From:	John Mays
To:	Burrows, Ronald; Yilma, Haimanot
Cc:	gfesko@blm.gov; "Holm, Eric"; "Rombough, Kyrik"; Lloyd.lisa@epa.gov; "Richard Blubaugh"
Subject:	Final Air Modelling Report and Protocol (1 of 3)
Date:	Thursday, July 11, 2013 3:49:28 PM
Attachments:	Dewey-Burdock Final Modeling Protocol and Results Part 1.pdf Powertech Air Model 071113 Cover Letter.pdf

Mr. Burrows,

Please see the attached cover letter and the first part of the report, "**Ambient Air Quality Final Modeling Protocol and Impact Analysis, Dewey-Burdock Project**". Due to the size of the document, two more emails are necessary complete this transmittal. We will also be sending a hardcopy of this transmittal by mail.

The electronic data files for the model will be provided on a DVD-ROM and follow under a separate letter.

Sincerely,

John

John M. Mays
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Please do not print this e-mail unless necessary

POWERTECH (USA) INC.

RICHARD E. BLUBAUGH
Vice President – Environmental
Health & Safety Resources

July 11, 2013

Office of Federal and State Materials
and Environmental Management Programs
Uranium Recovery and Licensing Branch
U.S. Nuclear Regulatory Commission
TWFN, Mail Stop: 8 F 5
11545 Rockville Pike
Rockville, MD 20852-2738

ATTN: Mr. Ronald A. Burrows

Re: Air Modeling Final Protocol and Report

Dear Mr. Burrows

By this letter, Powertech (USA) Inc. respectfully submits the enclosed "Ambient Air Quality Final Modeling Protocol and Impact Analysis, Dewey-Burdock Project" including appendices. The report will be transmitted via email and hardcopy by mail. A DVD-ROM of the modeling data files will be transmitted separately.

If you have any questions regarding the submittal please contact myself or John Mays, VP of Engineering, who served as project lead on this matter.

Respectfully yours,

Richard Blubaugh
Vice President - Environmental Health & Safety Resources

cc: Haimanot Yilma, NRC SEIS Project Manager (via email)
Greg Fesko, BLM
Lisa Lloyd, NEPA Compliance and Review Program, EPA Region 8
Eric Holm, SD DENR
Kyrik Rombaugh, SD DENR (via email)
John Mays and Mark Hollenbeck, Powertech (USA) Inc.

Ambient Air Quality Final Modeling Protocol and Impact Analysis

Dewey-Burdock Project

Powertech (USA) Inc.

Edgemont, South Dakota

July 11, 2013

Prepared by:

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1 INTRODUCTION

Powertech (USA) Inc. (Powertech) has proposed to construct an in-situ recovery (ISR) uranium facility at the Dewey-Burdock site in southwestern South Dakota. An assessment of the potential air quality impacts of the proposed facility is requested as part of the NRC license application and Supplemental Environmental Impact Study (SEIS). Powertech enlisted IML Air Science to develop a project emissions inventory and to model the potential impacts of these emissions on ambient air quality. IML was also asked to assess potential project impacts on Air Quality Related Values (AQRVs) at the nearby Wind Cave National Park, a Class I area.

The air quality modeling protocol is presented in Sections 2 through 5. It addresses the approach for assessing the ambient air quality impacts from the proposed source emissions for comparison with the National Ambient Air Quality Standards (NAAQS) for particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). It also addresses the approach for comparing modeled project impacts to the Prevention of Significant Deterioration (PSD) increments for PM_{10}, $PM_{2.5}$, SO_2 and NO_2. Finally, the protocol establishes the methods and assumptions used to model impacts on AQRVs, including visibility and deposition impacts, at Wind Cave National Park. Project-related emissions of greenhouse gases (carbon dioxide or CO_2) will be estimated and summarized, but not modeled.

The modeling results and analysis are presented in Sections 6 and 7. Section 6 contains the ambient air quality impact analysis and Section 7 contains the AQRV analysis. Details concerning potential project emissions, modeling assumptions and parameter settings, and model outputs appear in Appendix A through Appendix H to this document.

1.1. Project Overview

The proposed Dewey-Burdock Project is a uranium in-situ recovery (ISR) facility in Custer and Fall River counties, South Dakota. The facility is composed of well fields, a central processing plant, and a satellite processing plant. The project will entail four phases: construction, operation, aquifer restoration and decommissioning. The construction phase will be further partitioned into a facilities construction phase and a well field construction phase. Fugitive emission sources of particulate matter (PM_{10},

$PM_{2.5}$) include construction and drilling activities, wind erosion, product transport, pickup traffic, delivery trucks, and passenger vehicles. Particulates (PM_{10}, $PM_{2.5}$), carbon monoxide (CO), and oxides of nitrogen and sulfur (NO_x and SO_2) will be emitted by mobile equipment engine exhaust and by stationary sources such as heaters, pumps, emergency generators and a thermal dryer.

1.2. Modeling Overview

The original emissions inventory calculations and dispersion modeling results for the Dewey-Burdock Project were submitted to NRC in 2009. Based on direction from NRC and EPA several corrections and refinements to the emissions inventory were made and published in the SEIS Draft Report in November of 2012. The agencies also requested a more comprehensive modeling analysis to include both fugitive dust and combustion emission sources, to characterize timing of the emissions, to model all inventoried pollutants, and to analyze AQRV impacts at Wind Cave National Park. The revised emissions were modeled in accordance with these requests; the associated modeling protocol and results were published in February 2013. Additional comments submitted by NRC and EPA, as well as South Dakota Department of Natural Resources (DENR) and the Bureau of Land Management (BLM), prompted further refinements to the emissions inventory and modeling protocol. Based on these refinements, final modeling runs were completed in June of 2013. This document presents the final modeling protocol and model predictions.

1.3. Document Overview

This document addresses two separate modeling scenarios: (1) modeling for ambient air quality impacts at the project boundary, at locations within 50 km of the project, and at Wind Cave National Park (a Class I area), and (2) modeling for AQRV impacts, including visibility and atmospheric deposition impacts, at Wind Cave National Park. Since these two scenarios utilize different modeling assumptions, domains, software models, and meteorological data sets, they are addressed separately.

Ambient air quality impact analysis will be performed using the AERMOD dispersion model. Sections 3 and 4 of this document apply to the AERMOD modeling protocol. AQRV impact analysis will be performed using the CALPUFF model. Section 5 applies to the CALMET/CALPUFF modeling protocol. Section 2 discusses project related emissions and modeled emission sources, which apply equally to AERMOD and CALPUFF.

