APPENDIX B

Air Quality Analysis Data

(Note: Color versions of figures in this Appendix are included in the file posted at the DOE NEPA website: http://www.eh.doe.gov/nepa/docs/deis/deis.html)

INTENTIONALLY LEFT BLANK

B.1 AIR QUALITY IMPACT ASSESSMENT

B.1.1 Predictive Modeling Approach

The AERMOD air quality model was used with the PRIME building downwash algorithm (Version 04300) for the Mesaba IGCC Power Plant modeling (Excelsior, 2006). The PRIME downwash algorithm in the AERMOD model accounts for building wake effects on dispersion. Direction-specific building dimensions and related parameters are generated with EPA's BPIP PRIME program. The Minnesota Pollution Control Agency (MPCA) prefers the AERMOD modeling system and EPA has included AERMOD as an approved guideline model. No wet or dry depletion/deposition was included in the modeling. The model was set to RURAL dispersion because the terrain/land use within 3 kilometers of the site is almost completely rural. The AERMOD was used with all regulatory options, and included:

- stack-tip downwash
- elevated terrain effects
- calms processing
- missing data processing
- "upper bound" values for supersquat buildings
- no exponential decay

The MPCA has processed meteorological data suitable for input to AERMOD for many locations in Minnesota. At Excelsior's request, Mr. Dennis Becker provided on July 5, 2005, an AERMET data file that was processed specifically for the area including the IGCC Power Plant Footprint, were used for the Mesaba IGCC Power Plant modeling with AERMOD. The meteorological data are based upon Hibbing, Minnesota hourly surface weather observations for the years 1972 through 1976.

The initial air quality modeling addressed the individual point sources of the Mesaba Energy Project, Phase I and Phase II, including four combustion turbine generator (CTG) stacks, two tank vent boiler (TVB) stacks, two auxiliary boilers, and two flare stacks, as well as all fugitive PM_{10} sources (Excelsior, 2006). The modeling was conducted to determine which pollutants will have significant ambient air impacts, and to identify the significant impact area (SIA) for each pollutant. Modeling was conducted for the criteria air pollutants, SO_2, carbon monoxide (CO), NO_X, and particulate matter less than 10 microns (PM_{10}), their respective applicable averaging time, and each operating scenario (i.e., normal operations, flaring, and startup). Ozone (O_3) emissions could not be modeled or analyzed because O_3 is not emitted directly from a combustion source. The O_3 precursor, volatile organic compounds (VOCs) were below the prevention of significant deterioration (PSD) significant threshold (see Table B.1-1). Emissions of lead (Pb) were not modeled because the potential Pb emissions from the proposed project will be less than the PSD significant threshold.

Table B.1-1. Annual Criteria Air Pollutant Emission (Phase I and Phase II)

Pollutant	PSD Significance Threshold (TPY)	Plantwide Potential to Emit (TPY)
CO	100	2,539
NO_X	40	2,872
SO_2	40	1390
PM	25	503

Table B.1-1. Annual Criteria Air Pollutant Emission (Phase I and Phase II)

Pollutant	PSD Significance Threshold (TPY)	Plantwide Potential to Emit (TPY)
PM_{10}	15	493(1)/709(2)
O_3 as VOC	40	197
Pb	0.6	0.03

(1) West Range Site
(2) East Range Site: Higher emissions because water quality at the East Range Site results in higher PM_{10} emissions from the cooling tower.
Source: Excelsior, 2006a

The SIA was determined for those pollutants, which are shown to have a significant impact in ambient air at any point. The SIA was defined for each pollutant as a circle, centered on the plant site, with a radius equal to the greatest distance to a significant impact for any applicable averaging time or emission scenario. No further modeling was conducted if any pollutant did not have a significant impact. However, for pollutants with significant impact, additional modeling was carried out to evaluate compliance with PSD increments and national ambient air quality standards (NAAQS). Applicable significant impact levels (SIL), PSD increments, and NAAQS are provided in Table B.1-2.

