March 9, 2015

APPENDIX 5.7-C

Dispersion Model Methods

Submitted to:
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REPORT

Reference Number: 1114220046-560-R-Rev0-4700

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1 Electronic Copy - BURNCO Rock Products
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1.0 INTRODUCTION

BURNCO Rock Products Ltd. (BURNCO) has proposed to construct and operate an aggregate mine using wet extraction techniques in Howe Sound, British Columbia (BC) (the Project).

This report supplements Chapter 5.7 of the Environmental Assessment Certificate Application/Environmental Impact Statement.

As a part of air assessment, the general approach used to evaluate the potential air quality effects of the Project included the following steps:

- Estimate the air emissions from the Project for the phase of activity (i.e., construction, operations, and closure and reclamation) determined to have the highest (i.e., bounding) quantity of air emissions.
- Develop a meteorological dataset for use in the dispersion modelling.
- **Predict the concentrations and deposition rates of indicator compounds released from the bounding phase of the Project dispersion modelling.**
- **Use dispersion modelling to predict the concentrations and deposition rates of the non-indicator compounds required as inputs to other disciplines affected by changes in air quality (e.g., human health).**
- Compare the predicted indicator compound concentrations to available criteria and standards, and assess the relevant significance of these effects.

This appendix outlines the third and fourth steps (**bolded**), namely the approach used for dispersion modelling.

2.0 REGULATORY FRAMEWORK

For projects located in BC, the Ministry of Environment (BC MoE, hereafter) has developed guidelines for undertaking dispersion modelling entitled *Guidelines for Air Quality Dispersion Modelling in British Columbia* (BC Modelling Guidelines, hereafter). The purpose of the guideline is to provide uniform benchmarks and a structured approach to the selection and application of dispersion models. Issues considered in the guideline include the following:

- determination of model performance by comparing model predictions to air quality observations;
- meteorological data requirements;
- receptor placement;
- consideration of permanent structure (e.g., building) downwash effects;
- incorporation of complex terrain; and
- assumptions for consideration when preparing source information.

3.0 MODEL SELECTION

Based on guidance provided in BC Modelling Guidelines (BC MoE 2008) and given the potential influences of complex terrain and anticipated non-steady-state meteorological conditions induced by complex terrain, the most appropriate model to use for the air assessment is the CALPUFF model in 3D mode.

3.1 CALPUFF Modelling System

The CALPUFF modelling system is made up of 3 main components:

- the CALMET meteorological model that generates meteorological input files;
- the CALPUFF transport and dispersion model that advects "puffs" of material emitted from sources to calculate hourly concentration/fluxes at receptors of interest; and
- CALPOST post processor (used to extract the data of interest from CALPUFF binary output files).

To predict concentrations using CALPUFF, a series of inputs are required. These inputs can be grouped into categories:

- dispersion meteorological data;
- terrain and receptors; and
- source configurations.

Each of these input categories are discussed separately in the following sections.

The following versions of the model were used:

- CALMET dispersion meteorology model (V6.326);
- CALPUFF dispersion model (V6.42, level 110325); and
- CALPOST post processor (V6.42).

3.2 Dispersion Meteorological Inputs

A 1-year meteorological data set was developed using the CALMET processor. CALMET is a diagnostic meteorological model that produces 3-dimensional wind fields based on parameterized treatments of terrain effects, such as slope flows, terrain blocking effects, and kinematic effects.

Due to the complex terrain surrounding the facility (valley and mountain structures and the land water interface along the southern edge of the facility) it was determined that CALPUFF would be executed using a fine terrain (grid) resolution of 100 m for the air quality assessment. Furthermore, no reliable meteorological station was available within the Project's valley. For the Project site, the meteorological data, specifically the wind speed and direction will be heavily influenced by the surrounding complex terrain and meteorological stations in neighbouring valleys may not be representative of the facility's meteorology. It was determined that CALMET would be executed in no-observation mode and observation data (from nearby meteorology stations found in surrounding valleys) will be used to validate the CALMET output. Fifth-Generation Mesoscale Model (MM5) data, generated in house, was used as the initial guess field in CALMET.

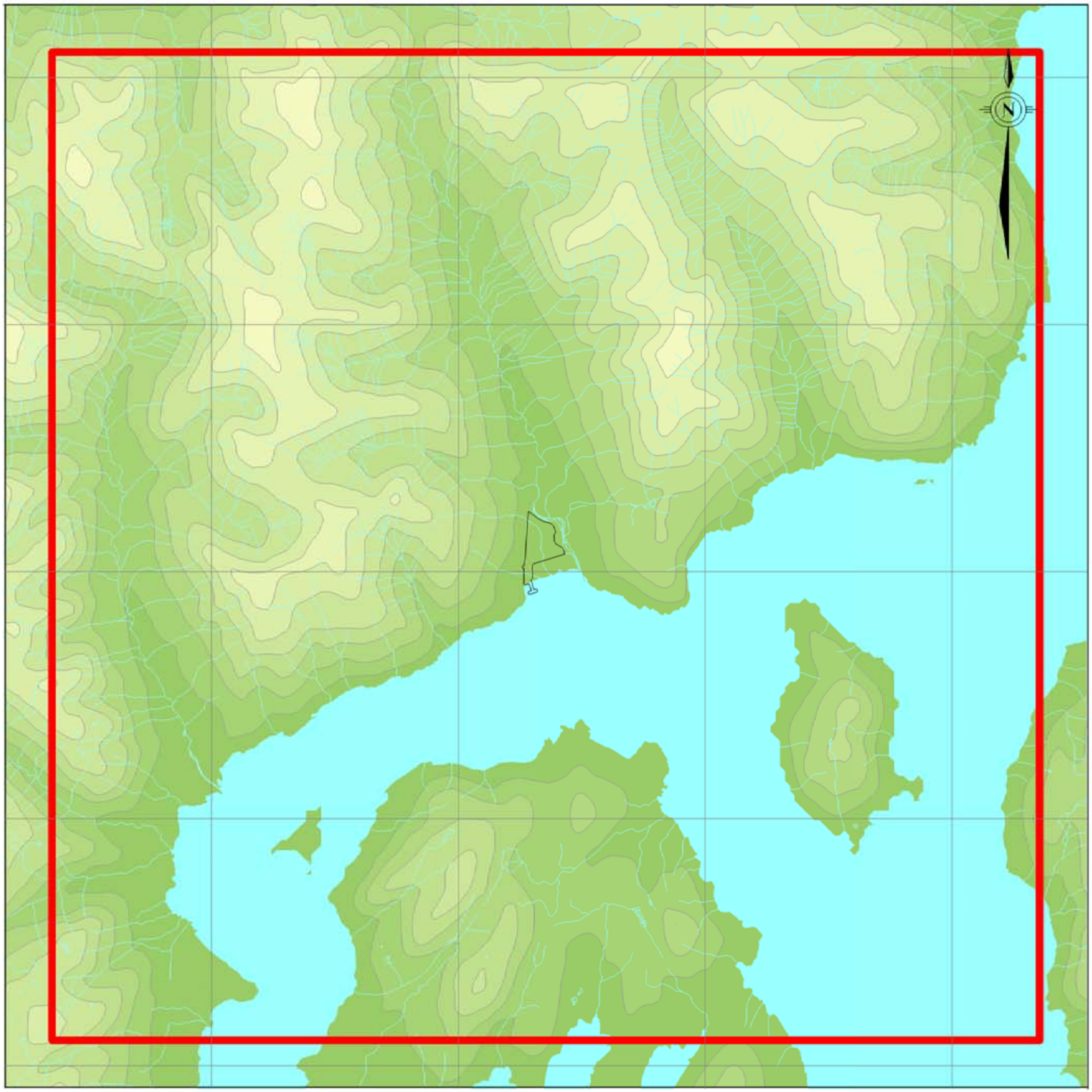
Specific details related to the development and validation of the dispersion meteorology for the air quality assessment for other disciplines can be found in Appendix 5.7-B and Chapter 9.1 and associated appendices.