1.4. Pollutants of Concern

Both combustion emissions and fugitive dust emissions will be modeled in the air quality and AQRV impact analyses. The stationary and fugitive emission sources at the Dewey-Burdock Project will produce particulate matter smaller than ten microns in size (PM_{10}) and particulate matter smaller than 2.5 microns in size ($PM_{2.5}$). Stationary and mobile sources will emit PM_{10}, $PM_{2.5}$, carbon monoxide (CO), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). For the AERMOD analysis, per Section 6.2.3 of EPA's Guideline on Air Quality Models (40CFR Part 51 Appendix W), it is assumed that 75% of NO_x emissions will be converted to NO_2. This assumed conversion is not necessary for CALPUFF, since it models atmospheric chemistry inherently. Thus, five criteria pollutants (PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2) will be analyzed for compliance with the NAAQS. Four of these pollutants, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 will be further analyzed for comparison with the PSD increments in Class I and Class II areas. This comparison will be made for disclosure purposes only, since Dewey-Burdock does not qualify as a PSD source.

Both the NAAQS and the PSD analyses will be conducted using the AERMOD software. The modeling domain for AERMOD will extend 55 km in all directions from the Dewey-Burdock Project. Modeled impacts within this domain will be compared to the NAAQS and Class II PSD increments. Since Wind Cave National Park is roughly 50 km from the project site, the Wind Cave park boundary will be included in the air quality impact analysis. Modeled impacts at Wind Cave will be compared to the NAAQS and PSD Class I increments.

These same pollutants have the potential to impact visibility at Wind Cave National Park. Moreover, SO_2 and NO_2 emissions may affect atmospheric deposition. For these reasons an AQRV analysis will be conducted using the CALMET/CALPUFF software. The modeling domain for CALPUFF will extend 100 km in all directions from the Dewey-Burdock Project to provide a 50-km buffer for the Wind Cave Class I area AQRV impact analysis.

The principle form of hazardous air pollutants (HAPs) will be formaldehyde in diesel engine exhaust. For the Dewey-Burdock Project formaldehyde emissions will be inventoried but not modeled. Diesel engines emit from 2% to 5% as much formaldehyde per unit of energy input as natural gas fired engines (EPA 1995c). The latter are used extensively in the region for compressor stations, heaters, and other applications in the oil and gas industry. Appendix A shows maximum annual formaldehyde emissions of 2.99 tons at Dewey-Burdock. This total is roughly equivalent to the annual emissions from a single, 2000-hp, natural gas fired compressor.

1.5. Regulatory Status

The Dewey-Burdock Project will be a non-categorical stationary source. Criteria pollutant emissions from the facility will be below the New Source Review major source threshold of 250 tons/year. Therefore, the facility will not be subject to PSD permitting regulations. The potential to emit HAPs will be less than 10 tons/year for any individual HAP, and less than 25 tons/year for all HAPs combined. Therefore, the facility will not be a major HAP source. Point source emissions of criteria pollutants from the facility will be less than the Title V source threshold of 100 tons per year.

It should be noted that it was determined by SD DENR, in a letter dated February 21, 2013 that no air quality permit is required by South Dakota because project emissions are below threshold levels that require permitting. This determination was made in response to the submission of a permit application by Powertech on November 5, 2012.

1.6. Results Summary

The modeling results presented in Section 6 predict concentrations below all NAAQS levels. With the regulatory default options selected, AERMOD predicted values greater than the PM_{10} 24-hr standard at three model receptors less than 200 meters from the public road. With a background of 41 μg/m^3 added to the project impacts, this initial model run predicted total concentrations greater than the PM_{10} 24-hr standard at 50 receptors (all located within a few hundred meters of the public road or project boundary). AERMOD was re-run for these 50 receptors with the dry depletion option selected to account for natural PM_{10} particle deposition and corresponding plume depletion. This refined analysis predicted all receptors to be in compliance with the PM_{10} 24-hr standard when adding potential project impacts to the background concentration. Since Dewey-Burdock is the first ISR project for which extensive modeling has been required, there is no basis for direct comparison of these modeling results to similar projects.

In general the modeling results also predict concentrations below the PSD Class I and Class II increments. For the entire Class I area evaluated, modeled concentrations were below PSD Class I increments. Limited exceedances of the Class II 24-hour PM_{10} increment were predicted in close proximity to the modeled project sources. The refined PM_{10} analysis predicted concentrations above the Class II increment of 30 μg/m^3 at receptors that fall within a narrow corridor along the public road and the northwestern portion of the project boundary. None of these exceedances occurred at distances greater than 500 meters from the project boundary or the public road. Outside this corridor all modeled concentrations were below the PSD Class II increment. As previously stated, because overall pollutant emissions from the facility will be below the New Source Review major source threshold of 250 tons/year, the regulatory limits for the PSD Class I and Class II increments do not apply and are modeled solely at the request of NRC and EPA.

CALPUFF predicted potential impacts on AQRVs at Wind Cave National Park that are below the applicable thresholds. Maximum 3-year deposition rates for sulfur and nitrogen were below the respective deposition analysis thresholds. Potential visibility impacts were quantified as the 98th percentile of the 24-hour change in haze index, measured in deciviews (dv). Using this definition and selecting the conservative modeling assumption that coarse particulates can influence visibility 50 km away from the source, the highest-impact receptor showed a change of 0.35 dv. The threshold for contribution to visibility impairment is 0.5 dv (WRAP 2006).

2 EMISSION AND SOURCE DATA

2.1. Facility Processes and Emission Controls Affected

The nature of the proposed facility is to extract uranium oxide in solution from uranium bearing formations using in-situ recovery. The solution is processed at on-site facilities to recover yellow cake for transport to an off-site refining facility. Facility processes and emission controls planned for the Dewey-Burdock Project include the use of a dust suppressant to control fugitive dust emissions from unpaved roads, a vacuum dryer to eliminate yellow cake dust generation, and standard diesel engine controls to minimize tailpipe emissions.

2.2. Emission Factors Used to Calculate Potential Emissions

The Dewey-Burdock Project will generate both on-site and off-site emissions. On-site emissions will include stationary source, fugitive dust and tailpipe emissions occurring within the project boundary. Off-site emissions related to the project will be associated with vehicle traffic accessing the project by an unpaved county road. The off-site emissions inventory will include fugitive dust from the road and combustion emissions from vehicle tailpipes. Both on-site and off-site sources will be modeled for ambient air quality and AQRV impacts.

In general, fugitive dust emissions from the Dewey-Burdock Project will include traffic on unpaved roads, drilling and earth moving activities, road maintenance, topsoil stripping and reclamation, and wind erosion on disturbed areas. Emission factors for these sources are provided in EPA's AP-42, Compilation of Air Pollutant Emission Factors as listed below (EPA 1995c):

- Unpaved roads — Chapter 13, Section 13.2.2
- Drilling and earth moving — Chapter 11, Section 11.9, Table 11.9-4
- Topsoil stripping and reclamation — Chapter 11, Section 11.9, Table 11.9-4
- Wind erosion — Chapter 11, Section 11.9, Table 11.9-4

In some cases fugitive $PM_{2.5}$ emission factors were not available in AP-42. For wind erosion, a $PM_{2.5}$/ PM_{10} ratio of 15% was applied to the respective PM_{10} emission factor. For unpaved road dust, a $PM_{2.5}$/ PM_{10} ratio of 10% was applied to the respective PM_{10}

emission factor. These ratios follow recommendations in a study performed for the Western Regional Air Partnership (WRAP) by Midwest Research Institute (MRI 2006).