Table B.1-2. Applicable Air Quality Standards, Increments and SILs for Phase I and Phase II

Pollutant	Averaging Time	NAAQS (µg/m^3)	PSD Class II Increment (µg/m^3)	Significant Impact Level (µg/m^3)
SO_2	1-Hour	1,300	512	25
	3-Hour	915	512	25
	24-Hour	365	91	5
	Annual	60	20	1
NO_2	Annual	100	25	1
PM_{10}	24-Hour	150	30	5
	Annual	50	17	1
CO	1-Hour	40,000	NA	2,000
	8-Hour	10,000	NA	500

Source: Excelsior, 2006a

Source input for increment modeling included all point sources associated with Phase I and Phase II and all regional increment-consuming sources included in the emissions inventory provided by the MPCA. In addition to those sources included in the increment analysis, additional nearby sources (provided by MPCA) were added to the source inventory. Regional source impacts were included (for worst-case modeled impact times and receptors), by modeling the First-Approximation Run Data (FARDATA) emission inventory appropriate to the West Range Site and East Range Site, as provided by MPCA modeling staff. For comparison to the NAAQS, a background concentration representing natural or pristine background plus one SIL was added to all model-predicted concentrations.

In addition to the modeling analyses described above, model results were applied to address other PSD requirements: the potential need for pre-construction monitoring and additional impact analyses relating to growth, soils and vegetation, visibility impairment, and deposition.

B.1.1.1 Modeled Emissions Rates

The maximum expected point source criteria pollutant emission rates from each phase of the Mesaba Energy Project for different averaging times and operating scenarios, as presented in Tables B.1-3, B.1-4, and B.1-5, were used as model input for the air modeling analyses. The stack parameters in Table B.1-6 were also used as input data. The data presented in Table B.1-3 represent emissions during normal operation of Phases I and II, which were modeled as the "base case" to define the expected air quality impacts of the Mesaba IGCC Power Plant. To address emission rates and stack gas conditions for short-term averaging times, air modeling was also carried out for applicable averaging times (24 hours and less) using the emission rates given in Tables B.1-4 and B.1-5. The emission rates represent worst-case maximum emissions for each scenario.

Other sources at the Mesaba IGCC Power Plant will consist of two emergency fire pumps and two emergency diesel generators per phase. Because these sources will operate for only short time periods, when the primary emission sources will not be in operation, they were not included in the air modeling analyses. Hours of operation for these other sources will likely be limited by permit conditions. The emissions from periodic testing of these emergency resources are negligible in comparison to the sources shown in Tables B.1-3 through B.1-6. Fugitive emissions of PM_{10} will result from the storage and handling of coal and other materials have been modeled under normal operations and are provided in Table B.1-3.

Table B.1-3. Modeling Emission Rates for Normal Operation (1) – Each Phase

Source	Averaging Time	SO_2		CO		PM_{10} (2)		NO_x	
		lb/hr	g/s	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
Combustion Turbines Generator (3)	1-Hour	183	23.06	95	11.97				
	3-Hour	152	19.15						
	8-Hour			95	11.97				
	24-Hour	114	14.36			25	3.15		
	Annual	76	9.58			25	3.15	158	19.91
Tank Vent Boiler	1-Hour	8.4	1.06	5.9	0.74				
	3-Hour	7.5	0.94						
	8-Hour			5.9	0.74				
	24-Hour	6.4	0.81			0.7	0.09		
	Annual	3.6	0.45			0.2	0.03	6	0.76
Auxiliary Boiler	1-Hour	0.37	0.05	9.6	1.21				
	3-Hour	0.37	0.05						
	8-Hour			9.6	1.21				
	24-Hour	0.37	0.05			0.65	0.08		
	Annual	0.09	0.01			0.16	0.02	1.16	0.15

Table B.1-3. Modeling Emission Rates for Normal Operation (1) – Each Phase

Source	Averaging Time	SO_2		CO		PM_{10} (2)		NO_x	
		lb/hr	g/s	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
Flare	1-Hour	0.01	0.001	1.1	0.14				
	3-Hour	0.01	0.001						
	8-Hour			1.1	0.14				
	24-Hour	0.01	0.001			0.02	0.002		
	Annual	2.8	0.35			0.38	0.05	3.1	0.39