3.3 CALPUFF Dispersion Model Inputs

It was assumed that all emission sources were emitting continuously at their maximum daily emission rates. In reality, most sources would not operate continuously; they would only operate during facility's operational hours, which will be governed by available daily sunlight.

3.3.1 Modelling Domain

CALPUFF's local study area domain is a 20 by 20 km rectangle, with a spatial resolution of 100 m centred on the Project. This domain size is expected to be sufficiently large to include all potentially sensitive receptors that may be impacted by on-site sources. The coordinates of the domain are presented in Table 1 and the domain is illustrated in Figure 1. The spatial resolution of the CALPUFF grid is 100 m.



5 0 5

SCALE KILOMETERS

LEGEND

Project Boundary

CALPUFF domain

Terrain elevation (masl)

0 200 400 600 800 1000 1200 1400 1600

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83

PROJECT
BURNCO ROCK PRODUCTS LTD.
AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE
CALPUFF MODEL DOMAIN

Golder Associates

PROJECT	11-1422-0046		PHASE No.4700
DESIGN	SD	11 Apr. 13	SCALE AS SHOWN REV. 0
AIR	TB	06 May. 14	**FIGURE: 1**
CHECK	JR	23 Feb. 15	
REVIEW	SC	27 Feb. 15	

\\bur1-d-filesrv1\Active_2011\1422\11-1422-0046 Burnco McNab Creek EA\Phase 4700 Air Climate\06 Data\modelling\domain\CALPUFFdomain.srf

Table 1: CALPUFF Model Domain Coordinates (UTM Zone 10)

Location	UTM Easting (m)	UTM Northing (m)
Southwest	461,771	5,480,514
Northwest	461,771	5,500,514
Southeast	481,771	5,480,514
Northeast	481,771	5,500,514

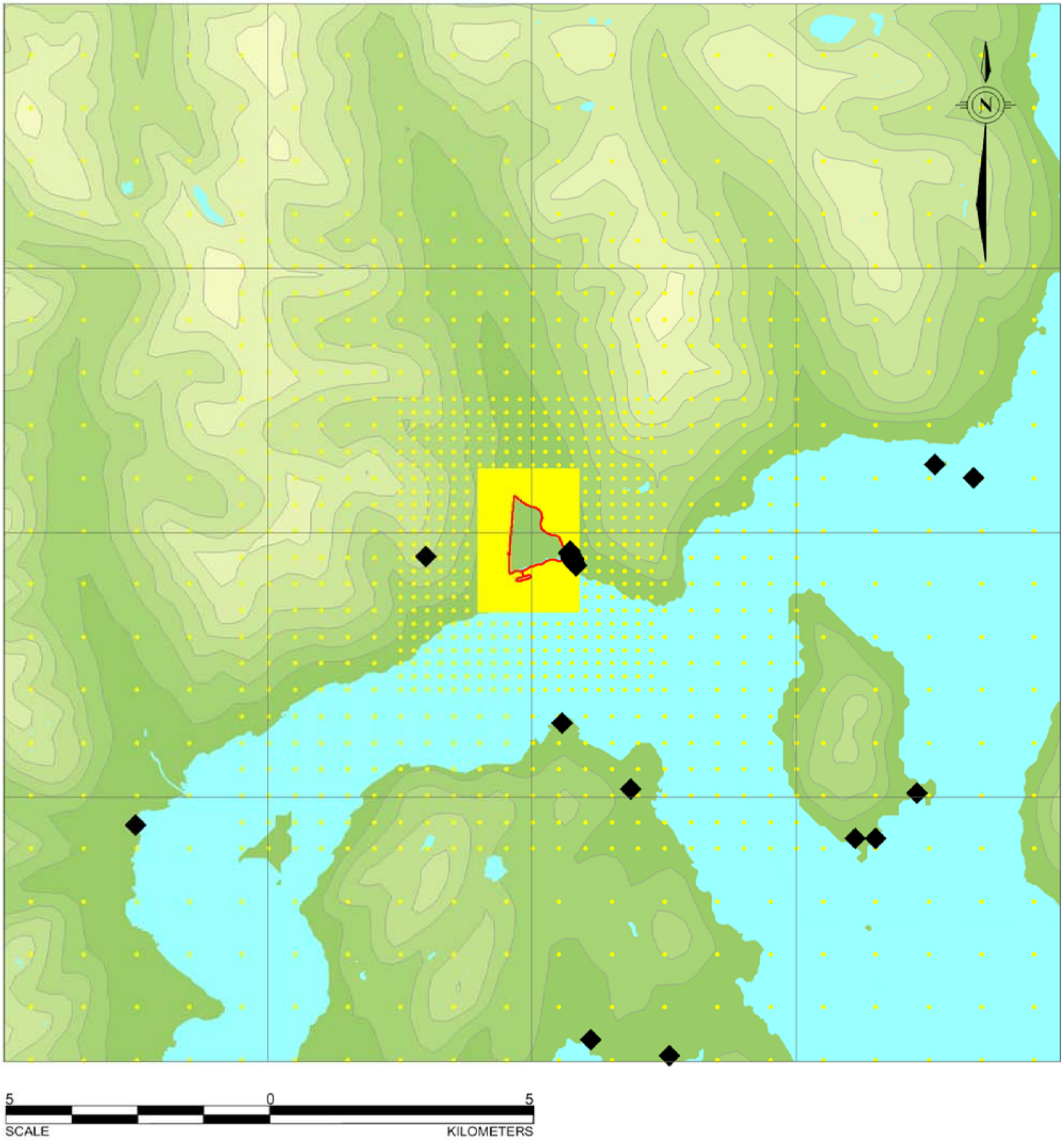
3.3.2 Model Receptors

Ambient concentrations resulting from on-site emissions were predicted at selected groups of receptors to provide a better understanding of the potential impacts of the Project. Receptors placement is consistent with the recommendations described in BC Modelling Guidelines (BC MoE 2008) recommendations and receptor groups consist of a standard receptor grid, fence-line receptors, and sensitive receptors. The standard nested receptor grid includes the following:

- 50 m spacing within 500 m of source locations;
- 250 m spacing within 2 km of source locations;
- 500 m spacing within 5 km of source locations; and
- 1,000 m spacing beyond 5 km of the source.

Receptors will also be placed at 20 m intervals along the property boundary of the facility.

Discrete potentially sensitive receptors will include twelve seasonal cottages located within 0.37 km of the Project's fenceline and recreational areas (campsites) located >3 km from the Project on Gambier Island near Ekins Point; Table 2 summarizes the location of discrete sensitive receptors. A beach, which is exposed during low tide, south of the Project is not contained within BURNCO's property boundary and, may be publicly accessible. This beach area is within 500 m of Project emission sources and the nested receptor grid spacing over the beach area is 50 m. Figure 2 shows the gridded, fence-line and sensitive receptors in the CALPUFF model domain.