Published fugitive dust emission factors are modified by specific control measures. EPA guidance provided in AP-42 allows for natural mitigation of fugitive dust emissions based on days of precipitation per year (page 13.2.2-7, Equation 2). Figure 13.2.2-1 in AP-42 shows a contour plot of days per year with precipitation greater than or equal to 0.01" (wet days). For the Dewey-Burdock Project area this value is 90 days per year, and applies to all unpaved roads (on-site and off-site). Guidance also typically allows for 50% control efficiency with the use of water trucks for dust suppression on unpaved roads. For the Dewey-Burdock Project, the number of water trucks and frequency of water application justify a higher control efficiency, as supported in Appendix D. In this case, a control efficiency of 60% will be used for on-site roads. For the purpose of calculating fugitive dust emissions, no control will be assumed for the public road.

Gasoline and diesel equipment tailpipe emissions were calculated using emission factors from several sources. THC (total hydrocarbon), SO_2, CO_2 and aldehyde emission factors were taken from AP-42 Chapter 3, Table 3.3-1. NO_x, CO, and PM_{10} emission factors for diesel engines are based on EPA standards for various engine tier ratings (EPA 1998). Drill rigs were assumed to have Tier 1 engines, while all other mobile diesel equipment was assumed to conform to Tier 3 standards. The THC emission factor for Tier 1 diesel engines was used for drill rigs, in place of AP-42. $PM_{2.5}$ emissions from equipment tailpipes were assumed to be 97% of PM_{10} emissions (EPA 2004a). Emission factors for propane fired heaters and emergency generators were obtained from AP-42, Table 1.5-1 (EPA 1995c). Emission factors for diesel pumps were taken from AP-42, Table 3.3-1 (EPA 1995c).

2.3. Schedule of Fugitive Particulate Emissions

The potential fugitive emission rates from the Dewey-Burdock Project are summarized in Table 2-1. Detailed emission calculations for the proposed project have been provided in Appendix A. The basis for timing and the source apportionment of equipment-generated fugitive emissions are presented in Appendix B. Year 7 will be modeled since it shows the highest total for fugitive dust emissions. Table 2-1shows that during year 7 four phases are expected to be active, including well field construction, operation, restoration and decommissioning. Both on-site and off-site, project related fugitive dust emissions will be modeled for NAAQS, PSD and AQRV impacts.

Table 2-1: Potential Fugitive Emissions by Year (tons/year)

SCHEDULE		ON-SITE FUGITIVE EMISSIONS (INCLUDING WIND EROSION)		OFF-SITE FUGITIVE EMISSIONS	
Year	Phases	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
1	CF	225.91	24.15	56.91	5.69
2	CW, O	284.49	30.00	69.18	6.92
3	CW, O	284.90	30.06	69.18	6.92
4	CW, O, R	293.01	30.89	75.43	7.54
5	CW, O, R	293.42	30.95	75.43	7.54
6	CW, O, R	293.75	31.00	75.43	7.54
7	CW, O, R, D	354.19	37.06	103.80	10.38
8	CW, O, R, D	352.38	36.79	103.80	10.38
9	O, R, D	198.93	21.41	76.50	7.65
10	R, D	97.99	11.31	34.62	3.46
11	D	90.20	10.52	28.37	2.84
12	D	90.12	10.51	28.37	2.84
13	D	90.09	10.51	28.37	2.84
14	D	90.08	10.51	28.37	2.84

CF = Construction of Facilities
CW = Construction of Wellfields
O = Operation
R = Restoration
D = Decommissioning and Reclamation

2.4. Schedule of Tailpipe Emissions

Table 2-2 summarizes potential combustion emissions from equipment tailpipes. As with fugitive emissions, the highest annual tailpipe emissions of PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_x are projected for year 7. Detailed emission calculations for the proposed project have been provided in Appendix A. The basis for timing of tailpipe emissions is presented in Appendix B. Year 7 will be modeled since it shows the highest total emissions. Both on-site and off-site, project related tailpipe emissions are represented in Table 2-2 and will be modeled for NAAQS, PSD and AQRV impacts.

Table 2-2: Potential Tailpipe Emissions by Year

Mobile Engine Combustion Emissions (tons/year)					
	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO
Year 1	51.08	2.97	2.88	8.58	49.05
Year 2	54.82	3.17	3.07	9.03	51.01
Year 3	54.82	3.17	3.07	9.03	51.01
Year 4	56.05	3.25	3.15	9.10	51.79
Year 5	56.05	3.25	3.15	9.10	51.79
Year 6	56.05	3.25	3.15	9.10	51.79
Year 7	68.46	3.87	3.75	11.31	58.90
Year 8	68.46	3.87	3.75	11.31	58.90
Year 9	27.54	1.51	1.47	4.26	17.20
Year 10	13.64	0.70	0.68	2.27	7.89
Year 11	12.41	0.62	0.60	2.21	7.11
Year 12	12.41	0.62	0.60	2.21	7.11
Year 13	12.41	0.62	0.60	2.21	7.11
Year 14	12.41	0.62	0.60	2.21	7.11

For purposes of modeling in AERMOD, NO_x emissions will be multiplied by 0.75 to estimate NO_2 emissions. NO_2 is the regulated pollutant, with associated NAAQS and PSD increments, per Section 6.2.3 of EPA's Guideline on Air Quality Models (40 CFR 51 Appendix W).

2.5. Stationary Equipment Emissions

Table 2-3 summarizes stationary equipment emissions. With the exception of startup construction, these emissions are assumed to be constant from year to year.

Table 2-3: Potential Stationary Equipment Emissions per Year

Stationary Equipment Emissions (tons/yr)					
Pollutant	**Space Heater**	**Dryer Thermal Fluid Heater**	**Emergency Generator**	**Pump**	**Total**
NO_x	0.74	0.91	0.00	0.04	1.69
PM10/PM2.5	0.040	0.049	0.000	0.003	0.092
SO_2	0.001	0.001	0.000	0.003	0.005
CO	0.43	0.52	0.00	0.01	0.96

2.6. Source Parameters

The modeled emission sources in AERMOD will include area sources, line-area sources and point sources. The line-area sources include the haul road, access roads and public road. Area sources include disturbed acreage, well fields, reclamation areas, and plant facilities. AERMOD release heights for area and line-area sources of fugitive dust will follow recent EPA guidance (EPA 2012) assuming average vehicle heights are 3.0 meters for project roads and well fields, and 2.0 meters for the public road. Based on this guidance, release heights for 3-meter and 2-meter vehicle heights are 2.55 and 1.70 meters, respectively. Corresponding sigma-Z values are 2.37 and 1.58 meters, respectively. For those sources dominated by wind erosion (e.g. land application and facilities areas), release heights are assumed to be 1 foot and sigma-Z is assumed to be zero. Release heights for equipment tailpipe emissions are assumed to be 1 meter, with a sigma-Z of zero.