(1)Short-term emissions represent normal plant operation on syngas fuel; annual emissions are worst-case annual operation including flaring, gasifier outages, etc.
(2)PM_{10} emissions include filterable and condensable portions.
(3)There will be two CTGs per phase. Modeling emission rates should be doubled.
Source: Excelsior, 2006a

Table B.1-4. Modeling Emission Rates for Worst-Case Flaring Scenario – Each Phase

Source	Averaging Time	SO_2		CO		PM_{10} (1)		NO_x	
		lb/hr	g/s	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
Flare	1-Hour	1,040	131.04	5,680	715.67				
	3-Hour	734	92.48						
	8-Hour			5,345	637.46				
	24-Hour	183	23.06			14.1	1.78		

(1)PM_{10} emissions include filterable and condensable portions
Source: Excelsior, 2006a

Table B.1-5. Modeling Emission Rates for Worst-Case Start-up Operating Scenario – Each Phase

Source	Averaging Time	SO_2		CO		PM_{10} (1)		NO_x	
		lb/hr	g/s	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
Combustion Turbines Generators (2)	1-Hour	183	23.06	2,740	345.23				
	3-Hour	152	19.15						
	8-Hour			541	68.21				
	24-Hour	114	14.36			25	3.15		
Tank Vent Boiler	1-Hour	8.4	1.06	5.9	0.74				
	3-Hour	7.5	0.94						
	8-Hour			5.9	0.74				
	24-Hour	6.4	0.81			0.7	0.09		
Auxiliary Boiler	24-Hour	0.37	0.05	9.6	1.21	0.65	0.08		
Flare	1-Hour	0.11	0.01	22	2.77				
	3-Hour	0.11	0.01						

Table B.1-5. Modeling Emission Rates for Worst-Case Start-up Operating Scenario – Each Phase

Source	Averaging Time	SO_2		CO		PM_{10} (1)		NO_x	
		lb/hr	g/s	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
	8-Hour			22	2.77				
	24-Hour	0.11	0.01			0.32	0.04		

(1) PM_{10} emissions include filterable and condensable portions
(2)There will be two CTGs per phase. Modeling emission rates should be doubled.
All flare emissions and Combustion Turbine CO emissions represent start-up operation. These rates exceed Normal Operation values. All other emission rates are worst-case Normal Operation values, which are higher than during startup.
Source: Excelsior, 2006a