LEGEND

Elevations are shown at 200 m contour intervals

Gridded Receptors

Fenceline Receptors

Discrete Receptors

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT

BURNCO ROCK PRODUCTS LTD.
AGGREGATE PROJECT, BRITISH COLUMBIA

TITLE

RECEPTORS WITHIN THE CALPUFF DOMAIN

Golder Associates

PROJECT NO.11-1422-0046			PHASE No.4700	
DESIGN	TB	02 Aug. 13	SCALE AS SHOWN	REV. 0
AIR	TB	25 Nov. 14	**FIGURE: 2**	
CHECK	JR	18 Dec. 14		
REVIEW	SC	22 Dec. 14		

//bur1-d-filesrv1/Active/_2011/1422/11-1422-0046/Phase 4700/07 Deliverables/EA_modelling_report/Appendix/Figures - Dispersion Methodology/Figure 2 Receptor.srf

Table 2: Sensitive Receptors of Interest within CALPUFF Domain (UTM Zone 10)

Receptors	Easting (m)	Northing (m)
Residence R1	472,492	5,490,163
Residence R2	472,473	5,490,134
Residence R3	472,502	5,490,113
Residence R4	472,514	5,490,093
Residence R5	472,526	5,490,064
Residence R6	472,512	5,490,043
Residence R7	472,517	5,490,024
Residence R8	472,553	5,490,032
Residence R9	472,530	5,489,996
Residence R10	472,561	5,490,005
Residence R11	472,545	5,489,970
Residence R12	472,580	5,489,941
Residence R13	472,604	5,489,898
Residence R14	472,604	5,489,883
Residence R15 - Unoccupied	469,764	5,490,065
Ekins Point	472,345	5,486,912
McNab Upstream	471,594	5,491,495
Anvil Island	477,888	5,484,737
Camp Artaban	474,374	5,480,622
KAIKALAHUN 25	464,260	5,484,988
KWUM KWUM	479,401	5,491,810

3.3.3 Model Options

CALPUFF model offers various switch options for users to customize model runs that best fit to each Project. While option selection requires careful deliberation, this is a strong tool that is available to the users. Model switch selections for the air quality assessment are generally consistent with the recommendations found in the BC Modelling Guidelines (BC MoE 2008). A summary of the CALPUFF recommended switch selection along with the switches to be used within the assessment are detailed in Appendix A.

3.3.4 Building Downwash

Building downwash is a phenomenon caused by air movement around buildings. Buildings or other solid structures may affect the flow of air in the vicinity of a source and cause eddies to form on the downwind side of a building. In some situations, the stack emissions may be trapped in the wake of a building or other structures, which may result in elevated ground-level concentrations. In this assessment, there were no significant stacks that required assessment of building downwash.

3.4 Source Parameterization

The CALPUFF modelling system requires sources to be characterized as area, volume, or point. The source type will depend on the configuration of individual sources. A summary of these source types is provided in Table 3.

Table 3: Summary of Types of Sources for CALPUFF Modelling

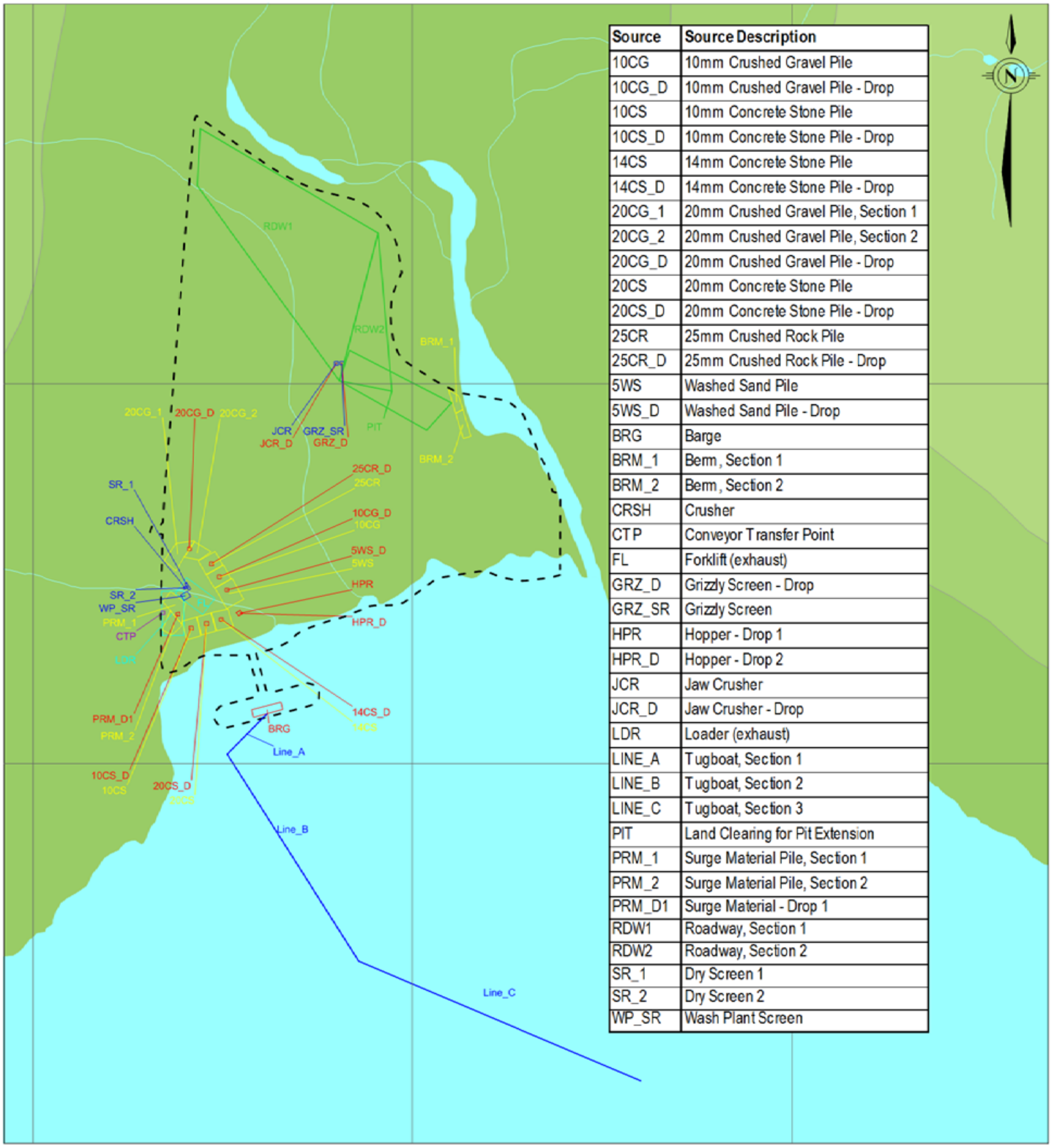
Type	Description	Example
Point	Releases from a specific source such as a stack or isolated vent.	Stacks, individual vents
Line	Building vents, roadways, marine vessel routes	Buoyant releases along a set path such as building vents or shipping routes.
Area	Used to model low-level or ground-level emissions with little or no plume rise. Input as square, rectangle, polygon, or circle	Storage piles, open-pits
Volume	Sources that initially disperse 3-dimensionally with no plume rise.	Windows, doors, conveying system transfer points, crushers/screeners, haul roads

Where appropriate, multiple sources can be combined to a single source. This is based on the following characteristics:

- the source characteristics of the individual stacks or vents must be similar;
- the emission rate from the individual release points must be similar; and
- the sources must be located over an area of volume that can be reasonably well defined.