For CALPUFF modeling, the point, area and line-area sources will be identical to those used for AERMOD, with one exception. Since CALPUFF models multiple pollutants simultaneously (fugitive dust and gaseous emissions), uniform release heights and sigma-Z values of 1.0 meters will be used for all area and line-area sources.

Appendix B details the apportionment of equipment and fugitive emissions among these sources. Based on this apportionment process, Table 2-4 summarizes area and line-area source emissions (tons/year), including both on-site and off-site emissions.

Table 2-4: Year 7 Area and Line-Area Source Emission Totals

Area/Line Source Totals	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO
Disturbed	164.88	18.52	16.62	2.15	11.67
AccessRdSat	10.53	1.08	0.72	0.21	0.61
AccessRdCPP	21.13	2.18	1.45	0.43	1.24
NewWells	73.27	8.82	30.18	5.18	34.86
FacilitiesCPP	5.70	0.85	4.62	0.36	1.27
FacilitiesSat	2.85	0.42	2.24	0.17	0.55
HaulRd	6.10	0.64	0.59	0.18	0.51
OperWells	20.01	2.09	1.96	0.61	1.70
DecomWells	43.50	4.58	7.30	1.59	4.49
LandAPDewey	5.35	0.80			
LandAPBurdock	4.57	0.68			
AccessRdPublic	103.96	10.54	2.78	0.42	2.00
Year 7 Totals (tpy)	**461.86**	**51.20**	**68.46**	**11.31**	**58.90**

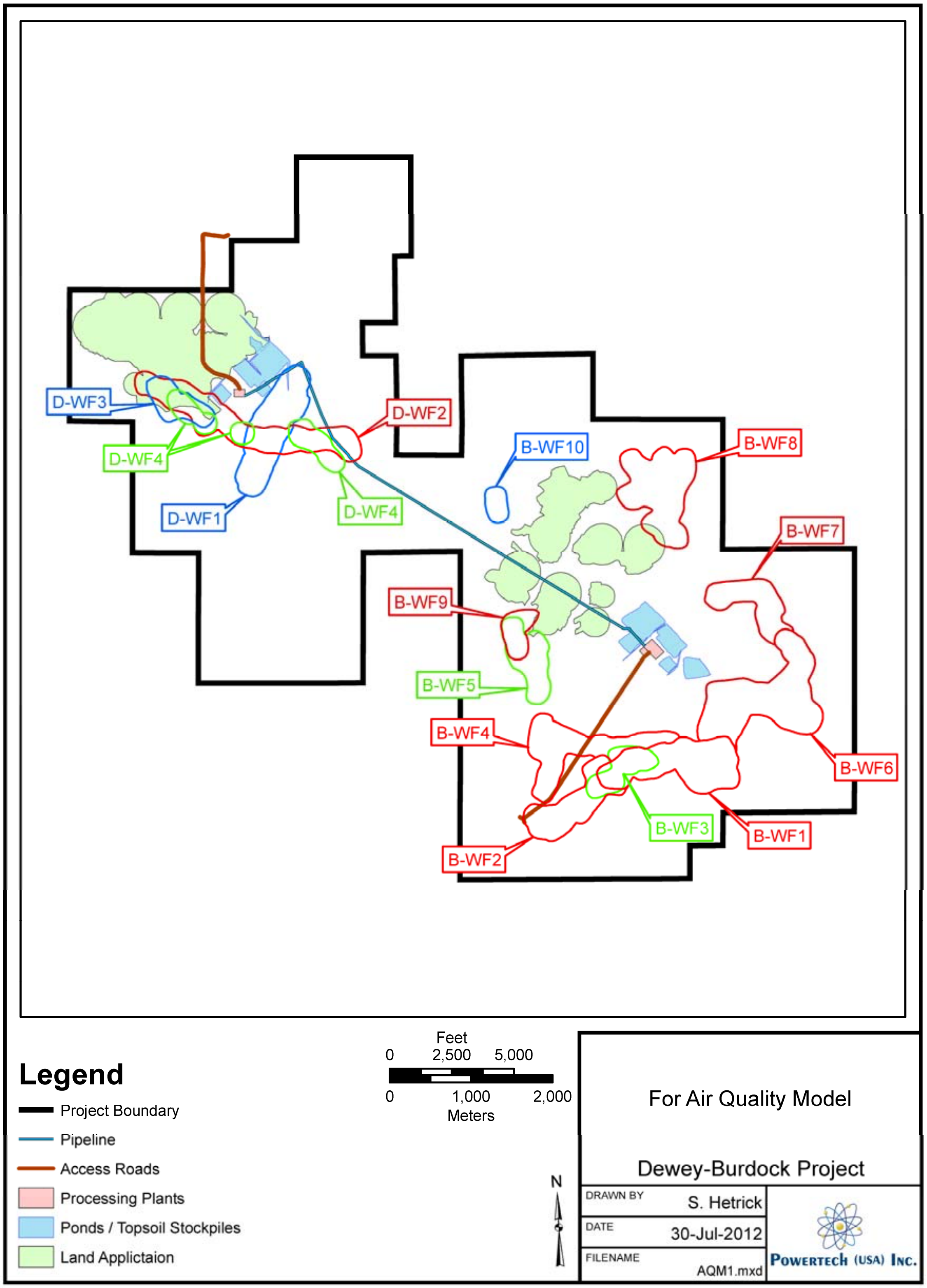
Table 2-5 summarizes point source emission rates (tons/year) and associated stack parameters for the modeled year. All modeled point sources have a vertical discharge. The modeled CPP heater source includes multiple space heaters located within the main facility.

Table 2-5: Point Source Emission Totals and Stack Parameters

	Emissions (tons/year)					Stack Parameters			
Point Source Totals	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Ht (m)	Diam (in)	(Deg F)	(ft/sec)
CPP_Point_Dryer	0.049	0.049	0.909	0.001	0.524	9.0	18.3	200	4.2
CPP_Point_Heater	0.020	0.020	0.369	0.000	0.213	5.0	5.6	160	4.4
CPP_Point_Pump	0.001	0.001	0.020	0.001	0.004	4.0	3.1	240	46.7
Sat_Point_Heater	0.020	0.020	0.369	0.000	0.213	5.0	5.6	160	4.4
Sat_Point_Pump	0.001	0.001	0.020	0.001	0.004	4.0	3.1	240	46.7
Year 7 totals (tpy)	**0.092**	**0.092**	**1.687**	**0.005**	**0.959**				

Figure 2-1 shows the locations and orientations of modeled area and line-area sources for the Dewey-Burdock Project. Area sources will be digitized as rectangles and polygons to reduce model complexity and execution time. Modeled point sources reside at the processing plants, which include a satellite plant in the northwestern portion of the project area, and the central processing plant in the southeastern portion of the project area. Roads will be modeled as line-area sources. Not shown in Figure 2-1 is the unpaved section of county road providing access to the project site. Fugitive dust and tailpipe emissions from this road will also be modeled.