Table B.1-6. Modeling Stack Parameters

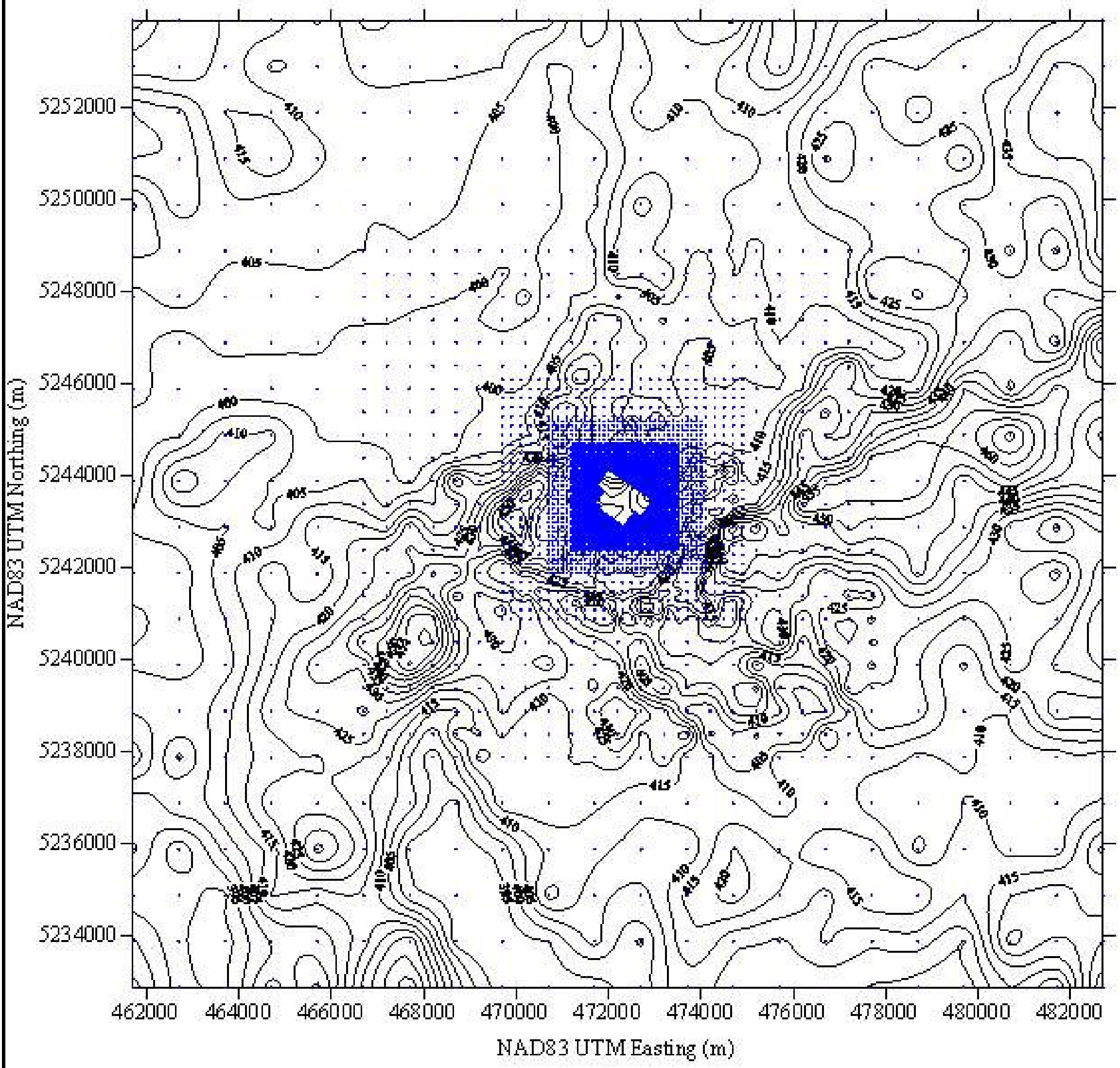
Source/Scenario	Averaging Time	Stack Height (m)	Stack Diameter (m)	Gas Temperature (K)	Velocity (m/s)
Combustion Turbines Generator	Normal Operation	45.72	6.1	394.3	20.08
	Startup	45.72	6.1	366.5	11.64
Tank Vent Boiler	Short-term	64.01	1.83	579.8	8.46
	Annual	64.01	1.83	579.8	1.95
	Start-up	64.01	1.83	579.8	5.21
Auxiliary Boiler		12.19	1.52	422.1	9.7
Flare (1)	Normal Operation	56.39	0.25	1,273	20
	Start-up	56.39	1.11	1,273	20
	Flaring: 1-hr	56.39	10.72	1,273	20
	Flaring: 3-hrs	56.39	10.4	1,273	20
	Flaring: 8-hrs	56.39	10.4	1,273	20
	Flaring: 24-hrs	56.39	7.36	1,273	20
	Flaring: Annual	56.39	0.25	1,273	20

(1)Flare parameters determined by SCREEN 3 methodology based on total heat release.
(2)There will be two CTGs per phase. Modeling emission rates should be doubled.
Source: Excelsior, 2006a

As part of the NAAQS analysis, a Good Engineering Practice (GEP) Height analysis was conducted. The evaluation demonstrated that all the stacks are less than GEP; therefore they were modeled at their actual heights.

B.1.1.2 Receptor Grid

The receptor grid that was modeled for the Mesaba IGCC Power Plant (see Figure B.1-1) consists of seven nested Cartesian grids covering a total 441-square-kilometer (170-square-mile) area surrounding the plant site. Receptors are located along the Project fence line with a spacing of 10 meters. The inner Cartesian grid, with a spacing of 25 meters, covers an approximate 2.5-square-kilometer area surrounding the plant site.



Modeling Receptor Grid and
Terrain Elevations (m)

MCVEHIL-MONNETT ASSOCIATES, INC.

Note: Terrain elevations were determined from USGS 7.5 minute DEM data and were processed with AERMAP.