3.4.1 Area Sources

Area sources are used to model low level or ground releases. In general, area sources result in much higher ground level concentrations than those of volume or point sources. Since there are no generators onsite to remain conservative all onsite emission sources within the Project were treated as area sources these include vehicular haul traffic, stock piles, and land clearing actives. To account for the elevated release heights of the taller area sources (material drops, crushing and screening) the release height and the initial sigma z values were calculated based on guidance from the User's Guide for the AMS/EPA Regulatory Model- AERMOD (US EPA 2004). The source location plan and a description of each area source can be seen from Figure 3 and Table 4.



Source	Source Description
10CG	10mm Crushed Gravel Pile
10CG_D	10mm Crushed Gravel Pile - Drop
10CS	10mm Concrete Stone Pile
10CS_D	10mm Concrete Stone Pile - Drop
14CS	14mm Concrete Stone Pile
14CS_D	14mm Concrete Stone Pile - Drop
20CG_1	20mm Crushed Gravel Pile, Section 1
20CG_2	20mm Crushed Gravel Pile, Section 2
20CG_D	20mm Crushed Gravel Pile - Drop
20CS	20mm Concrete Stone Pile
20CS_D	20mm Concrete Stone Pile - Drop
25CR	25mm Crushed Rock Pile
25CR_D	25mm Crushed Rock Pile - Drop
5WS	Washed Sand Pile
5WS_D	Washed Sand Pile - Drop
BRG	Barge
BRM_1	Berm, Section 1
BRM_2	Berm, Section 2
CRSH	Crusher
CTP	Conveyor Transfer Point
FL	Forklift (exhaust)
GRZ_D	Grizzly Screen - Drop
GRZ_SR	Grizzly Screen
HPR	Hopper - Drop 1
HPR_D	Hopper - Drop 2
JCR	Jaw Crusher
JCR_D	Jaw Crusher - Drop
LDR	Loader (exhaust)
LINE_A	Tugboat, Section 1
LINE_B	Tugboat, Section 2
LINE_C	Tugboat, Section 3
PIT	Land Clearing for Pit Extension
PRM_1	Surge Material Pile, Section 1
PRM_2	Surge Material Pile, Section 2
PRM_D1	Surge Material - Drop 1
RDW1	Roadway, Section 1
RDW2	Roadway, Section 2
SR_1	Dry Screen 1
SR_2	Dry Screen 2
WP_SR	Wash Plant Screen

LEGEND

- *Elevations are shown at 200 m contour intervals*
- *BURNCO fenceline*
- *Tug boat (Line Sources)*
- *Stockpiles (Area Sources)*
- *Material drops (Area Sources)*
- *Screens and crushers (Area Sources)*
- *Land clearing (Area Sources)*
- *Loader and forklift (exhaust) (Area Sources)*
- *Conveyor transfer point (Area Sources)*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT

BURNCO ROCK PRODUCTS LTD.
AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

SOURCE LOCATION PLAN

Golder Associates

PROJECT	11-1422-0046		PHASE No.4700	
DESIGN	TB	20 Mar. 2014	SCALE AS SHOWN	REV. 0
AIR	TB	1 Dec. 2014	FIGURE: 3	
CHECK	JR	3 Dec. 2014		
REVIEW	SC	22 Dec. 2014		

Table 4: List of Area Sources

Area Source ID	Area Source Description	Source Surface Area (m^2)	Effective Height (m)	Area Source Initial Sigma Z (m)
PIT	Pit Expansion - Year 12	25,088	0.0	0.0
BRM_1	Berm – Split 1	1,063	5.0	4.7
BRM_2	Berm – Split 2	1,490	5.0	4.7
JCR	Jaw Crusher	100	3.0	2.8
JCR_D	Jaw Crusher – Material Drop	4	2.0	1.9
GRZ_SR	Grizzly Screen	90	3.0	2.8
GRZ_D	Grizzly Screen – Material Drop	4	2.0	1.9
PRM_D1	6" Pitrun Surge Material - Material Drop	95	8.0	7.4
PRM_1	6" Pitrun Surge Material - Split 1	2,522	7.0	6.5
PRM_2	6” Pitrun Surge Material - Split 2	1,729	7.0	6.5
FL	Forklift	4,820	2.0	1.9
LDR	Loader	6,816	1.2	1.1
SR_1	Dry Screen 1	55	5.0	4.7
CRSH	Crusher	52	3.8	3.5
SR_2	Dry Screen 2	66	5.0	4.7
25CR	25mm Crushed Rock	2,084	9.7	9.0
25CR_D	25mm Crushed Rock - Material Drop	100	10.7	9.9
10CG	10mm Crushed Gravel	2,103	9.7	9.0
10CG_D	10mm Crushed Gravel - Material Drop	100	10.7	9.9
20CG_1	20mm Crushed Gravel - Split 1	2,890	7.0	6.5
20CG_2	20mm Crushed Gravel - Split 2	1,764	7.0	6.5
20CG_D	20mm Crushed Gravel - Material Drop	90	8.0	7.4
WP_SR	Wash Plant Screen	342	5.0	4.7
14CS	14mm Concrete Stone	2,223	9.7	9.0
14CS_D	14mm Concrete Stone - Material Drop	90	10.7	9.9
10CS	10mm Concrete Stone	1,994	9.7	9.0
10CS_D	10mm Concrete Stone - Material Drop	100	10.7	9.9
5WS	Washed Sand	3,218	9.7	9.0
5WS_D	Washed Sand – Material Drop	90	10.7	9.9
20CS	20mm Concrete Stone	1,913	9.7	9.0
20CS_D	20mm Concrete Stone - Material Drop	110	10.7	9.9
HPR	Hopper	126	2.5	2.3
HPR_D	Hopper - Material Drop	126	1.0	0.9
BRG	Barge	1,604	2.9	2.7
RDW1	Roadway to North Berm – Split 1	135,157	2.0	1.9
RDW2	Roadway to North Berm – Split 2	28,218	2.0	1.9
CTP	Conveyor Transfer Point	86	1.0	0.9

Details regarding emission rates and calculation methods are discussed in Appendix 5.7-A.

3.4.2 Line Sources

Line sources were used to model the release of tug boat combustions emissions along the vessel's travel path into and out of the Project, while the vessel was in maneuvering mode. The source location plan and a description of each line source can be seen from Figure 3 and Table 5. Line source inputs into the CALPUFF model can only be input as straight lines. To represent the tug's maneuvering travel path near the Project three line sources were used; therefore, maneuvering emission rates from the tugboat vessel exhaust emission activities were split over the three line sources.

Table 5: List of Line Sources

Line Source ID	Line Source Description	Length (m)	Release Height (m)
LineA	Tugboat, Section 1	148	5
LineB	Tugboat, Section 2	646	5
LineC	Tugboat, Section 3	807	5

3.4.3 Emission Activities and Sources

The emission activities as documented in Appendix 5.7-A are assigned to specific area sources as detailed in Append B. For emission activities that are split between two (or more) area sources, the ratio between the source's surface areas are used to weight the emission activity.

4.0 CLOSING

The CALPUFF air dispersion model was the model of choice for assessing the effects the Facility will have on offside receptors. Modelling options are consistent with guidelines recommended by BC MoE (2008). The selected modelling domain is expected to be sufficiently large to include all potentially sensitive receptors that may be impacted by on-site sources. Emission activities documented in Appendix 5.7-A was assigned to emission sources an inputted into the model.