Figure 2-1: Dewey-Burdock Project Emission Source Locations



Source emission rates will be assumed to be uniform during the time each source is active, but variable throughout the modeled year based on equipment duty cycles. For point sources, average emission rates in tons/year will be converted to lbs./hour for the hours each source is operated. For area and line-area sources, average emission rates of tons/year will be converted to lbs./hour/ft^2 for the hours each source is active and the area over which the source emissions are distributed. Line-area sources in AERMOD and CALPUFF are actually rectangular areas chained together in a prescribed line.

Appendix B presents the method used to derive variable emission rates for non-continuous emission sources. Tables B-4 and B-5 in Appendix B show the assumed timing of emissions for AERMOD and CALPUFF, respectively. These tables differ slightly because AERMOD allows greater flexibility and higher resolution in specifying the timing of emissions.

2.7. Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions will be inventoried but not modeled. There are no NAAQS associated with GHG concentrations in the atmosphere. The only significant sources of GHG associated with the Dewey-Burdock Project are combustion emissions and process emissions, in the form of CO_2. Combustion emissions from equipment engine exhaust, gas-powered generators and heaters, and diesel-powered pumps are estimated using emission factors from AP-42. Appendix A presents the estimated CO_2 totals from combustion, with a maximum of 9,166 tons per year (tpy). Process emissions are estimated based on process assumptions and production rates. Appendix A also presents the estimated CO_2 from the uranium recovery process, with a maximum of 485 tpy. Total direct, project-related GHG emissions are projected to be 9,651 tpy.

3 AMBIENT AIR QUALITY IMPACT MODELING METHODOLOGY

3.1. Model Selection and Justification

The proposed facility includes multiple sources, including point, line-area and area sources that have a wide range of parameters that are too complex to merge into a single emission point. Therefore, criteria pollutant emissions will be modeled with the American Meteorological Society (AMS) and EPA Regulatory model (AERMOD) Version 12345 to evaluate air dispersion from multiple sources. AERMOD was chosen over the Industrial Source Complex (ISC3) model since it has been promulgated by the EPA as the preferred air dispersion model in the Agency's "Guideline on Air Quality Models" (40 CFR 51 Appendix W). AERMOD officially replaced the ISC3 air dispersion model effective December 9, 2006 (one year after rule promulgation) as published in the Federal Register on November 9, 2005. The Lakes Environmental software will be used to implement the AERMOD model (Lakes AERMOD View Version 8.2.0).

3.2. Model Options

The AERMOD regulatory settings will be left in the default settings with two exceptions. First, the plume volume molar ratio method (PVMRM) will be used to estimate the influence of atmospheric ozone on NO_2 conversion (EPA 2004b). This non-default setting was selected to facilitate modeling the conversion of NO_x to NO_2, which is enabled by the presence of ozone. A conservative estimate of 60 ppb will be used for the ambient ozone concentration; actual monthly averages at Wind Cave range from 35 to 50 ppb. Absent any source-specific conversion data, EPA recommends a “national default” NO_2/NO_x ratio of 75% (EPA 2005a). The historical default value of 0.10 will be used for the in-stack NO_2/NO_x ratio. Recent EPA guidance suggests 0.50 as a default (EPA 2011), absent any source-specific data. However, the Texas Commission on Environmental Quality recommends a NO_2/NO_x ratio of 0.15 for reciprocating diesel engines with NO_x emission factors in the range of 2 to 10 g/hp-hr (TCEQ 2012). This range applies to most of the engines at Dewey-Burdock. Modeling results presented below indicate the choice of 0.10 or 0.15 makes no difference in the modeled NO_2 impacts.

Second, for modeling short-term PM_{10} impacts, the dry depletion option will be evaluated and compared to the default setting (no dry depletion). Section 3.9 below discusses the basis for modeling fugitive dust emissions using dry depletion. Table 3-1 summarizes the non-default settings used for AERMOD.

Table 3-1: Non-Default Settings in AERMOD

NON-DEFAULT OPTION	PURPOSE	MODELING SCENARIO
PVMRM	Modeling NO_2 with ozone	All averaging intervals for NO_2
Dry Depletion	Account for particle deposition	Refined PM_{10} 24-hr analysis

3.3. Averaging Periods

For the purpose of this modeling analysis, the annual and 24-hour averaging periods will be utilized for PM_{10} and $PM_{2.5}$ modeling. The 8-hour and 1-hour averaging periods will be used for CO modeling. The annual and 1-hour averaging periods will be used for NO_2 while the annual, 24-hour, 3-hour and 1-hour averaging periods will be used for SO_2 modeling. These averaging periods are consistent with the NAAQS primary and secondary standards and the PSD increments. All short-term model results will be presented in the format of the appropriate NAAQS standard. These include: (a) 4^{th} high 24-hour PM_{10} value over three years, (b) 3-year average of yearly 98^{th} percentile, or 8^{th} high 24-hour $PM_{2.5}$ values, (c) 3-year average of yearly 98^{th} percentile, or 8^{th} high 1-hour NO_2 values, (d) 3-year average of yearly 99^{th} percentile, or 4^{th} high 1-hour SO_2 values.

3.4. Building Downwash

Based on the proposed facility design, buildings and/or structures will cause negligible influences on normal atmospheric flow in the immediate vicinity of the emission sources. Therefore building downwash will not be modeled.

3.5. Elevation Data

The terrain surrounding the Dewey-Burdock Project is relatively flat. However, the terrain encompassing model receptors includes hills and valleys. Therefore, the Elevated Terrain mode will be used. Receptor elevations will be entered based on elevations obtained from USGS digital elevation model (DEM) files.

3.6. Receptor Network

Figure 3-1 displays the AERMOD receptor placement (designated as green crosses on the map). The model domain includes a total of 4,220 receptors, including fenceline, hot spot grid, intermediate grid and coarse grid receptors. The receptor grid extends in all directions from the project site to fully encompass the nearest Class I area, Wind Cave

National Park, roughly 50 km from the project site. Figure 3-2 shows the AERMOD receptor locations in the vicinity of the Dewey-Burdock Project. The receptor network is described below.

3.6.1. Fenceline Receptors

Fenceline receptors will be placed along the project boundary at least every 100 meters in linear fenceline distance, with a receptor placed at each boundary corner. To test the sensitivity of modeling results to receptor spacing, project emissions were modeled in AERMOD under two special scenarios: (a) receptors placed at 250-meter intervals around the project boundary, and (b) receptors placed at 25-meter intervals around the project boundary. Appendix C presents the results of this study, which indicates very low sensitivity to receptor spacing and supports the choice of 100 meter spacing. In addition to the project boundary receptors, 44 receptors will be placed at roughly uniform spacing around the Wind Cave National Park boundary, approximately 50 kilometers from the project site. Areas inside the project boundary will not be analyzed.

