.90   34.90   34.90   34.90   34.90
34.90
     SO BUILDWID STCK2       37.43   36.25   35.95   36.70   36.33
42.98
     SO BUILDWID STCK2       39.84   41.88   35.96   37.00   36.91
34.93
     SO BUILDWID STCK2       36.78   37.52   37.12   35.59   36.37
37.47
     SO BUILDWID STCK2       37.43   36.25   35.95   36.70   36.33
42.98
     SO BUILDWID STCK2       39.84   41.88   35.96   37.00   36.91
34.93
     SO BUILDWID STCK2       36.78   37.52   37.12   35.59   36.37
37.47
     SO BUILDLEN STCK2       28.12   32.01   35.71   33.42   30.11
32.77
     SO BUILDLEN STCK2       26.60   45.29   27.41   31.24   34.11
33.97
     SO BUILDLEN STCK2       30.66   26.42   21.38   15.68   17.93
23.38
     SO BUILDLEN STCK2       28.12   32.01   35.71   33.42   30.11
32.77
     SO BUILDLEN STCK2       26.60   45.29   27.41   31.24   34.11
33.97
     SO BUILDLEN STCK2       30.66   26.42   21.38   15.68   17.93
23.38
     SO XBADJ    STCK2       -0.13    1.35  -29.33  -23.63  -17.20  -
78.24
     SO XBADJ    STCK2      -72.52    8.23    2.63    4.32    5.88   -
2.14
     SO XBADJ    STCK2       -4.24   -6.20   -7.98   -9.52  -14.90  -
21.78
     SO XBADJ    STCK2      -28.00  -33.36   -6.37   -9.79  -12.91
45.47
     SO XBADJ    STCK2       45.92  -53.52  -30.04  -35.56  -39.99  -
31.83
     SO XBADJ    STCK2      -26.43  -20.22  -13.40   -6.17   -3.02   -
1.60
     SO YBADJ    STCK2      -20.89  -18.14  -25.23  -26.77  -27.49   -
```

```
9.60
     SO YBADJ    STCK2     -20.21  -19.71  -22.57  -19.43  -15.69
20.25
     SO YBADJ    STCK2      22.53   24.12   24.98   25.08   24.42
23.00
     SO YBADJ    STCK2      20.89   18.14   25.23   26.77   27.49
9.60
     SO YBADJ    STCK2      20.21   19.71   22.57   19.43   15.69  -
20.25
     SO YBADJ    STCK2     -22.53  -24.12  -24.98  -25.08  -24.42  -
23.00


     SO BUILDHGT STCK3      34.90   31.00   31.00   31.00   31.00
31.00
     SO BUILDHGT STCK3      31.00   31.00   31.00   31.00   31.00
31.00
     SO BUILDHGT STCK3      31.00   34.90   34.90   34.90   34.90
34.90
     SO BUILDHGT STCK3      34.90   34.90   34.90   34.90   34.90
31.00
     SO BUILDHGT STCK3      31.00   31.00   31.00   31.00   31.00
31.00
     SO BUILDHGT STCK3      31.00   34.90   34.90   34.90   34.90
34.90
     SO BUILDWID STCK3      38.59   40.33   44.09   46.52   47.53
47.10
     SO BUILDWID STCK3      45.24   47.03   48.32   48.14   46.50
43.45
     SO BUILDWID STCK3      39.07   37.95   36.71   28.17   30.69
38.69
     SO BUILDWID STCK3      37.43   36.25   35.95   36.70   36.33
47.10
     SO BUILDWID STCK3      45.24   47.03   48.32   48.14   46.50
43.45
     SO BUILDWID STCK3      39.07   37.95   36.71   28.17   30.69
38.69
     SO BUILDLEN STCK3      46.12   46.50   43.45   39.07   33.51
26.93
     SO BUILDLEN STCK3      19.53   22.32   29.27   35.34   40.33
44.09
     SO BUILDLEN STCK3      46.52   44.81   56.32   53.36   55.73
58.14
     SO BUILDLEN STCK3      28.12   32.01   35.71   33.42   30.11
26.93
     SO BUILDLEN STCK3      19.53   22.32   29.27   35.34   40.33
44.09
     SO BUILDLEN STCK3      46.52   44.81   56.32   53.36   55.73
58.14
     SO XBADJ    STCK3      39.82   -0.16   -1.88   -3.55   -5.11   -
6.52
     SO XBADJ    STCK3      -7.73  -14.08  -22.44  -30.12  -36.88  -
42.52
     SO XBADJ    STCK3     -46.87  -86.74 -103.09 -103.54 -104.46 -
103.10
     SO XBADJ    STCK3    -138.10 -143.55 -113.29 -110.19 -103.74  -
20.41
     SO XBADJ    STCK3     -11.81   -8.23   -6.83   -5.22   -3.45   -
1.57
     SO XBADJ    STCK3       0.35   41.93   46.76   50.18   48.73
```

```
44.96
     SO YBADJ    STCK3       31.15   16.71   20.47   23.61   26.03
27.65
     SO YBADJ    STCK3       28.44   28.36   27.42   25.65   23.10
19.84
     SO YBADJ    STCK3       15.98   28.23   18.62    5.36   -9.01  -
22.15
     SO YBADJ    STCK3       30.99    8.97   -2.94  -19.54  -35.56  -
27.65
     SO YBADJ    STCK3      -28.44  -28.36  -27.42  -25.65  -23.10  -
19.84
     SO YBADJ    STCK3      -15.98  -28.23  -18.62   -5.36    9.01
22.15
```

ATTACHMENT D-7

Sample CALPUFF Input File (140,000 tpy Facility)

```
York/Durham - unit emission rate from main stack, Sensitive receptors
No deposition, with building downwash - Site B1
Species: Unit emission rate (1 g/s); Year=YEAR-REP;          Date: March
2009
---------------- 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 =CPUFF.LST  !
CONC.DAT      output   ! CONDAT =CPUFF.CON     !
DFLX.DAT      output   * DFDAT  =             *
WFLX.DAT      output   * WFDAT  =             *

VISB.DAT      output   * VISDAT =             *
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
------------------------------------------------------------------------
--------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
------------------------------------------------------------------------
--------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =             *
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    ! CSTDAT=../COAST.DAT   !
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
```

```
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
-------------------------------------------------------------------------
--------
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 = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                Default: 1       ! NMETDAT =   6
!