REFERENCES

BC MoE (British Columbia Ministry of Environment). 2008. Guidelines for Air Quality Dispersion Modelling in British Columbia. Environmental Protection Division Environmental Quality Branch Air Protection Section.

US EPA (United States Environmental Protection Agency). 2004. User's Guide for the AMS/EPA regulatory Model- AERMOD. Document No. EPA-454/B-03-001.

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APPENDIX A

CALPUFF Options and Flags

Table A-1: CALPUFF Model Options

Input Group	Parameter	Default Value	Values Used in the Modelling	Description
Group 1 - General Run Control Parameters	METRUN	-	0	Run period explicitly defined below
	IBYR	-	2012	Starting year for run if METRUN = 0
	IBMO	-	1	Starting month for run if METRUN = 0
	IBDY	-	1	Starting day for run if METRUN = 0
	IBHR	-	0	Starting hour for run if METRUN = 0
	IBMIN	-	0	Starting minute for run if METRUN = 0
	IBSEC	-	0	Starting hour for run if METRUN = 0
	IEYR	-	2012	Ending year for run if METRUN = 0
	IEMO	-	12	Ending month for run if METRUN = 0
	IEDY	-	31	Ending day for run if METRUN = 0
	IEHR	-	23	Ending hour for run if METRUN = 0
	IEMIN	-	0	Ending minute for run if METRUN = 0
	IESEC	-	3600	Ending second for run if METRUN = 0
	XBTZ	-	8	PST = 8, MST = 7, CST = 6, EST = 5
	NSPEC	5	3	TSP, PM10 and PM2.5 (3 species) will be modelled
	NSE	3	3	Number of chemical species to be emitted
	ITEST	2	2	Program is executed after SETUP phase
	MRESTART	0	0	Does not read or write a restart file
	NRESPD	0	0	Destart file written only at last period
	METFM	1	1	CALMET binary file (CALMET.MET)
	MPRFFM	1	1	Meteorological profile data format
	AVET	60.0	60	Averaging time (minutes)
	PGTIME	60.0	60	PG Averaging Time (minutes)
Group 2 - Technical Options	MGAUSS	1	1	Gaussian distribution used in near field
	MCTADJ	3	3	Partial plume path terrain adjustment
	MCTSG	0	0	Subgrid-scale complex terrain not modelled
	MSLUG	0	0	Near-field puffs not modelled as elongated
	MTRANS	1	1	Transitional plume rise modelled
	MTIP	1	1	Stack tip downwash used
	MBDW	1	n/a	Method to simulate building downwash (PRIME method). The prime algorithm was developed to address deficiencies within the ISC building downwash algorithms. Building downwash was not used in the modelling.
	MRISE	1	1	Briggs plume rise used
	MSHEAR	0	0	Vertical wind shear not modelled
	MSPLIT	0	0	Puffs are not split
	MCHEM	1	0	Transformation rates computed internally. Chemistry transformation within CALPUFF was not modelled.
	MAQCHEM	0	n/a	Chemistry transformation not modelled
	MWET	1	0	Wet removal not modelled
	MDRY	1	0	Dry deposition not modelled
	MTILT	0	0	Gravitation settling not modelled
	MDISP	3	2	Dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (u*, w*, L, etc.) this means dispersion coefficients will be unique to the modelling area and meteorological conditions.
	MTURBVW	3	n/a	Only used is MDISP is 1 or 5
	MDISP2	3	3	PG dispersion coefficients for RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas
	MTAULY	0	0	Method used for Lagrangian timescale for Sigma-y, used only if MDISP=1,2 or MDISP2=1,2 (Default of 0 means Draxler default 617.284 s)
	MTAUADV	0	0	Method used for Advective-Decay timescale for Turbulence, used only if MDISP=2 or MDISP2=2 (0 = No turbulence advection)
	MCTURB	1	1	Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables (Used only if MDISP = 2 or MDISP2 = 2)
	MROUGH	0	0	PG sigma-y and sigma-z not adjusted for roughness
	MPARTL	1	1	Partial plume penetration of elevated inversion
	MPARTLBA	1	1	Partial plume penetration of elevated inversion modeled for buoyant area sources (Default 1)
	MTINV	0	0	Strength of temperature inversion not computed from measured/default gradients
	MPDF	0	1	Probability density function (PDF) will be used for dispersion under convective conditions, this means that for consistency the PDF will be used for both convective and non-convective conditions
	MSGTIBL	0	0	Sub-grid TIBL module not used for shoreline
	MBCON	0	0	Boundary conditions not modelled
	MSOURCE	0	0	Individual source contributions not saved
	MFOG	0	0	Do not configure for FOG Model output
	MREG	1	0	Do not test options specified to see if they conform to regulatory values. This switch primarily relates to US regulatory specifics

Input Group	Parameter	Default Value	Values Used in the Modelling	Description
Group 3- Species list	CSPEC	-	$PM_{2.5}$, PM_{10}, TSP	List of chemical species
	MODELED	-	1,1,1	Is pollutant modelled? (0=no, 1=yes)
	EMITTED	-	1,1,1	Is pollutant emitted? (0=no, 1=yes)
	DRY DEPOSITED	-	n/a	Pollutant dry deposition not modelled
	OUTPUT GROUP	-	n/a	Groups not used
Group 4 - Map Projection and Grid Control Parameters	PMAP	UTM	UTM	Map projection
	FEAST	0	n/a	Not used if PMAP = UTM
	FNORTH	0	n/a	Not used if PMAP = UTM
	IUTMZN	-	10	UTM zone
	UTMHEM	N	N	Hemisphere for UTM projection (N = north, S = south)
	RLAT0	-	n/a	Latitude of projection origin (not used if PMAP = UTM)
	RLON0	-	n/a	Longitude of projection origin (not used if PMAP = UTM)
	XLAT1	-	n/a	Not used if PMAP = UTM
	XLAT2	-	n/a	Not used if PMAP = UTM
	DATUM	-	NAR-C	Datum-region for output coordinates
	NX	-	220	Number of X grid cells in meteorological grid
	NY	-	220	Number of Y grid cells in meteorological grid
	NZ	-	10	Number of vertical layers in meteorological grid
	DGRIDKM	-	0.10	Grid spacing in kilometres
	ZFACE	-	0, 20, 50, 100, 200, 400, 800, 1200, 1600, 2200, 3000	Cell face heights in meteorological grid (metres)
	XORIGKM	-	460.771	Reference X coordinate for south-west corner of grid cell (1,1) of meteorological grid (kilometres)
	YORIGKM	-	5479.514	Reference Y coordinate for south-west corner of grid cell (1,1) of meteorological grid (kilometres)
	IBCOMP	-	11	X index of lower left corner of the computational grid
	JBCOMP	-	11	Y index of lower left corner of the computational grid
	IECOMP	-	211	X index of upper right corner of the computational grid
	JECOMP	-	211	Y index of upper right corner of the computational grid
	LSAMP	T	F	Sampling grid is not used rather discrete receptors will be defined.
	IBSAMP	-	n/a	Sampling grid is not used.
	JBSAMP	-	n/a	Sampling grid is not used.
	IESAMP	-	n/a	Sampling grid is not used.
	JESAMP	-	n/a	Sampling grid is not used.
	MESHDN	1	n/a	Sampling grid is not used.
Group 5 – Output Options	ICON	1	1	Output file CONC.DAT containing concentration fields is created
	IDRY	1	0	Dry flux is not modelled in the air quality assessment
	IWET	1	0	Wet flux is not modelled in the air quality assessment
	IT2D	0	0	2D Temperature file
	IRHO	0	0	2D Density file
	IVIS	1	0	Output file containing relative humidity data is not created
	IQAPLOT	1	1	QA plot file output option
	IPFTRAK	0	0	Diagnostic puff-tracking output option
	LCOMPRS	T	F	Do not perform data compression in output files
	IMFLX	0	0	Mass flux across specified boundaries for selected species not reported hourly
	IMBAL	0	0	Mass balance for each species not reported hourly
	INRISE	0	0	Plume properties output option
	ICPRT	0	0	Do not print concentration fields to the line
	IDPRT	0	0	Do not print dry flux fields to the line
	IWPRT	0	0	Do not print wet flux fields to the line
	ICFRQ	1	n/a	Not applicable when ICPRT=0
	IDFRQ	1	n/a	Not applicable when IDPRT=0
	IWFRQ	1	n/a	Not applicable when IWPRT=0
	IPRTU	1	n/a	Units not printed to dos prompt
	IMESG	2	2	Messages tracking the progress of run are written on screen
	CONCENTRATION	-	0,0,0	Concentrations printed to output list file (0 = no, 1 = yes)
	CONCENTRATION	-	1,1,1	Concentrations saved to disk (0=no, 1=yes)
	DRY FLUXES	-	n/a	Dry fluxes printed to output list file (0=no, 1=yes) Dry deposition not modelled
	DRY FLUXES	-	n/a	Dry fluxes saved to disk (0=no, 1=yes) Dry deposition not modelled
	WET FLUXES	-	n/a	Wet fluxes printed to output list file (0=no, 1=yes) Wet deposition not modelled
	WET FLUXES	-	n/a	Wet fluxes saved to disk (0=no, 1=yes) Wet deposition not modelled
	MASS FLUX	-	n/a	Mass fluxes saved on disk (0=no, 1=yes) Deposition not modelled
	LDEBUG	F	F	Logical value for debug output
	IPFDEB	1	1	First puff to track
	NPFDEB	1	1	Number of puffs to track
	NN1	1	1	Meteorological period to start output
	NN2	10	10	Meteorological period to end output