Figure 3-1: Dewey-Burdock Project AERMOD Receptors In Domain

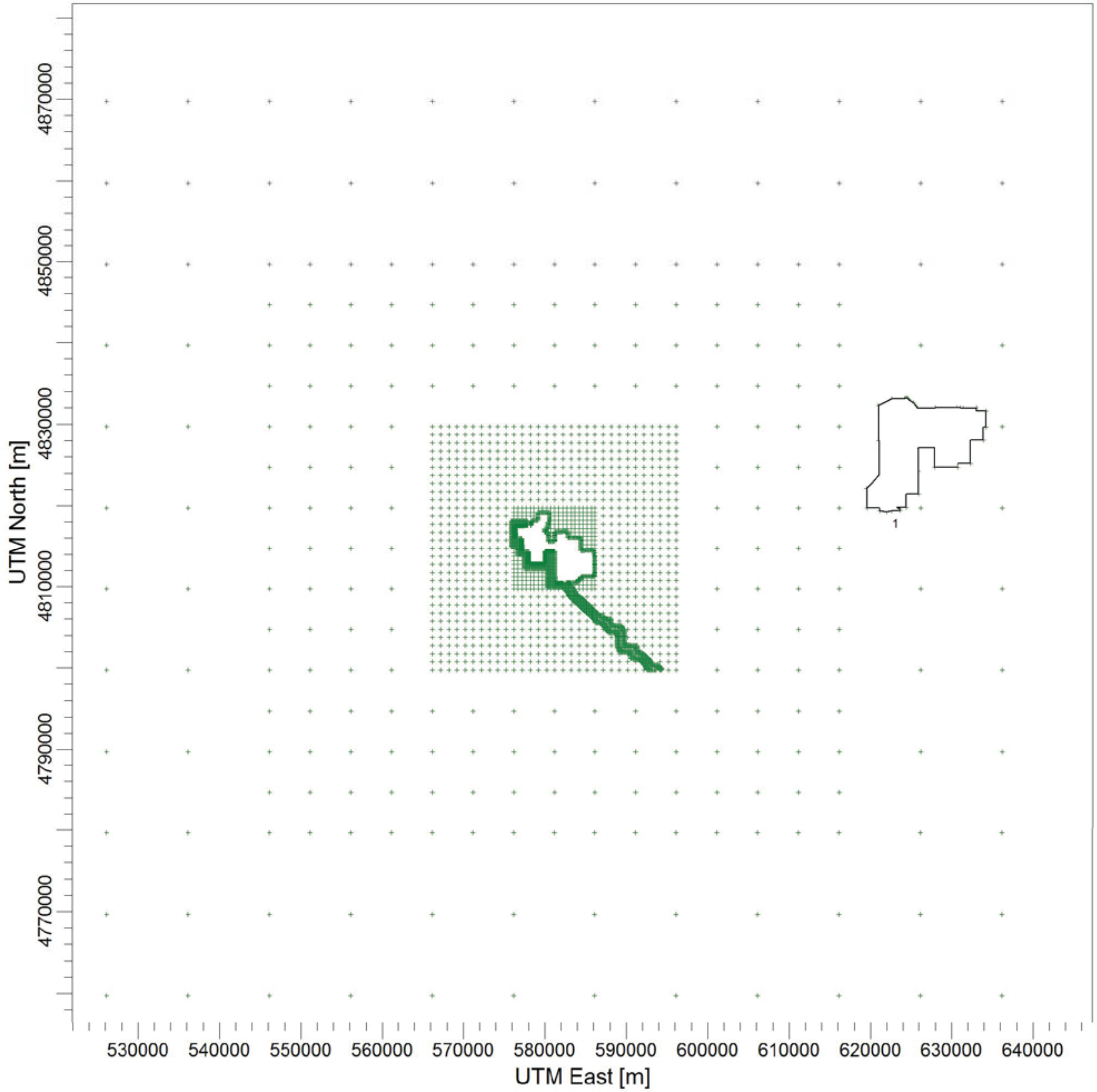
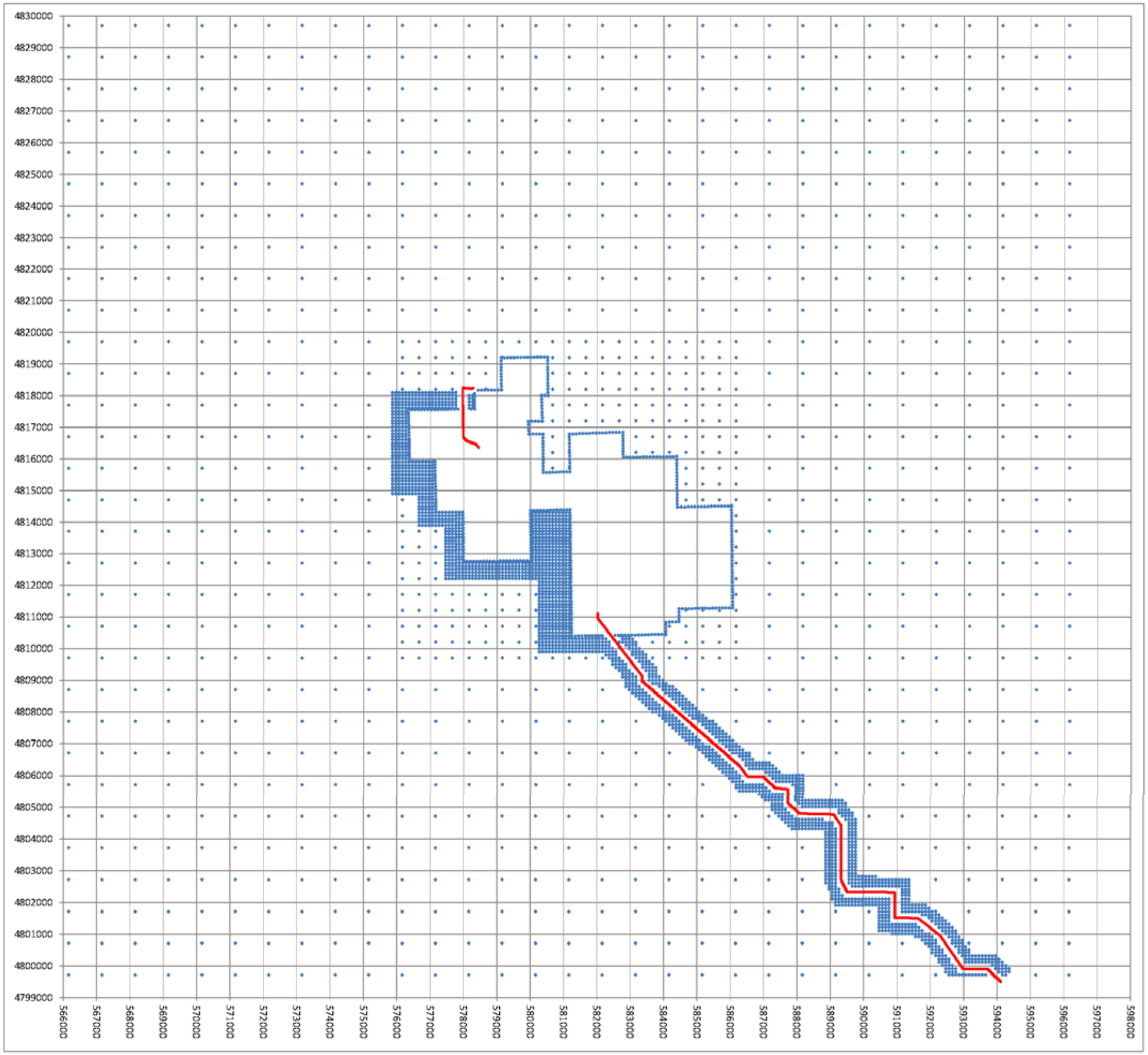