Source: Excelsior, 2006

Figure B.1-1. Modeling Receptor Grid and Terrain Elevations (m)

Successive grids have gradually increasing spacing at greater distances from the fence line, as are provided in Table B.1-7.

Table B.1-7. Mesaba IGCC Power Plant Receptor Grids

Grid Level	Level Description	Spacing
1st	IGCC Power Plant fence line	10-meter
2nd	2.4 km area around site	25-meter
3rd	0.25-km wide border	50-meter
4th	0.5-km wide border	100-meter
5th	1.0-km border	200-meter
6th	3.0-km border	500-meter
7th	5.0-km wide border	1,000-meter

Source: Excelsior, 2006

B.1.1.3 Regional Source Input and Background Concentrations

To account for impacts of distant and regional sources, the FARDATA approach developed by MPCA was applied. With this approach, a distant/regional modeling inventory FARDATA was included in AERMOD EVENT model runs for highest impact cases. The FARDATA provided an approximation of the date-/time-specific impacts of all regional sources, which were added to the impacts from the Mesaba Energy Project and nearby sources. Regional source inventories applicable to modeling for the Mesaba IGCC Power Plant prospective project sites were included in all PSD increment and NAAQS modeling analyses. Data on increment-consuming (or expanding) sources were provided (by Chris Nelson of MPCA on 8/17/05) from the following “nearby”/regional major sources (Excelsior, 2006a):

- Blandin Paper Company/Rapids Energy Center
- Potlatch – Grand Rapids
- Minnesota Power – Clay Boswell
- Keewatin Taconite

Of note, the major emission reduction plans recently announced by Minnesota Power for its Syl Laskin, Clay Boswell, and Taconite Harbor power generation facilities were not included in the modeling analysis; thereby introducing a further degree of conservatism into the resulting emission profiles.

Increment consuming emissions were included in the input file as positive numbers and increment-expanding emissions (decreases since the baseline date) were included as negative numbers. Total modeled emissions of regional increment sources are listed in Table B.1-8.

Table B.1-8. Regional Sources Modeled Emissions for Mesaba Energy Project PSD Increment Modeling

Source	SO_2		PM_{10}		NO_x	
	lb/hr	g/s	lb/hr	g/s	lb/hr	g/s
Blandin Paper Company	-178.68	-22.513	-0.13	-0.016	-116.91	-14.73
	595.66	75.052	53.84	6.784	117.72	14.832
Minnesota Power – Clay Boswell	6,130.89	772.48	510.9	64.373		
Potlatch – Grand Rapids			63.4	7.988	95.67	12.054

Source: Excelsior, 2006a

For comparison to PSD increments, one SIL is added to final model-predicted concentrations, in accordance with MPCA guidance. For the NAAQS analyses, one SIL plus a "natural background" concentration was added to total model-predicted concentrations (Excelsior, 2006a). The natural background concentrations in Table B.1-9 were utilized.

Table B.1-9. Natural Background Concentration Modeled

Pollutant	Average Time	Concentration ($\mu g/m^3$)
SO_2	Short-term	10
	Annual	2
NO_2	Annual	5
PM_{10}	24-Hour	20
	Annual	10

Source: Excelsior 2006

B.1.2 Class I Area-Related Modeling Approach

An air quality modeling analysis was conducted to estimate impacts of the Phase I and Phase II Mesaba IGCC Power Plant on air quality in Class I areas. The Class I air quality related value (AQRV) analyses addressed PSD Class I increments for SO_2, PM_{10}, and NO_X, sulfur (S) and nitrogen (N) deposition, and visibility impairment (regional haze). The dispersion modeling analysis used standard EPA long-range transport modeling methodologies, and followed guidance as presented in EPA's Guideline on Air Quality Models, the IWAQM Phase 2 report, and the FLAG Phase I report (Excelsior, 2006b). The analyses also incorporated suggestions and guidance received in pre-application meetings with the U.S. Forest Service and the National Park Service (Excelsior, 2006b). The Class I analyses addressed impacts to the Boundary Waters Canoe Area Wilderness (BWCAW), Voyageurs National Park (VNP), and the Rainbow Lakes Wilderness (RLW). The distance from the Project to the closest point in each of these Class I areas is approximately 61 miles (98 kilometers) for the BWCAW, 75 miles (121 kilometers) for VNP, and 117 miles (188 kilometers) for RLW. The next closest Class I area, Isle Royale National Park, is more than 300 kilometers from the station, beyond the distance where long-range transport modeling has been shown to provide realistic impact predictions.