     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  !

!END!

-------------
Subgroup (0a)
-------------

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

Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET1-REP.dat                  !  !END!
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET2-REP.dat                  !  !END!
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET3-REP.dat                  !  !END!
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET4-REP.dat                  !  !END!
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET5-REP.dat                  !  !END!
 none         input    ! METDAT=/HOME/PROJECTS/1009497.06/CALMET/3MN-
4K/MET6-REP.dat                  !  !END!

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

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 = IBYR-REP
!
    (used only if   Month (IBMO) -- No default       ! IBMO = IBMO-REP
!
     METRUN = 0)      Day (IBDY) -- No default       ! IBDY =  1  !
                     Hour (IBHR) -- No default       ! IBHR =  1  !

    Base time zone        (XBTZ) -- No default       ! XBTZ = 5.0  !
       PST = 8., MST = 7.
       CST = 6., EST = 5.

    Length of run (hours) (IRLG) -- No default       ! IRLG = IRLG-REP
!

    Number of chemical species (NSPEC)
                                Default: 5       ! NSPEC =  1   !

    Number of chemical species
    to be emitted  (NSE)        Default: 3       ! NSE =  1   !

    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)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                     Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                     Default: 60.0    ! PGTIME = 60. !


!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 simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW =   2
!
        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)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0
!
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates adjusted
            for aqueous phase reactions

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

     Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  0
!
        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 =  2
!

       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., 300


     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?
     (MPARTL)
        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 =  1  !
     (MPDF)
        0 = no
        1 = yes

     Sub-Grid TIBL module used for shore line?
                                           Default: 0     ! MSGTIBL = 1
!
     (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
                  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
                       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 =        CONT1 !         !END!

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

!        CONT1  =         1,               1,           0,
0   !

!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.

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

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  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  17   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = N  !
         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 = 0N  !
     (RLON0)                    No Default      ! RLON0 = 0E  !

         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 = 0N  !
     (XLAT2)                    No Default      ! XLAT2 = 0N  !

         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:

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

            No. X grid cells (NX)      No default     ! NX =  200   !
            No. Y grid cells (NY)      No default     ! NY =  160   !
         No. vertical layers (NZ)      No default     ! NZ =  8   !

           Grid spacing (DGRIDKM)      No default     ! DGRIDKM = 0.25 !
                                       Units: km

                Cell face heights
                    (ZFACE(nz+1))      No defaults
                                       Units: m
   ! ZFACE = .0, 20.0, 50.0, 100.0, 200.0, 500.0, 1000.0, 2000.0, 3300.0
!

            Reference Coordinates
```

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

X coordinate (XORIGKM)   No default   ! XORIGKM = 655.0
!
Y coordinate (YORIGKM)   No default   ! YORIGKM = 4845.0
!
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 = 1
!
(1 <= IBCOMP <= NX)

Y index of LL corner (JBCOMP)   No default   ! JBCOMP = 1
!
(1 <= JBCOMP <= NY)

X index of UR corner (IECOMP)   No default   ! IECOMP =
200   !
(1 <= IECOMP <= NX)

Y index of UR corner (JECOMP)   No default   ! JECOMP =
160   !
(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 = F !
(T=yes, F=no)

X index of LL corner (IBSAMP)   No default   ! IBSAMP = 0
!
(IBCOMP <= IBSAMP <= IECOMP)

```
        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  0
!
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  0
!
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  0
!
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1
!
        (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 =  0
!
   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 MASS FLUX OUTPUT OPTIONS:

      Mass flux across specified boundaries
      for selected species reported hourly?
      (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 hourly?
      (IMBAL)                         Default: 0         ! IMBAL =  0
!
       0 = no
       1 = yes (MASSBAL.DAT filename is
            specified in Input Group 0)


   LINE PRINTER OUTPUT OPTIONS:

      Print concentrations (ICPRT)    Default: 0         ! ICPRT =  1
!
      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 hours                Default: 1         ! ICFRQ =  1
!
      Dry flux print interval
      (IDFRQ) in hours                Default: 1         ! IDFRQ =  1
!
      Wet flux print interval
      (IWFRQ) in hours                Default: 1         ! IWFRQ =  1
!

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

      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?
   -------       ------------------------   ------------------------
------------------------   ---------------
!        CONT1 =     1,            1,            0,            0,
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
=  1  !

       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 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM
= 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)
      -------     -----------      ----------      ----------
--------------------     -----------------------


!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)
      -------      -------------------        ------------------