Input Group	Parameter	Default Value	Values Used in the Modelling	Description
Group 6 - Subgrid Scale Complex Terrain Inputs	NHILL	0	0	Number of terrain features
	NCTREC	0	0	Number of special complex terrain receptors
	MHILL	-	n/a	Complex terrain not used
	XHILL2M	1.0	n/a	Complex terrain not used
	ZHILL2M	1.0	n/a	Complex terrain not used
	XCTDMKM	-	n/a	Complex terrain not used
	YCTDMKM	-	n/a	Complex terrain not used
Group 7 - Chemical Parameters for Dry Deposition of Gases	DIFFUSIVITY	-	n/a	Dry deposition not modelled
	ALPHA STAR	-	n/a	Dry deposition not modelled
	REACTIVITY	-	n/a	Dry deposition not modelled
	MESOPHYLL RESISTANCE	-	n/a	Dry deposition not modelled
	HENRY'S LAW	-	n/a	Dry deposition not modelled
Group 8 - Size Parameters for Dry Deposition of Particles	GEOMETRIC MASS MEAN DIAMETER	-	n/a	Dry deposition not modelled
	GEOMETRIC STANDARD DEVIATION	-	n/a	Dry deposition not modelled
Group 9 - Miscellaneous Dry Deposition Parameters	RCUTR	30	n/a	Dry deposition not modelled
	RGR	10	n/a	Dry deposition not modelled
	REACTR	8	n/a	Dry deposition not modelled
	NINT	9	n/a	Dry deposition not modelled
	IVEG	1	n/a	Dry deposition not modelled
Group 10 – Wet Deposition Parameters	LIQUID	-	n/a	Wet deposition not modelled
	FROZEN	-	n/a	Wet deposition not modelled
Group 11 – Chemistry Parameters	MOZ	1	n/a	Chemistry transformation not modelled
	BCKO3	12*80	n/a	Chemistry transformation not modelled
	BCKNH3	12*10	n/a	Chemistry transformation not modelled
	RNITE1	0.2	n/a	Chemistry transformation not modelled
	RNITE2	2.0	n/a	Chemistry transformation not modelled
	RNITE3	2.0	n/a	Chemistry transformation not modelled
	MH2O2	1	n/a	Chemistry transformation not modelled
	BCKH2O2	12*1	n/a	Chemistry transformation not modelled
Group 12 – Miscellaneous Dispersion and Computational Parameters	SYTDEP	550	550	Horizontal size of a puff in metres beyond which the time dependant Heffter dispersion equation is used
	MHFTSZ	0	0	Do not use Heffter formulas for sigma z
	JSUP	5	5	Stability class used to determine dispersion rates for puffs above boundary layer
	CONK1	0.01	0.01	Vertical dispersion constant for stable conditions
	CONK2	0.1	0.1	Vertical dispersion constant for neutral/unstable conditions
	TBD	0.5	0.5	Use ISC transition point for determining the transition point between the Schulman-Scire to Huber-Snyder Building Downwash scheme
	IURB1	10	10	Lower range of land use categories for which urban dispersion is assumed
	IURB2	19	19	Upper range of land use categories for which urban dispersion is assumed
	ILANDUIN	20	20	Land use category for modelling domain
	ZOIN	0.25	0.25	Roughness length in metres for modelling domain
	XLAIN	3.0	3.0	Leaf area index for modelling domain
	ELEVIN	0.0	0	Elevation above sea level in (m)
	XLATIN	-999	-999	Latitude of station in degrees
	XLONIN	-999	-999	Longitude of station in degrees
	ANEMHT	10	10	Anemometer height in (m)
	ISIGMAV	1	1	Sigma-v is read from lateral turbulence data
	IMIXCTDM	0	0	Predicted mixing heights are used
	XMXLEN	1.0	1.0	Maximum length of emitted slug in meteorological grid units
	XSAMLEN	1.0	1.0	Maximum travel distance of slug or puff in meteorological grid units during one sampling unit
	MXNEW	99	99	Maximum number of puffs or slugs released from one source during one time step
	MXSAM	99	99	Maximum number of sampling steps during one time step for a puff or slug
	NCOUNT	2	2	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise
	SYMIN	1	1	Minimum sigma y in metres for a new puff or slug
	SZMIN	1	1	Minimum sigma z in metres for a new puff or slug
	SVMIN	0.5	0.5	Minimum turbulence (σv) for A stability over land (m/s)
		0.5	0.5	Minimum turbulence (σv) for B stability over land (m/s)
		0.5	0.5	Minimum turbulence (σv) for C stability over land (m/s)
		0.5	0.5	Minimum turbulence (σv) for D stability over land (m/s)