The CALPUFF air quality model was used for all Class I area analyses. CALPUFF is the approved EPA long-range transport model referenced in the Guideline on Air Quality Models and consists of the following three components:

- The CALMET model for processing of meteorological data;
- The CALPUFF model for the transport and dispersion calculations; and
- The CALPOST model for analysis and post-processing of model results.

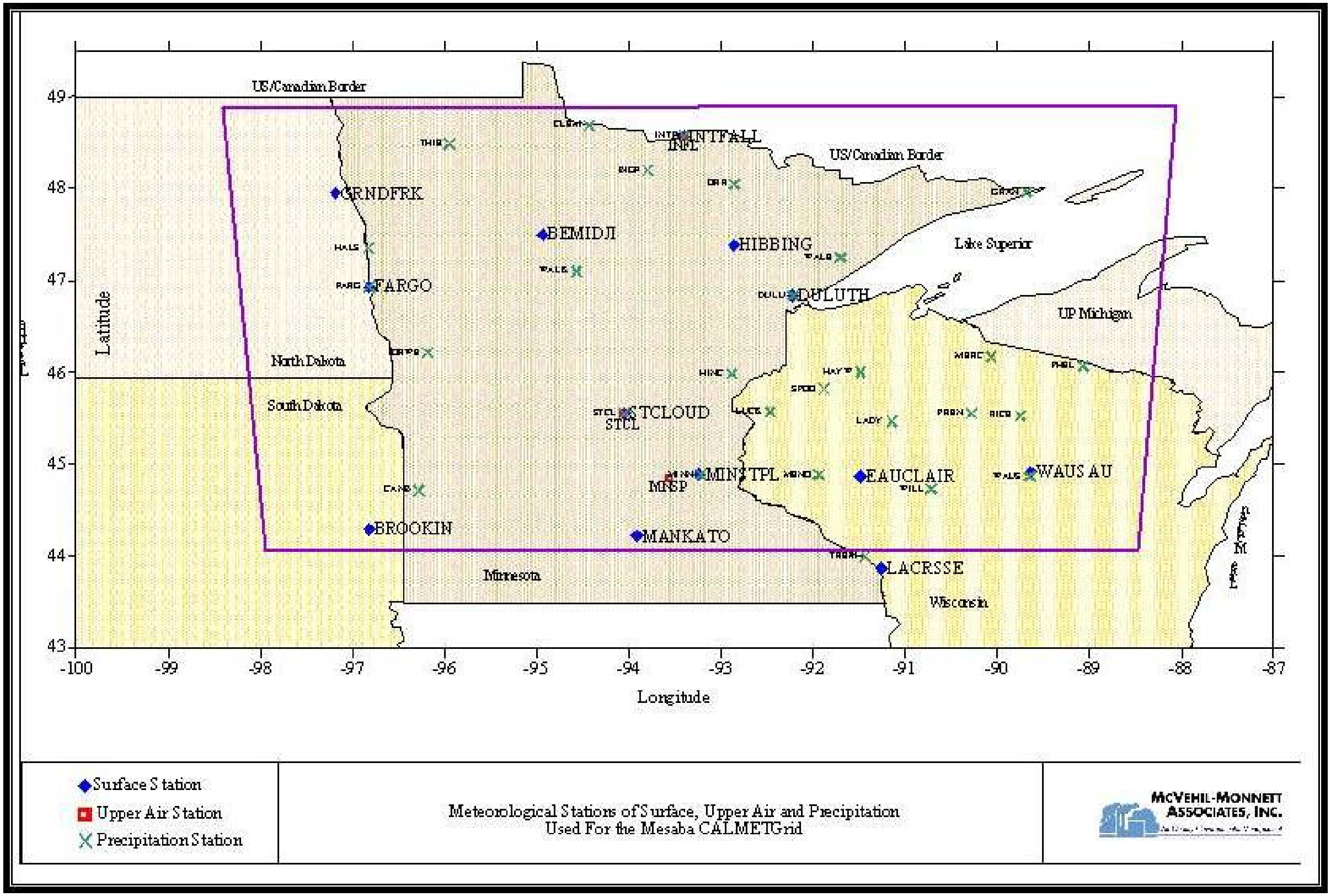
Input options and data utilized in the models generally corresponded to default or recommended values; however for the Mesaba Energy Project, a list of representative, project specific input parameters, were used (see Table B.1-10).