!END!
------------------------------------------------------------------------
-------
```

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

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8.0 !

     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.
       ---------      --------------       --------------

!END!
------------------------------------------------------------------------
-------

INPUT GROUP: 11 -- Chemistry Parameters
---------------

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

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                   Default: 12*80.
     !  BCKO3 = 17.30, 14.80, 32.70, 33.50, 32.90, 37.70, 36.50, 33.10,
30.10, 21.20, 19.10, 16.20 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                  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 (RNITE1)
     in percent/hour                   Default: 0.2         ! RNITE1 =
.2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0         ! RNITE2 =
2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0         ! RNITE3 =
2.0 !

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

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  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 SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The 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)
     to 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!
------------------------------------------------------------------------
-------

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
= 5.5E02 !

     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
= .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                   Default: 0.1    ! CONK2
= .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 =
.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
= 1.0 !

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

     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
= 1.0  !

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

     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 = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500,
0.500, 0.500, 0.500, 0.500, 0.500!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200,
0.120, 0.080, 0.060, 0.030, 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 !

     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
= .5 !

     Maximum mixing height (m)
     (XMAXZI)                               Default: 3000.  ! XMAXZI
= 3000.0 !

     Minimum mixing height (m)
     (XMINZI)                               Default: 50.    ! XMINZI
= 50.0 !

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                  Default   :
                                 ISC RURAL : 1.54, 3.09, 5.14, 8.23,
10.8 (10.8+)

                          Wind Speed Class :  1     2     3     4
5
                                             ---   ---   ---   ---
---
                                   ! WSCAT = 1.54, 3.09, 5.14, 8.23,
10.80 !

     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, 0.10, 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 = 0.020,   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 = 0.50, 0.50, 0.50, 0.50,
0.35, 0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                               Default: 10.        ! SL2PF =
10.0 !

     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
= 100.0 !

       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 = 1.0 !

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                          Default:  2.        !
SHSPLITH = 2.0 !

       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 = 1.0E-07 !

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

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

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

       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
= 500.0 !

       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
= 10.0 !

       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 =  1  !

     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

     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)
  ------   ---------- ---------- ------  ------   -------- -----
-------- ----- --------
```

```
   1 ! SRCNAM = STCK1 !
   1 ! X = 680.53008,   4860.3802, 87.6, 101.1,    1.7,    18.0, 405.15,
1.0, 1.0E00 !
   1 ! ZPLTFM  =       .0 !
   1 ! FMFAC  =      1.0 !   !END!

--------

    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.)
     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)
     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)

    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)
------
-------------------------------------------------------------------
1    ! SRCNAM  =   STCK1 !
1    ! HEIGHT  =  34.9,    34.9,      31,      31,   18.44,   18.44,
                  18.44,   18.44,   18.44,   18.44,      31,      31,
                  34.9,    34.9,    34.9,    34.9,    34.9,    34.9,
                  34.9,    34.9,      31,      31,   18.44,   18.44,
                  18.44,   18.44,   18.44,   18.44,      31,      31,
                  34.9,    34.9,    34.9,    34.9,    34.9,    34.9!
 1    ! WIDTH  =  54.17,    56.2,   32.98,   31.24,      48,   45.54,
                  41.69,   43.32,   46.55,   48.37,   31.92,   33.24,
                  42.89,   37.52,   37.12,   35.59,   36.37,   37.47,
                  54.17,    56.2,   32.98,   31.24,      48,   45.54,
                  41.69,   43.32,   46.55,   48.37,   31.92,   33.24,
                  42.89,   40.24,   39.78,   40.74,   45.29,    50.5!
1    ! LENGTH =   45.77,   45.65,   33.24,   33.55,   41.07,   35.88,
                  29.59,   32.65,   38.51,    43.2,   33.71,   32.98,
                  55.12,   26.42,   21.38,   15.68,   17.93,   23.38,
                  45.77,   45.65,   33.24,   33.55,   41.07,   35.88,
                  29.59,   32.65,   38.51,    43.2,   33.71,   32.98,
                  55.12,   52.05,   47.39,    41.3,   41.88,    44.5!
1    ! XBADJ  =   35.11,   28.81,    8.55,    3.38,  -10.13,  -11.87,
                  -13.25,   -19.1,  -26.52,  -33.14,  -38.73,  -43.15,
                  -85.14, -101.34, -102.58,  -100.7,   -99.9,  -98.01,
                  -80.88,  -74.46,  -41.79,  -36.93,  -30.94,     -24,
                  -16.34,  -13.56,  -11.99,  -10.06,    5.02,   10.17,
                  30.02,   36.31,    41.5,   45.42,   44.35,   40.34!
1    ! YBADJ  =   33.66,   43.02,   26.66,   30.64,   24.01,    25.5,
                  26.21,   26.03,   25.11,   23.43,   29.42,   25.17,
                  35.24,   29.33,   13.59,   -2.56,  -18.64,  -34.16,
                 -33.66,  -43.02,  -26.66,  -30.64,  -24.01,   -25.5,
                 -26.21,  -26.03,  -25.11,  -23.43,  -29.42,  -25.17,
                 -35.24,  -25.67,  -13.61,    0.18,   12.18,   23.27!
! END !
--------
    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)
---------------
```

```
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered 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.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                               Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling
factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where
temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)

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


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


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

     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
          ----------------------------
                                                         b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (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 IARU
     (e.g. 1 for g/m**2/s).

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

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                             a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    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: VARIABLE EMISSIONS DATA
          ------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered 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.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling
factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where
temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)

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

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

     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 =
.0 !
                                                       (in meters)

        Average building height (HBL)                  No default   ! HBL =
.0 !
                                                       (in meters)

        Average building width (WBL)                   No default   ! WBL =
.0 !
                                                       (in meters)

        Average line source width (WML)                No default   ! WML =
.0 !
                                                       (in meters)

        Average separation between buildings (DXL)  No default   ! DXL =
.0 !
                                                       (in meters)

        Average buoyancy parameter (FPRIMEL)           No default   !
FPRIMEL = .0 !
                                                       (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: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling
factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where
temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)
--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


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


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

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

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0
!

     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

     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
         X           Y        Effect.    Base     Initial    Initial
Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z
Rates
        (km)       (km)         (m)       (m)       (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 IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                         a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered 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.
```

```
     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling
factors,
                                   where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                   first group is Stability Class A,
                                   and the speed classes have upper
                                   bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where
temperature
                                   classes have upper bounds (C) of:
                                   0, 5, 10, 15, 20, 25, 30, 35, 40,
                                   45, 50, 50+)
--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


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

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC = 391
!

!END!
---------------
Subgroup (17b)
---------------
                                                    a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                       X            Y          Ground        Height   b
Receptor          Coordinate   Coordinate    Elevation   Above Ground
  No.                (km)         (km)          (m)           (m)
--------          ----------   ----------    ---------   ------------
     1 ! X =        678.53,     4860.0,       86.500,        0.000!   !END!
     2 ! X =        675.49,    4860.36,       73.000,        0.000!   !END!
     3 ! X =        681.64,    4860.35,       96.700,        0.000!   !END!
     4 ! X =        676.83,    4859.84,       76.000,        0.000!   !END!
     5 ! X =        685.77,    4863.88,       83.000,        0.000!   !END!
     6 ! X =        679.65,    4859.99,       80.200,        0.000!   !END!
     7 ! X =        681.58,    4862.07,      119.400,        0.000!   !END!
     8 ! X =        679.74,    4861.05,      104.200,        0.000!   !END!
     9 ! X =        687.22,    4864.25,       87.400,        0.000!   !END!
    10 ! X =        686.52,    4861.99,       73.000,        0.000!   !END!
    11 ! X =        679.87,    4859.74,       75.400,        0.000!   !END!
    12 ! X =        681.58,    4860.56,       98.000,        0.000!   !END!
```

```
13 ! X =     680.7,    4859.86,     92.500,        0.000!   !END!
14 ! X =    680.61,    4860.72,    104.300,        0.000!   !END!
15 ! X =    673.99,    4865.64,    134.200,        0.000!   !END!
16 ! X =    678.08,    4868.82,    166.500,        0.000!   !END!
17 ! X =    681.38,    4860.34,    100.700,        0.000!   !END!
18 ! X =    682.88,    4864.22,    124.100,        0.000!   !END!
19 ! X =    678.93,    4865.53,    143.200,        0.000!   !END!
20 ! X =    687.22,    4864.84,     87.400,        0.000!   !END!
21 ! X =    686.65,    4861.66,     73.500,        0.000!   !END!
22 ! X =    677.84,    4859.72,     73.000,        0.000!   !END!
23 ! X =    682.26,    4860.05,     95.100,        0.000!   !END!
24 ! X =    682.55,    4859.89,     81.800,        0.000!   !END!
25 ! X =    682.82,    4859.76,     82.900,        0.000!   !END!
26 ! X =    683.02,    4859.94,     89.500,        0.000!   !END!
27 ! X =    683.32,    4859.68,     77.700,        0.000!   !END!
28 ! X =    683.31,    4860.02,     84.500,        0.000!   !END!
29 ! X =    683.72,    4859.92,     82.900,        0.000!   !END!
30 ! X =     682.7,     4860.0,     81.800,        0.000!   !END!
31 ! X =    684.35,    4861.18,     94.400,        0.000!   !END!
32 ! X =    682.16,    4861.23,    124.000,        0.000!   !END!
33 ! X =    684.56,    4861.07,    109.700,        0.000!   !END!
34 ! X =    684.66,    4861.32,     91.400,        0.000!   !END!
35 ! X =    684.91,    4861.15,     94.400,        0.000!   !END!
36 ! X =    677.33,    4862.98,    128.900,        0.000!   !END!
37 ! X =    676.19,    4862.61,    126.900,        0.000!   !END!
38 ! X =    675.97,    4863.48,    128.800,        0.000!   !END!
39 ! X =    676.61,    4863.21,    125.900,        0.000!   !END!
40 ! X =    676.83,    4863.59,    127.300,        0.000!   !END!
41 ! X =     677.2,    4864.07,    134.400,        0.000!   !END!
42 ! X =    677.72,    4863.63,    132.800,        0.000!   !END!