Figure 3-2: Dewey-Burdock Project AERMOD Receptors Near Project and Public Road



3.6.2. Hot Spot Grid

A fine grid of receptors will be placed at 100-meter spacing within a 500-meter-wide corridor along the western and southern portions of the project boundary and along the public road accessing the project (Figure 3-2). Receptors will not be placed closer than 150 meters from the centerline of the public road. The placement of these hot spot receptors is based on preliminary modeling, which predicted that high, 24-hour PM_{10} values would be limited to this narrow corridor.

3.6.3. Intermediate Grid

In addition to the hot spot grid, an intermediate grid of receptors will be placed at 500-meter spacing, from the project fenceline outward to a distance 5 kilometers (km) in all directions from the project center. A second intermediate grid will be placed at 1-km spacing, from the outer edge of the first intermediate grid outward in all directions to a distance 15 km from the project center (Figure 3-2).

3.6.4. Coarse Grid

A coarse grid will be placed at 5-km spacing, from the outer edge of the intermediate grid outward in all directions to a distance of 35 km from the project center. A second coarse grid will also be placed at 10-km spacing, from the outer edge of the 5-km grid in all directions to a distance of 55 km from the project center (Figure 3-1).

3.7. Meteorological Data

The baseline meteorological data collected from the Dewey-Burdock site represents only one year (July 2007 to July 2008). EPA recommends that AERMOD be run with a minimum of three years of meteorological data. Therefore the model will use three years of hourly data from the meteorological station at Newcastle, Wyoming (2009 through 2011). Hourly data from a nearby station are needed for AERMOD in order to simulate wind speeds and directions synchronous with hourly emissions data. Newcastle is approximately 30 miles north-northwest of the Dewey-Burdock Project site and provides a better comparison to the Dewey-Burdock project area than the nearest National Weather Service (NWS) station (Chadron, NE) in terms of elevation, surrounding topography and proximity to the southwestern flank of the Black Hills. The station meets EPA’s Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA, 2000). The Newcastle station has been accepted by NRC in conjunction with the Dewey-Burdock Project, as suitable for conducting the regional weather analysis.

No upper air data are available at the Dewey-Burdock or Newcastle sites. The upper air data will be obtained from the nearest available (and only reasonable) source, the Rapid City, South Dakota National Weather Service upper air site. This data set will be processed using the AERMET program. The surface characteristics (albedo, bowen ratio and roughness) representative of the land type surrounding the meteorological station location are required by the AERMET data processing procedures. AERSURFACE will be used to estimate the surface characteristics at the site based on land use/type files generated by the USGS. The AERMET program will combine the on-site meteorological data with the upper air data to create the AERMOD meteorological data files.

3.8. Background Concentrations

For this ambient air quality impact analysis, only the project impacts were initially modeled. Based on agency comments, background concentrations for each pollutant and averaging interval will be added to the modeled impacts to assess total ambient concentrations. The source for background concentrations is Table 3.7-3 of the Dewey-Burdock Project Draft SEIS (NRC 2012). This table was constructed from the 2008-2010 Wind Cave monitoring history. The 24-hour PM_{10} background of 85 μg/m^3 reported in the Draft SEIS is biased due to prescribed forest fires that burned very near the ambient monitor in 2009. South Dakota DENR recalculated the 2008-2010, 24-hour PM_{10} background as 41 μg/m^3 with these exceptional fire events removed. Table 3-2 lists the background concentrations used for this modeling analysis.

Note that for the AQRV impact analysis, certain background constituents will be incorporated into the model (see Section 5 below) and the modeled results will be compared to background conditions.

Table 3-2: Assumed Background Concentrations for Modeling Analysis

Pollutant	Averaging Interval and Statistic	Back-ground (µg/m^3)	NAAQS Limit (µg/m^3)
PM_{10}	Annual Average	--	--
	4th High 24-Hr Maximum	41.0	150
$PM_{2.5}$	Annual Average	4.8	12
	24-Hr High	10.9	35
NO_2	Annual Average	0.4	100
	98th Percentile of Daily 1-Hr Highs	5.6	187
SO_2	Annual Average	--	--
	24-Hr	--	--
	3-Hr	20.9	1300
	99th Percentile of Daily 1-Hr Highs	15.7	200
CO	8-Hr High	315.5	10000
	1-Hr High	1097.3	40000

3.9. Dry Depletion Option

Fugitive dust emissions from mobile equipment and wind erosion are the principal contributors to near-field PM_{10} impacts at Dewey-Burdock. EPA studies have established the tendency for ground-level, fugitive dust emissions to partially settle out within a short distance of the emission source (EPA 1994a) (EPA 1995a). This deposition includes a portion of the PM_{10} fraction (Countess 2001). Conservation of mass requires that deposition be accompanied by plume depletion. This is the purpose of the dry depletion option in AERMOD and its predecessor model, ISC3 (EPA 1995b). Dry depletion accounts for the partial settling and deposition of PM_{10} particles as the dust plume disperses away from the source. The mechanisms for particle deposition and settling include gravity, diffusion, impaction and others. Failure to account for deposition and depletion can lead dispersion models such as AERMOD to significantly over-predict maximum 24-hour PM_{10} concentrations.

Several studies have cited the tendency of ISC3, the predecessor to AERMOD, to over-predict maximum 24-hour PM_{10} concentrations by a factor of four (Cliff 2011, Sullivan 2006, Pace 2005). Moreover, a study by McVehil-Monnett demonstrated AERMOD to be equivalent to, or more conservative than ISC3 in predicting short-term impacts from fugitive dust emissions (MMA 2011). EPA scientist Thompson Pace recently proposed a conceptual model “to approximate the dust removal near the source that is not accounted for in either the current emissions inventories or commonly used regional scale air quality models” (Pace 2005).