Table B.1-10. CALMET/CALPUFF Non-Default Input Parameters

Input Group	Parameter	Mesaba Selection	Explanation
CALMET			
5	IKINE	1	Kinemateic effects option used to better account for terrain effects
	RMAX 1	30 km	No default values
	RMAX 2	40 km	No default values
	RMAX 3	40 km	No default values
	TERRAD	15 km	No default values
	R1	5	No default values
	R2	15	No default values
CALPUFF			
3	Species Modeled	SO_2, SO_4, NO_X, EC, SOA, $PM_{2.5}$, HNO_3, NO_3	Modeled all species emitted by Mesaba sources, and others (HNO_3, NO_3) involved in plume chemistry
4	LSAMP	F	No gridded receptors (sampling grid) used
8	Part. Size	Mean = 0.48	All particulate species assumed $PM_{2.5}$
		Std. Dev. = 2	
11	MOZ	0	Constant ozone background
	$BCK0_3$	40.0 ppb	Representation background ozone concentration
	$BCKNH_3$	1.0 ppb	Conservative background ammonia concentration (0.5 ppb recommended for forested lands)
12	NSPLIT	3	Puff-splitting used (default)

Source: Excelsior, 2006

The CALPUFF modeling analysis used meteorological data for the years 1990, 1992, and 1996. Additional surface, upper air, and precipitation data were used in CALMET to refine the meteorological fields. Hourly surface data from 13 stations were used along with precipitation data from 28 stations. Upper air data from two stations were used: St. Cloud, Minnesota and International Falls, Minnesota for 1990 and 1992, and Minneapolis, Minnesota and International Falls, Minnesota for 1996. Figure B.1-2 shows the locations of meteorological stations used for the CALMET processing.



Source: Excelsior, 2006

Figure B.1.2. Meteorological Stations of Surface, Upper Air, and Precipitation Used for CALMET Modeling of Mesaba Energy Project

B.1.2.1 Class I Areas Modeling Domain

The CALMET/CALPUFF modeling domain was a 700- by 500-kilometer area approximately centered on the Mesaba IGCC Power Plant proposed project sites site, with a 4-kilometer grid spacing. The coordinate system was Lambert Conformal. Receptor locations within each of the Class I areas were obtained from the National Park Service. Figure B.1-3 shows the modeling domain, terrain elevation contours, and the modeling receptors.