43 ! X =    678.27,     4864.2,    136.600,        0.000!   !END!
44 ! X =    678.18,    4863.37,    136.900,        0.000!   !END!
45 ! X =    677.18,     4862.5,    124.500,        0.000!   !END!
46 ! X =    683.54,    4864.22,    126.900,        0.000!   !END!
47 ! X =    683.77,    4863.92,    119.700,        0.000!   !END!
48 ! X =    683.67,    4863.53,    119.300,        0.000!   !END!
49 ! X =     684.5,    4863.85,    115.900,        0.000!   !END!
50 ! X =    684.24,    4863.52,    107.100,        0.000!   !END!
51 ! X =    684.27,     4863.2,    104.100,        0.000!   !END!
52 ! X =    683.99,    4862.63,    106.200,        0.000!   !END!
53 ! X =    684.61,    4862.96,     92.800,        0.000!   !END!
54 ! X =    684.78,    4863.33,    100.500,        0.000!   !END!
55 ! X =    685.27,    4863.24,     97.800,        0.000!   !END!
56 ! X =     677.4,    4860.98,     99.000,        0.000!   !END!
57 ! X =    676.63,    4860.82,    101.700,        0.000!   !END!
58 ! X =    676.92,    4861.93,    117.100,        0.000!   !END!
59 ! X =    676.73,    4861.32,    107.800,        0.000!   !END!
60 ! X =    676.09,    4861.39,     95.700,        0.000!   !END!
61 ! X =    676.18,    4861.72,    105.200,        0.000!   !END!
62 ! X =    675.67,    4861.78,     89.600,        0.000!   !END!
63 ! X =    676.05,    4862.06,    122.800,        0.000!   !END!
64 ! X =    676.64,    4862.13,    121.200,        0.000!   !END!
65 ! X =    676.57,    4861.63,    106.700,        0.000!   !END!
66 ! X =    684.65,    4863.18,     96.700,        0.000!   !END!
67 ! X =    685.17,    4863.93,     98.200,        0.000!   !END!
68 ! X =    685.45,     4863.1,     92.100,        0.000!   !END!
69 ! X =    685.53,    4864.69,    113.200,        0.000!   !END!
70 ! X =    685.74,    4864.79,    113.400,        0.000!   !END!
71 ! X =    685.52,    4864.85,    114.800,        0.000!   !END!
72 ! X =    685.44,    4864.88,    114.600,        0.000!   !END!
```

```
 73 ! X =      686.36,    4864.71,      96.500,        0.000!   !END!
 74 ! X =      685.72,    4865.13,     115.300,        0.000!   !END!
 75 ! X =      678.26,    4863.57,     139.700,        0.000!   !END!
 76 ! X =      677.69,    4864.04,     134.500,        0.000!   !END!
 77 ! X =      676.48,    4862.53,     128.400,        0.000!   !END!
 78 ! X =      678.32,    4864.76,     135.900,        0.000!   !END!
 79 ! X =      678.51,    4865.06,     137.900,        0.000!   !END!
 80 ! X =      672.79,    4863.94,     108.100,        0.000!   !END!
 81 ! X =      673.95,    4863.59,      99.300,        0.000!   !END!
 82 ! X =      671.75,    4864.89,     118.100,        0.000!   !END!
 83 ! X =      685.71,    4864.67,     114.500,        0.000!   !END!
 84 ! X =      684.18,    4863.62,     108.900,        0.000!   !END!
 85 ! X =      678.42,    4864.48,     135.100,        0.000!   !END!
 86 ! X =      685.33,    4863.44,      93.200,        0.000!   !END!
 87 ! X =      685.15,    4863.24,      97.100,        0.000!   !END!
 88 ! X =      672.68,    4862.04,     104.000,        0.000!   !END!
 89 ! X =      672.08,    4865.29,     117.900,        0.000!   !END!
 90 ! X =      672.64,    4859.66,     102.800,        0.000!   !END!
 91 ! X =      673.74,    4858.96,      81.600,        0.000!   !END!
 92 ! X =      673.12,    4863.39,     104.200,        0.000!   !END!
 93 ! X =       673.9,    4862.28,      99.900,        0.000!   !END!
 94 ! X =      671.47,     4861.8,      99.000,        0.000!   !END!
 95 ! X =      673.06,    4862.63,      96.700,        0.000!   !END!
 96 ! X =      674.92,    4863.96,     124.800,        0.000!   !END!
 97 ! X =      671.36,    4862.95,     113.000,        0.000!   !END!
 98 ! X =      671.68,    4862.71,     108.000,        0.000!   !END!
 99 ! X =       671.6,    4860.14,     103.500,        0.000!   !END!
100 ! X =      670.95,    4857.98,      82.200,        0.000!   !END!
101 ! X =      677.51,    4864.74,     130.500,        0.000!   !END!
102 ! X =      676.52,    4862.68,     129.100,        0.000!   !END!
103 ! X =      677.66,     4863.6,     132.200,        0.000!   !END!
104 ! X =      677.67,    4863.41,     134.100,        0.000!   !END!
105 ! X =      674.87,    4864.67,     139.500,        0.000!   !END!
106 ! X =       673.2,    4864.75,     106.300,        0.000!   !END!
107 ! X =      674.79,    4864.92,     141.500,        0.000!   !END!
108 ! X =      686.32,     4864.4,      96.900,        0.000!   !END!
109 ! X =      676.06,    4862.18,     128.700,        0.000!   !END!
110 ! X =      671.23,    4863.62,     129.600,        0.000!   !END!
111 ! X =      676.05,     4863.9,     135.600,        0.000!   !END!
112 ! X =      671.71,    4862.36,     106.900,        0.000!   !END!
113 ! X =       684.2,    4864.12,     116.000,        0.000!   !END!
114 ! X =      685.48,    4865.15,     118.600,        0.000!   !END!
115 ! X =      686.84,    4864.73,      94.400,        0.000!   !END!
116 ! X =      673.48,    4863.34,     100.600,        0.000!   !END!
117 ! X =      671.83,     4864.4,     113.200,        0.000!   !END!
118 ! X =      671.61,    4864.54,     118.100,        0.000!   !END!
119 ! X =      671.36,    4862.96,     113.100,        0.000!   !END!
120 ! X =      671.51,    4862.26,     110.200,        0.000!   !END!
121 ! X =       672.6,    4863.08,     109.900,        0.000!   !END!
122 ! X =      671.72,    4862.89,     108.800,        0.000!   !END!
123 ! X =      686.72,    4865.65,      96.300,        0.000!   !END!
124 ! X =      676.17,    4865.67,     143.200,        0.000!   !END!
125 ! X =      676.12,    4863.98,     134.000,        0.000!   !END!
126 ! X =      684.65,    4863.18,      96.700,        0.000!   !END!
127 ! X =      685.38,    4863.58,      90.900,        0.000!   !END!
128 ! X =      685.02,    4863.95,     103.900,        0.000!   !END!
129 ! X =      686.24,    4864.09,      89.200,        0.000!   !END!
130 ! X =      686.72,    4863.73,      84.900,        0.000!   !END!
131 ! X =      686.36,    4864.75,      96.200,        0.000!   !END!
132 ! X =       685.5,    4865.01,     116.400,        0.000!   !END!
```

```
133 ! X =     686.73,    4866.06,      96.800,        0.000!   !END!
134 ! X =     685.19,    4866.57,     130.300,        0.000!   !END!
135 ! X =     685.97,    4866.98,     118.800,        0.000!   !END!
136 ! X =     677.71,    4864.73,     136.100,        0.000!   !END!
137 ! X =     675.99,    4864.27,     137.500,        0.000!   !END!
138 ! X =     676.61,    4862.74,     130.400,        0.000!   !END!
139 ! X =     677.22,    4863.76,     133.800,        0.000!   !END!
140 ! X =     678.15,    4863.87,     138.000,        0.000!   !END!
141 ! X =     678.31,     4863.6,     138.000,        0.000!   !END!
142 ! X =     677.01,    4862.47,     122.400,        0.000!   !END!
143 ! X =     677.43,    4866.69,     151.200,        0.000!   !END!
144 ! X =     675.27,    4863.56,     131.200,        0.000!   !END!
145 ! X =     673.48,    4860.03,     100.700,        0.000!   !END!
146 ! X =     670.86,    4860.71,     110.000,        0.000!   !END!
147 ! X =     672.66,    4863.91,     112.500,        0.000!   !END!
148 ! X =     672.74,    4859.23,      98.200,        0.000!   !END!