Input Group	Parameter	Default Value	Values Used in the Modelling	Description
Group 12 – Miscellaneous Dispersion and Computational Parameters		0.5	0.5	Minimum turbulence (σv) for E stability over land (m/s)
		0.5	0.5	Minimum turbulence (σv) for F stability over land (m/s)
		0.37	0.37	Minimum turbulence (σv) for A stability over water (m/s)
		0.37	0.37	Minimum turbulence (σv) for B stability over water (m/s)
		0.37	0.37	Minimum turbulence (σv) for C stability over water (m/s)
		0.37	0.37	Minimum turbulence (σv) for D stability over water (m/s)
		0.37	0.37	Minimum turbulence (σv) for E stability over water (m/s)
		0.37	0.37	Minimum turbulence (σv) for F stability over water (m/s)
	SWMIN	0.2	0.2	Minimum turbulence (σw) for A stability over land (m/s)
		0.12	0.12	Minimum turbulence (σw) for B stability over land (m/s)
		0.08	0.08	Minimum turbulence (σw) for C stability over land (m/s)
		0.06	0.06	Minimum turbulence (σw) for D stability over land (m/s)
		0.03	0 03	Minimum turbulence (σw) for E stability over land (m/s)
		0.016	0.016	Minimum turbulence (σw) for F stability over land (m/s)
		0.2	0.2	Minimum turbulence (σw) for A stability over water (m/s)
		0.12	0.12	Minimum turbulence (σw) for B stability over water (m/s)
		0.08	0.08	Minimum turbulence (σw) for C stability over water (m/s)
		0.06	0.06	Minimum turbulence (σw) for D stability over water (m/s)
		0.03	0 03	Minimum turbulence (σw) for E stability over water (m/s)
		0.016	0.016	Minimum turbulence (σw) for F stability over water (m/s)
	CDIV	0.0,0.0	0.0, 0.0	Divergence criteria for dw/dz in met cells
	NLUTIBL	4	4	Search radius in number of cells for nearest land and water cells used in the subgrid TIBL module
	WSCALM WSCAT	0.5	0.5	Minimum wind speed allowed for non-calm conditions (m/s)
	XMAXZI	3000	3,000	Maximum mixing height (m)
	XMINZI	50	50	Minimum mixing height (m)
	WSCAT	1.54	1.54	Wind speed category 1 (m/s)
		3.09	3.09	Wind speed category 2 (m/s)
		5.14	5.14	Wind speed category 3 (m/s)
		8.23	8.23	Wind speed category 4 (m/s)
		10.8	10.8	Wind speed category 5 (m/s)
	PLX0	0.07	0.07	Wind speed profile exponent for A stability
		0.07	0.07	Wind speed profile exponent for B stability
		0.10	0.1	Wind speed profile exponent for C stability
		0.15	0.15	Wind speed profile exponent for D stability
		0.35	0.35	Wind speed profile exponent for E stability
		0.55	0.55	Wind speed profile exponent for F stability
	PTG0	0.02	0.02	Potential temperature gradient for E stability (K/m)
		0.035	0.035	Potential temperature gradient for F stability (K/m)
	PPC	0.5	0.5	Plume path coefficient for A stability
		0.5	0.5	Plume path coefficient for B stability
		0.5	0.5	Plume path coefficient for C stability
		0.5	0.5	Plume path coefficient for D stability
		0.35	0.35	Plume path coefficient for E stability
		0.35	0.35	Plume path coefficient for F stability
	SL2PF	10	10	Slug-to-puff transition criterion factor equal to sigma y/length of slug
	NSPLIT	3	2	Number of puffs that result every time a puff is split (not used since NSPLIT=0)
	IRESPLIT	Hour 17 = 1	0,0,0,0,0,0,0,0,0, 0,0,0,0,0,0,0,0,1, 0,0,0,0,0,0	Time(s) of day when split puffs are eligible to be split once again
	ZISPLIT	100	100	Minimum allowable last hour's mixing height for puff splitting (m)
	ROLDMAX	0.25	0.25	Maximum allowable ratio of last hour's mixing height and maximum mixing height experienced by the puff for puff splitting
	NSPLITH	5	5	Number of puffs that result every time a puff is split
	SYSPLITH	1	1	Minimum sigma-y (grid cells units) of puff before it may be split
	SHSPLITH	2	2	Minimum puff elongation rate (SYSPLITH/h) due to wind shear before it may be split
	CNSPLITH	1.0E-07	1.0E–07	Minimum concentration (g/m3) of each species in puff before it may be split
	EPSSLUG	1.0E-04	1.00E–04	Fractional convergence criterion for numerical SLUG sampling integration
	EPSAREA	1.0E-06	1.00E–06	Fractional convergence criterion for numerical AREA source integration
	DSRISE	1.0	1	Trajectory step-length (m) used for numerical rise integration
	HTMINBC	500	500.0	Minimum height (m) to which BC puffs are mixed as they are emitted.
	RSAMPBC	10.0	10.0	Search radius (km) about a receptor for sampling nearest BC puff.
	MDEPBC	1	1	Near-surface depletion adjustment to concentration profile used when sampling BC puffs.