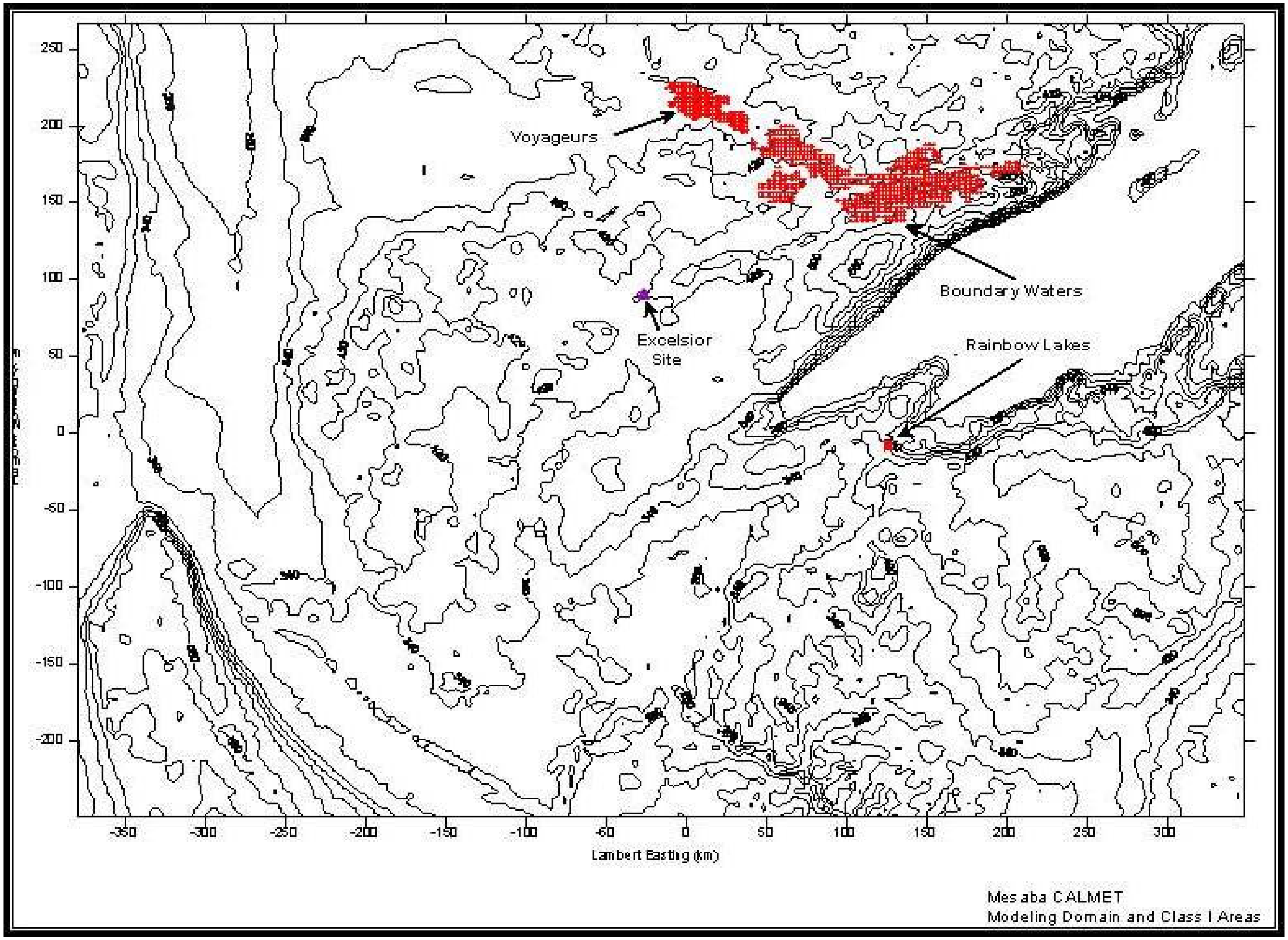
B.1.2.2 Modeled Emission Rates

Pollutant emission rates (Table B.1-11) represent the maximum expected emissions and the appropriate averaging times from the Mesaba IGCC Power Plant for Phase I and Phase II and are used for CALPUFF modeling.

Table B.1-11. Modeling Emission Rates For Phase I and Phase II CALPUFF Modeling

Parameter	Averaging Time	Combustion Turbines (each of four)	Tank Vent Boilers (each of two)
Stack height (m)		45.72	64.01
Stack diameter (m)		6.1	1.83
Temp (K)		394.3	579.8
Velocity (m/s)	Short-term	20.1	8.46
	Annual	20.1	1.95
SO_2	3-hr (g/s)	19.15	0.94
	24-hr	14.36	0.81
	Annual	9.58	0.45
NO_x	3-hr (g/s)	19.66	2.46
	24-hr	19.66	2.46
	Annual	19.91	0.76
Elemental Carbon (g/s)	All time periods	0.787	0
Sulfate (g/s)	All time periods	0.945	0
Organic aerosol (g/s)	All time periods	1.397	0
$PM_{2.5}$ (g/s)	All time periods	0	0.088
PM_{10} (g/s)	All time periods	0	0

Source: Excelsior, 2006



Source: Application to Minnesota Pollution Control Agency for a Part 70 Permit to Construct, URS 2006

Figure B.1-3. CALMET Modeling Domain and Class I Areas Included in Analysis