149 ! X =     673.58,    4862.69,      97.400,        0.000!   !END!
150 ! X =     673.71,    4861.97,      92.100,        0.000!   !END!
151 ! X =     672.37,    4859.93,     101.400,        0.000!   !END!
152 ! X =     672.56,    4866.05,     137.800,        0.000!   !END!
153 ! X =      675.1,    4862.93,     100.300,        0.000!   !END!
154 ! X =     673.24,     4865.2,     120.500,        0.000!   !END!
155 ! X =     674.16,    4863.03,      93.200,        0.000!   !END!
156 ! X =     671.91,     4864.7,     113.600,        0.000!   !END!
157 ! X =     673.29,    4858.77,      82.300,        0.000!   !END!
158 ! X =     671.66,    4863.12,     116.500,        0.000!   !END!
159 ! X =     673.85,    4866.71,     168.300,        0.000!   !END!
160 ! X =     672.62,    4862.11,     106.700,        0.000!   !END!
161 ! X =     673.57,     4861.9,      92.300,        0.000!   !END!
162 ! X =     671.79,    4861.95,     110.400,        0.000!   !END!
163 ! X =     673.76,    4864.21,     104.900,        0.000!   !END!
164 ! X =     672.24,    4864.62,     111.200,        0.000!   !END!
165 ! X =     673.21,    4858.68,      81.600,        0.000!   !END!
166 ! X =     675.47,    4863.22,     133.500,        0.000!   !END!
167 ! X =     672.44,    4858.75,      98.000,        0.000!   !END!
168 ! X =      672.8,    4864.44,     104.300,        0.000!   !END!
169 ! X =     671.35,    4863.28,     119.000,        0.000!   !END!
170 ! X =     673.21,    4862.13,      95.300,        0.000!   !END!
171 ! X =     671.02,    4860.95,     107.800,        0.000!   !END!
172 ! X =     670.99,    4861.09,     104.000,        0.000!   !END!
173 ! X =     674.15,    4862.29,      99.500,        0.000!   !END!
174 ! X =     672.01,    4861.71,     108.300,        0.000!   !END!
175 ! X =     684.17,    4863.62,     109.000,        0.000!   !END!
176 ! X =     683.92,    4866.64,     145.000,        0.000!   !END!
177 ! X =     680.45,    4865.77,     151.900,        0.000!   !END!
178 ! X =     685.61,    4864.52,     105.900,        0.000!   !END!
179 ! X =     686.29,    4865.06,      96.600,        0.000!   !END!
180 ! X =     683.88,    4864.74,     119.800,        0.000!   !END!
181 ! X =     684.65,    4866.46,     131.400,        0.000!   !END!
182 ! X =      678.1,    4864.84,     138.700,        0.000!   !END!
183 ! X =     678.47,    4863.43,     132.300,        0.000!   !END!
184 ! X =     674.14,    4862.76,      95.900,        0.000!   !END!
185 ! X =     673.82,    4864.36,     105.700,        0.000!   !END!
186 ! X =     673.15,    4858.57,      84.600,        0.000!   !END!
187 ! X =     671.29,    4863.58,     131.700,        0.000!   !END!
188 ! X =     671.44,    4861.66,      99.100,        0.000!   !END!
189 ! X =     673.24,    4860.89,     102.100,        0.000!   !END!
190 ! X =     684.25,     4866.5,     142.100,        0.000!   !END!
191 ! X =     673.91,    4859.55,      85.500,        0.000!   !END!
192 ! X =     675.05,    4864.18,     132.100,        0.000!   !END!
```

```
193 ! X =      685.28,    4866.02,     124.900,        0.000!   !END!
194 ! X =      685.36,    4864.52,      95.600,        0.000!   !END!
195 ! X =      685.63,    4864.17,      90.400,        0.000!   !END!
196 ! X =      685.85,    4863.64,      79.900,        0.000!   !END!
197 ! X =      686.16,    4863.62,      80.500,        0.000!   !END!
198 ! X =      685.93,    4863.38,      77.700,        0.000!   !END!
199 ! X =      681.69,    4864.72,     141.700,        0.000!   !END!
200 ! X =      681.77,    4864.63,     137.200,        0.000!   !END!
201 ! X =      681.89,    4864.51,     136.700,        0.000!   !END!
202 ! X =      681.97,    4864.44,     135.400,        0.000!   !END!
203 ! X =      681.94,    4864.68,     136.800,        0.000!   !END!
204 ! X =      682.05,    4864.59,     137.700,        0.000!   !END!
205 ! X =      682.17,    4864.63,     136.200,        0.000!   !END!
206 ! X =      682.26,    4864.52,     132.200,        0.000!   !END!
207 ! X =      682.38,    4864.59,     130.600,        0.000!   !END!
208 ! X =      682.46,     4864.5,     129.400,        0.000!   !END!
209 ! X =      686.23,    4861.16,      79.900,        0.000!   !END!
210 ! X =      686.18,    4861.25,      84.700,        0.000!   !END!
211 ! X =      686.15,    4861.29,      82.900,        0.000!   !END!
212 ! X =      686.35,    4861.34,      74.600,        0.000!   !END!
213 ! X =      686.41,    4861.45,      75.000,        0.000!   !END!
214 ! X =       686.5,     4861.6,      76.400,        0.000!   !END!
215 ! X =       686.7,    4861.79,      74.700,        0.000!   !END!
216 ! X =       686.9,    4861.96,      81.900,        0.000!   !END!
217 ! X =      686.87,    4862.12,      86.500,        0.000!   !END!
218 ! X =      687.19,    4862.05,      76.300,        0.000!   !END!
219 ! X =      687.52,    4862.13,      79.600,        0.000!   !END!
220 ! X =      678.65,    4860.34,      99.300,        0.000!   !END!
221 ! X =      678.41,    4860.15,      91.000,        0.000!   !END!
222 ! X =      678.65,    4860.05,      94.500,        0.000!   !END!
223 ! X =      678.73,    4859.86,      91.700,        0.000!   !END!
224 ! X =      678.51,    4859.81,      83.100,        0.000!   !END!
225 ! X =      678.87,     4859.7,      84.300,        0.000!   !END!
226 ! X =      678.72,     4860.2,      99.700,        0.000!   !END!
227 ! X =       678.8,    4860.01,      99.200,        0.000!   !END!
228 ! X =      678.85,    4859.85,      94.400,        0.000!   !END!
229 ! X =       681.1,    4861.68,     124.900,        0.000!   !END!
230 ! X =      681.12,    4861.86,     130.700,        0.000!   !END!
231 ! X =      680.99,    4861.98,     129.200,        0.000!   !END!
232 ! X =      680.97,    4862.07,     129.600,        0.000!   !END!
233 ! X =      681.02,    4862.09,     130.600,        0.000!   !END!
234 ! X =      680.94,    4862.12,     129.200,        0.000!   !END!
235 ! X =      680.99,    4862.18,     129.900,        0.000!   !END!
236 ! X =      680.98,    4862.21,     129.900,        0.000!   !END!
237 ! X =      680.96,    4862.29,     127.800,        0.000!   !END!
238 ! X =      680.86,    4862.32,     125.400,        0.000!   !END!
239 ! X =      680.99,     4862.4,     128.200,        0.000!   !END!
240 ! X =      681.55,    4860.87,     108.700,        0.000!   !END!
241 ! X =      681.56,    4860.69,     101.200,        0.000!   !END!
242 ! X =      681.58,    4860.61,      98.700,        0.000!   !END!
243 ! X =      681.88,    4860.25,      97.900,        0.000!   !END!
244 ! X =      682.17,    4860.32,      98.000,        0.000!   !END!
245 ! X =      679.57,    4861.05,      96.300,        0.000!   !END!
246 ! X =      679.45,    4861.05,      99.300,        0.000!   !END!
247 ! X =      679.13,    4860.95,     101.900,        0.000!   !END!
248 ! X =      679.11,    4860.94,     101.200,        0.000!   !END!
249 ! X =      679.06,    4860.99,     100.900,        0.000!   !END!
250 ! X =      679.08,    4860.93,      99.900,        0.000!   !END!
251 ! X =      678.81,    4860.84,      98.400,        0.000!   !END!
252 ! X =      678.84,    4860.78,      95.900,        0.000!   !END!
```