APPENDIX B

Emission Sources and Assigned Emission Activity

Table B-1: Emission Source with Assigned Emission Activities

Source ID	Source Description	Major Activity	Detailed Activity
PIT	Pit Expansion - Year 12	I.1 Land Clearing	A1 - Fugitive PM Emissions - Bulldozing
		I.1 Land Clearing	A2 - Fugitive PM Emissions - Excavating
		I.1 Land Clearing	A3 - Fugitive PM Emissions - Material Drop into Rock Trucks - Material Drops
		I.1 Land Clearing	A5 - Fugitive PM Emissions - Rock Trucks - Fugitive Road Dust
		I.1 Land Clearing	B1 - Exhaust Emissions - Excavator
		I.1 Land Clearing	B2 - Exhaust Emissions - Rock Trucks (3)
		I.1 Land Clearing	B3 - Exhaust Emissions - Bulldozer
BRM_1	Berm - Split 1	I.1 Land Clearing	A4 - Fugitive PM Emissions - Material from Rock Trucks to Berm - Material Drops
		II.1 Surge Material	A - Fugitive PM Emissions - Stockpile Wind Erosion
BRM_2	Berm - Split 2	I.1 Land Clearing	A4 - Fugitive PM Emissions - Material from Rock Trucks to Berm - Material Drops
		II.1 Surge Material	A - Fugitive PM Emissions - Stockpile Wind Erosion
JCR	Jaw Crusher	I.5 Jaw Crushing	A1 - Fugitive PM Emissions - Crushing
JCR_D	Jaw Crusher - Material Drop	I.5 Jaw Crushing	A2 - Fugitive PM Emissions - Jaw Crusher to Surge Material conveyor - Material Drops
GRZ_SR	Grizzly Screen	I.4 Grizzly Screen (6" material)	A1 - Fugitive PM Emissions - Screening
		I.4 Grizzly Screen (6" material)	A2 - Fugitive PM Emissions - Dewatering Screen
GRZ_D	Grizzly Screen - Material Drop	I.4 Grizzly Screen (6" material)	A3 - Fugitive PM Emissions - Grizzly Screen to Surge Material conveyor - Material Drops
PRM_D1	6" Pitrun Surge Material - Material Drop	I.6 Surge Material	A2 - Fugitive PM Emissions - Conveyor to Surge Material - Material Drops
PRM_1	6" Pitrun Surge Material - Split 1	II.1 Surge Material	A1 - Fugitive PM Emissions - Stockpile Wind Erosion
PRM_2	6" Pitrun Surge Material - Split 2	II.1 Surge Material	A1 - Fugitive PM Emissions - Stockpile Wind Erosion
FL	Forklift	II.8 Processing Plant Area	B - Exhaust Emissions - Forklift
LDR	Loader	II.1 Surge Material	B - Exhaust Emissions - Loader
SR_1	Dry Screen 1	II.2 Dry Screen 1	A1 - Fugitive PM Emissions - Screening
		II.2 Dry Screen 1	A2 - Fugitive PM Emissions - Dry Screen 1 to Crusher conveyor - Material Drops
		II.2 Dry Screen 1	A3 - Fugitive PM Emissions - Dry Screen 1 to 20 mm Crushed Gravel Stockpile conveyor - Material Drops
CRSH	Crusher	II.3 Crushing	A - Fugitive PM Emissions - Crushing
		IV.1 Welding	C - Combustion
SR_2	Dry Screen 2	II.4 Dry Screen 2	A1 - Fugitive PM Emissions - Screening
		II.4 Dry Screen 2	A2 - Fugitive PM Emissions - Dry Screen 2 to Crusher conveyor - Material Drops
		II.5 25mm Crushed Rock	A1 - Fugitive PM Emissions - Dry Screen 2 to 25 mm Crushed Rock Stockpile conveyor - Material Drops
		II.6 10mm Crushed Gravel	A1 - Fugitive PM Emissions - Dry Screen 2 to 10 mm Crushed Gravel Stockpile Conveyor - Material Drops
		II.7 20mm Crushed Gravel	A1 - Fugitive PM Emissions - Dry Screen 2 to 20 mm Crushed Gravel Stockpile Conveyor - Material Drops
25CR	25mm Crushed Rock	II.5 25mm Crushed Rock	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
25CR_D	25mm Crushed Rock - Material Drop	II.5 25mm Crushed Rock	A2 - Fugitive PM Emissions - Conveyor to 25 mm Crushed Rock Stockpile - Material Drops
10CG	10mm Crushed Gravel	II.6 10mm Crushed Gravel	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
10CG_D	10mm Crushed Gravel - Material Drop	II.6 10mm Crushed Gravel	A2 - Fugitive PM Emissions - Conveyor to 10 mm Crushed Gravel Stockpile - Material Drops
20CG_1	20mm Crushed Gravel - Split 1	II.7 20mm Crushed Gravel	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
20CG_2	20mm Crushed Gravel - Split 2	II.7 20mm Crushed Gravel	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
20CG_D	20mm Crushed Gravel - Material Drop	II.7 20mm Crushed Gravel	A2 - Fugitive PM Emissions - Conveyor to 20 mm Crushed Gravel Stockpile - Material Drops
		II.7 20mm Crushed Gravel	A4 - Fugitive PM Emissions - Screen 1 conveyor to 20 mm Crushed Gravel Stockpile - Material Drops
WP_SR	Wash Plant Screen	II.8 Wash Plant Screen	A - Fugitive PM Emissions - Screening
		II.9 14mm Concrete Stone	A1 - Fugitive PM Emissions - WP to 14 mm Concrete Stone Stockpile conveyor - Material Drops
		II.10 10 mm Concrete Stone	A1 - Fugitive PM Emissions - WP to 10 mm Concrete Stone Stockpile conveyor - Material Drops
		II.11 Washed Sand (5mm)	A1 - Fugitive PM Emissions - WP to 5 mm Washed Sand Stockpile conveyor - Material Drops
		II.12 20mm Concrete Stone	A1 - Fugitive PM Emissions - WP to 20 mm Concrete Stone Stockpile conveyor - Material Drops
14CS	14mm Concrete Stone	II.9 14mm Concrete Stone	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
14CS_D	14mm Concrete Stone - Material Drop	II.9 14mm Concrete Stone	A2 - Fugitive PM Emissions - Conveyor to 14 mm Concrete Stone Stockpile - Material Drops

Source ID	Source Description	Major Activity	Detailed Activity
10CS	10mm Concrete Stone	II.10 10mm Concrete Stone	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
10CS_D	10mm Concrete Stone - Material Drop	II.10 10 mm Concrete Stone	A2 - Fugitive PM Emissions - Conveyor to 10 mm Concrete Stone Stockpile - Material Drops
5WS	Washed Sand	II.11 Washed Sand (5mm)	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
5WS_D	Washed Sand - Material Drop	II.11 Washed Sand (5mm)	A2 - Fugitive PM Emissions - Conveyor to 5 mm Washed Sand Stockpile - Material Drops
20CS	20mm Concrete Stone	II.12 20mm Concrete Stone	A3 - Fugitive PM Emissions - Stockpile Wind Erosion
20CS_D	20mm Concrete Stone - Material Drop	II.12 20mm Concrete Stone	A2 - Fugitive PM Emissions - Conveyor to 20 mm Concrete Stone Stockpile Material Drops
HPR	Hopper	III.1 Hopper	A1 - Fugitive PM Emissions: Drop of 25 mm Crushed Rock to Hopper - Material Drops
		III.1 Hopper	A2 - Fugitive PM Emissions: Drop of 10 mm Crushed Gravel to Hopper - Material Drops
		III.1 Hopper	A3 - Fugitive PM Emissions: Drop of 20 mm Crushed Gravel to Hopper - Material Drops
		III.1 Hopper	A4 - Fugitive PM Emissions: Drop of 14 mm Concrete Stone to Hopper - Material Drops
		III.1 Hopper	A5 - Fugitive PM Emissions: Drop of 10 mm Concrete Stone to Hopper - Material Drops
		III.1 Hopper	A6 - Fugitive PM Emissions: Drop of 5 mm Washed Sand to Hopper - Material Drops
		III.1 Hopper	A7 - Fugitive PM Emissions: Drop of 20 mm Concrete Stone to Hopper - Material Drops
HPR_D	Hopper - Material Drop	III.2 Barge	A1 - Fugitive PM Emissions: Hopper to Barge conveyor - Material Drops
BRG	Barge	III.2 Barge	A2 - Fugitive PM Emissions: Conveyor to Barge - 25 mm Crushed Rock - Material Drops
		III.2 Barge	A3 - Fugitive PM Emissions: Conveyor to Barge - 10 mm Crushed Gravel - Material Drops
		III.2 Barge	A4 - Fugitive PM Emissions: Conveyor to Barge - 20 mm Crushed Gravel - Material Drops
		III.2 Barge	A5 - Fugitive PM Emissions: Conveyor to Barge - 14 mm Concrete Stone - Material Drops
		III.2 Barge	A6 - Fugitive PM Emissions: Conveyor to Barge - 10 mm Concrete Stone - Material Drops
		III.2 Barge	A7 - Fugitive PM Emissions: Conveyor to Barge - 5 mm Washed Sand - Material Drops
		III.2 Barge	A8 - Fugitive PM Emissions: Conveyor to Barge - 20 mm Concrete Stone - Material Drops
LineA	Tugboat, Section 1	III.3 Tugboat	B – Exhaust Emissions – Seaspan Commander (Underway Mode)
LineB	Tugboat, Section 2	III.3 Tugboat	B – Exhaust Emissions – Seaspan Commander (Underway Mode)
LineC	Tugboat, Section 3	III.3 Tugboat	B – Exhaust Emissions – Seaspan Commander (Underway Mode)
RDW1	Roadway to North Berm - Split 1	I.1 Land Clearing	A5 - Fugitive PM Emissions - Rock Trucks - Fugitive Road Dust
		I.1 Land Clearing	B2 - Exhaust Emissions - Rock Trucks (3)
RDW2	Roadway to North Berm - Split 2	I.1 Land Clearing	A5 - Fugitive PM Emissions - Rock Trucks - Fugitive Road Dust
		I.1 Land Clearing	B2 - Exhaust Emissions - Rock Trucks (3)
CTP	Conveyor Transfer Point	I.6 Surge Material	A1 - Fugitive PM Emissions - Conveyor transfer point - Mine area to Surge Material - Conveyor Transfer Point

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