253 ! X =	680.0,	4861.03,	102.700,	0.000!	!END!
254 ! X =	680.06,	4861.06,	104.100,	0.000!	!END!
255 ! X =	680.29,	4861.15,	104.500,	0.000!	!END!
256 ! X =	680.54,	4861.2,	104.200,	0.000!	!END!
257 ! X =	680.35,	4861.29,	105.800,	0.000!	!END!
258 ! X =	680.31,	4861.28,	106.000,	0.000!	!END!
259 ! X =	680.27,	4861.26,	105.600,	0.000!	!END!
260 ! X =	680.23,	4861.25,	105.000,	0.000!	!END!
261 ! X =	680.18,	4861.23,	104.800,	0.000!	!END!
262 ! X =	680.09,	4861.19,	105.100,	0.000!	!END!
263 ! X =	680.07,	4861.25,	105.700,	0.000!	!END!
264 ! X =	680.02,	4861.19,	104.300,	0.000!	!END!
265 ! X =	680.82,	4860.22,	99.900,	0.000!	!END!
266 ! X =	680.4,	4860.73,	101.700,	0.000!	!END!
267 ! X =	680.36,	4859.96,	92.600,	0.000!	!END!
268 ! X =	680.08,	4859.99,	83.800,	0.000!	!END!
269 ! X =	680.82,	4860.71,	102.200,	0.000!	!END!
270 ! X =	681.07,	4859.94,	102.700,	0.000!	!END!
271 ! X =	679.9,	4860.07,	81.800,	0.000!	!END!
272 ! X =	680.13,	4860.69,	101.000,	0.000!	!END!
273 ! X =	680.25,	4860.26,	96.100,	0.000!	!END!
274 ! X =	679.9,	4860.51,	94.800,	0.000!	!END!
275 ! X =	679.87,	4860.45,	92.000,	0.000!	!END!
276 ! X =	679.28,	4859.98,	90.800,	0.000!	!END!
277 ! X =	679.39,	4860.65,	95.900,	0.000!	!END!
278 ! X =	679.26,	4860.57,	93.200,	0.000!	!END!
279 ! X =	680.15,	4861.3,	105.600,	0.000!	!END!
280 ! X =	679.94,	4861.21,	102.500,	0.000!	!END!
281 ! X =	680.86,	4861.46,	115.800,	0.000!	!END!
282 ! X =	681.39,	4861.67,	124.600,	0.000!	!END!
283 ! X =	680.68,	4861.6,	113.400,	0.000!	!END!
284 ! X =	680.06,	4861.34,	107.500,	0.000!	!END!
285 ! X =	679.68,	4861.21,	104.100,	0.000!	!END!
286 ! X =	681.34,	4861.79,	124.600,	0.000!	!END!
287 ! X =	685.64,	4864.81,	114.500,	0.000!	!END!
288 ! X =	685.46,	4864.62,	108.300,	0.000!	!END!
289 ! X =	684.16,	4864.6,	121.500,	0.000!	!END!
290 ! X =	684.59,	4862.41,	89.200,	0.000!	!END!
291 ! X =	681.49,	4865.72,	149.600,	0.000!	!END!
292 ! X =	681.57,	4863.67,	127.900,	0.000!	!END!
293 ! X =	678.57,	4862.82,	132.700,	0.000!	!END!
294 ! X =	680.03,	4867.32,	154.400,	0.000!	!END!
295 ! X =	678.1,	4864.63,	135.900,	0.000!	!END!
296 ! X =	679.83,	4860.7,	98.000,	0.000!	!END!
297 ! X =	679.36,	4861.02,	99.900,	0.000!	!END!
298 ! X =	676.42,	4860.46,	92.100,	0.000!	!END!
299 ! X =	682.97,	4862.2,	109.400,	0.000!	!END!
300 ! X =	683.55,	4861.96,	97.900,	0.000!	!END!
301 ! X =	682.55,	4862.32,	112.500,	0.000!	!END!
302 ! X =	683.24,	4862.39,	105.800,	0.000!	!END!
303 ! X =	682.51,	4862.86,	119.900,	0.000!	!END!
304 ! X =	683.13,	4863.65,	121.300,	0.000!	!END!
305 ! X =	688.21,	4862.51,	84.800,	0.000!	!END!
306 ! X =	687.99,	4863.22,	83.300,	0.000!	!END!
307 ! X =	688.82,	4862.84,	84.100,	0.000!	!END!
308 ! X =	689.05,	4863.37,	106.400,	0.000!	!END!
309 ! X =	688.27,	4863.76,	87.800,	0.000!	!END!
310 ! X =	689.91,	4863.1,	91.300,	0.000!	!END!
311 ! X =	688.93,	4864.39,	107.400,	0.000!	!END!
312 ! X =	689.68,	4863.84,	106.100,	0.000!	!END!

313	! X =	687.56,	4862.51,	79.000,	0.000!	!END!
314	! X =	687.24,	4863.17,	84.900,	0.000!	!END!
315	! X =	687.02,	4863.9,	84.400,	0.000!	!END!
316	! X =	688.16,	4865.39,	96.100,	0.000!	!END!
317	! X =	685.03,	4868.25,	145.500,	0.000!	!END!
318	! X =	687.29,	4867.04,	106.200,	0.000!	!END!
319	! X =	685.68,	4867.15,	127.100,	0.000!	!END!
320	! X =	686.75,	4865.87,	92.800,	0.000!	!END!
321	! X =	687.03,	4862.37,	75.100,	0.000!	!END!
322	! X =	686.63,	4863.02,	84.000,	0.000!	!END!
323	! X =	683.38,	4865.37,	132.600,	0.000!	!END!
324	! X =	683.11,	4867.15,	153.600,	0.000!	!END!
325	! X =	682.45,	4869.42,	158.700,	0.000!	!END!
326	! X =	684.78,	4864.89,	115.800,	0.000!	!END!
327	! X =	684.55,	4866.4,	130.700,	0.000!	!END!
328	! X =	679.94,	4864.88,	144.600,	0.000!	!END!
329	! X =	679.06,	4863.89,	133.500,	0.000!	!END!
330	! X =	679.71,	4862.77,	118.600,	0.000!	!END!
331	! X =	678.9,	4861.8,	119.500,	0.000!	!END!
332	! X =	680.35,	4862.16,	125.000,	0.000!	!END!
333	! X =	679.82,	4861.63,	105.000,	0.000!	!END!
334	! X =	678.43,	4860.94,	100.400,	0.000!	!END!
335	! X =	677.75,	4861.24,	94.900,	0.000!	!END!
336	! X =	677.64,	4861.79,	111.400,	0.000!	!END!
337	! X =	678.53,	4862.14,	129.400,	0.000!	!END!
338	! X =	678.01,	4862.78,	129.400,	0.000!	!END!
339	! X =	677.88,	4860.59,	96.100,	0.000!	!END!
340	! X =	677.44,	4867.86,	154.700,	0.000!	!END!
341	! X =	679.67,	4866.61,	154.500,	0.000!	!END!
342	! X =	678.66,	4867.47,	161.400,	0.000!	!END!
343	! X =	676.19,	4866.84,	149.600,	0.000!	!END!
344	! X =	678.27,	4866.09,	150.200,	0.000!	!END!
345	! X =	681.24,	4867.1,	156.400,	0.000!	!END!
346	! X =	682.17,	4868.08,	162.800,	0.000!	!END!
347	! X =	679.37,	4868.63,	156.800,	0.000!	!END!
348	! X =	680.31,	4869.97,	161.900,	0.000!	!END!
349	! X =	676.49,	4869.29,	196.800,	0.000!	!END!
350	! X =	676.85,	4865.41,	138.800,	0.000!	!END!
351	! X =	681.15,	4868.68,	157.700,	0.000!	!END!
352	! X =	675.42,	4859.83,	79.300,	0.000!	!END!
353	! X =	675.15,	4860.55,	77.400,	0.000!	!END!
354	! X =	675.3,	4860.89,	86.300,	0.000!	!END!
355	! X =	675.65,	4860.64,	74.800,	0.000!	!END!
356	! X =	675.67,	4860.08,	73.000,	0.000!	!END!
357	! X =	676.04,	4860.32,	73.000,	0.000!	!END!
358	! X =	675.92,	4859.82,	74.400,	0.000!	!END!
359	! X =	676.71,	4860.9,	105.900,	0.000!	!END!
360	! X =	677.31,	4860.53,	98.900,	0.000!	!END!
361	! X =	676.56,	4860.26,	76.600,	0.000!	!END!
362	! X =	676.7,	4859.7,	79.200,	0.000!	!END!
363	! X =	677.56,	4860.06,	84.700,	0.000!	!END!
364	! X =	678.2,	4859.83,	80.900,	0.000!	!END!
365	! X =	674.18,	4861.02,	89.400,	0.000!	!END!
366	! X =	674.59,	4862.61,	85.500,	0.000!	!END!
367	! X =	672.86,	4862.81,	101.700,	0.000!	!END!
368	! X =	675.67,	4864.47,	135.500,	0.000!	!END!
369	! X =	672.44,	4864.71,	112.600,	0.000!	!END!
370	! X =	674.83,	4866.91,	160.700,	0.000!	!END!
371	! X =	675.8,	4868.59,	177.500,	0.000!	!END!
372	! X =	686.08,	4862.78,	80.900,	0.000!	!END!

```
   373 ! X =      685.78,    4862.14,      82.800,       0.000!   !END!
   374 ! X =      685.08,    4862.83,      85.500,       0.000!   !END!
   375 ! X =      680.98,    4865.67,     157.900,       0.000!   !END!
   376 ! X =      680.91,    4863.97,     132.800,       0.000!   !END!
   377 ! X =       682.6,    4863.66,     125.600,       0.000!   !END!
   378 ! X =      682.21,    4862.91,     115.900,       0.000!   !END!
   379 ! X =      683.22,    4861.11,     115.400,       0.000!   !END!
   380 ! X =      683.95,    4862.36,     108.300,       0.000!   !END!
   381 ! X =      685.36,    4861.14,      86.000,       0.000!   !END!
   382 ! X =      688.61,    4862.63,      77.500,       0.000!   !END!
   383 ! X =      673.88,    4859.13,      82.900,       0.000!   !END!
   384 ! X =      671.67,    4862.79,     108.100,       0.000!   !END!
   385 ! X =      671.67,    4861.59,      99.600,       0.000!   !END!
   386 ! X =      672.82,    4861.29,     100.800,       0.000!   !END!
   387 ! X =      672.36,    4860.26,      96.900,       0.000!   !END!
   388 ! X =      673.92,    4860.12,      88.300,       0.000!   !END!
   389 ! X =      673.15,    4859.42,      87.000,       0.000!   !END!
   390 ! X =      677.41,    4861.05,      96.600,       0.000!   !END!
   391 ! X =      688.28,     4864.7,      95.600,       0.000!   !END!
-------------
```

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.