EPA guidance emphasizes the need to coordinate the use of deposition modeling options with the appropriate reviewing authority (EPA 2005a). For the Dewey-Burdock Project, the AERMOD dry depletion option will not be used in the initial modeling analysis. The model execution times with dry depletion enabled are an order of magnitude longer, making it impractical to use for the entire modeling domain. The dry deposition option will, however, be considered in the refined analysis of 24-hour PM_{10} impacts. Modeling only those receptors from the initial modeling analysis that show high values, will reduce total execution time with the dry depletion option to a reasonable level. This is consistent with guidance provided by the New Mexico Air Quality Bureau (New Mexico 2006): “Because of the length of time to run a model with plume depletion, the Bureau recommends only applying plume depletion to receptors that are modeled to be above standards when the model is run without plume depletion.”

3.9.1. Rationale for Using Dry Depletion in Refined PM_{10} Analysis

The Dewey-Burdock Project meets EPA’s dry deposition criteria of multiple, quantifiable sources of fugitive emissions where a refined modeling analysis is being conducted and deposition is likely to occur (Trinity 2007). While these criteria were originally associated with ISC3, EPA guidance for AERMOD is similar (EPA 2005a). As with most (if not all) ISR projects, fugitive dust is the dominant pollutant at Dewey-Burdock. Historically, short-term modeling of PM_{10} impacts at receptors close to fugitive dust sources has been shown to over-predict ambient concentrations (Cliffs 2011) (MMA 2011). The results of a study posted by EPA “suggest that rapid deposition of PM_{10} particles, and the relatively long residence time of the optical plume associated with small particles (<2µm), may have led to overestimates of airborne particle mass in plumes” (Fitz 2002).

The likelihood of deposition of particles in the PM_{10} size range is large for this application. In addition to gravity settling, high modeled concentrations at receptors within a few hundred meters of the fugitive emission sources suggest the likelihood of high concentration gradients. These gradients are expected to produce significant diffusion-based settling. The Fugitive Dust Model (FDM) was developed two decades ago to compute concentration and deposition impacts from fugitive dust sources. A key feature of FDM was the improved gradient-transfer deposition algorithm, which is significant for particles in the PM_{10} size class (EPA 1992).

3.9.2. Precedent for Using Dry Depletion in Refined PM_{10} Analysis

Precedent has been established by state and federal agencies for using the dry depletion option in AERMOD to model short-term impacts from fugitive dust emissions. For example, a coal lease application in Utah triggered PM_{10} modeling that included a refined analysis using deposition and plume depletion (BLM 2010). Page 9 of Appendix K in the Alton Coal Lease DEIS states, "deposition was only considered for assessing the final PM_{10} modeled ambient air impacts." Page 10 states, "the primary pollutants of concern are fugitive dust."

The Colorado Department of Public Health and Environment (CDPHE) uses dry depletion to model PM_{10} impacts from fugitive dust sources at mining facilities seeking air quality construction permits (Majano 2013). Recent projects for which this option was used include the Lafarge Gypsum Ranch Pit, Oxbow Mining's Elk Creek Mine, and Bowie Resources' Bowie N.2 Mine (currently under review). The Wyoming Department of Environmental Quality indicated that it would accept the use of plume depletion algorithms in AERMOD as long as an applicant justifies the inputs, including particle size, particle density and mass fraction (Nall 2013).

A large landfill project in eastern Oregon also modeled fugitive dust impacts using dry depletion (Westbrook 2007). The primary emission source at this facility is haul road traffic transporting waste material. The Oregon Department of Environmental Quality worked with the landfill owners to refine both the emissions inventory and the modeling protocol. The document lists plume depletion as one of the options implemented, and discusses the importance of considering PM_{10} deposition and plume depletion when modeling fugitive dust.

EPA cited dry deposition in a study conducted using ISC3 at a Wyoming surface coal mine (EPA 1995b). "In order to appropriately model the particulate emission scenarios, the depletion of dispersed particles from the plume due to gravitational settling and other dry deposition factors were considered."

A recent modeling analysis was triggered by high fugitive dust impacts in the Salt River area of Arizona. Maricopa County was reclassified as a serious PM_{10} nonattainment area on June 10, 1996. The primary sources of particulate pollution in this area are "fugitive dust from construction sites, agricultural fields, unpaved parking lots and roads, disturbed vacant lots and paved roads" (Maricopa 2006). Cited among the "general characteristics that make AERMOD suitable for application in the Salt River Study area" is the claim that "gravitational settling and dry deposition are handled well."

3.9.3. Input Parameters for Dry Depletion Option

AERMOD provides two methods for specifying particle characteristics under the dry depletion option. Method 1, used for this analysis, requires the user to input particle size distribution and particle density. The latter, not to be confused with bulk density, is commonly cited in the literature as 2.65 g/cm^3 for soil particles. The Environmental Science Division of Argonne National Lab states, "A typical value of 2.65 g/cm^3 has been suggested to characterize the soil particle density of a general mineral soil (Freeze and Cherry 1979). Aluminosilicate clay minerals have particle density variations in the same range" (ANL 2013). A study of fugitive dust from unpaved road surfaces also cites 2.65 g/cm^3 for soil particle density (Watson 1996).

The original PM_{10} particle size distribution was obtained from the modeling protocol for a mine in Arizona (Rosemont 2009). The modelers for the Rosemont project acquired this distribution from AP-42 Section 13.2.4 and applied it to fugitive dust emissions from haul roads. Because Section 13.2.4 applies to aggregate handling and storage piles, another source was consulted to validate the use of this particle size distribution for haul road dust. A study by Watson, Chow and Pace referenced in a New Jersey Department of Environmental Protection report (NJDEP 2005) found that 52.3% of the particulate from road and soil dust is less than 10 μm in diameter. Of this particulate 10.7% was found to be smaller than 2.5 μm in diameter and the remaining 41.6% fell between 10 and 2.5 μm. Assuming that fugitive dust particle sizes follow a lognormal distribution (EPA 2013), these two data points were transformed into a multi-point particle size distribution for comparison to the original particle size distribution. The geometric mass mean diameter for the original distribution is 6.47 μm, while the mean diameter for the lognormal distribution is 5.76 μm. Since these values are very similar, the original PM_{10} size distribution will be retained for both CALPUFF and AERMOD dry deposition modeling (Table 5-2).

4 APPLICABLE REGULATORY LIMITS FOR CITERIA POLLUTANTS

4.1. Methodology for Evaluation of Compliance with Standards

The modeled concentration of the five criteria pollutants will be compared to the National Ambient Air Quality Standards. Predicted PM_{10}, $PM_{2.5}$, SO_2, and NO_2 concentrations will also be compared to the allowable Prevention of Significant Deterioration (PSD) increments for Class I and Class II airsheds. The Dewey-Burdock Project is not subject to a regulatory PSD increment analysis since it is not a major emission source. The PSD increments and modeled concentrations are provided for disclosure purposes only.

4.2. NAAQS and PSD Increments

The applicable standards and associated averaging intervals to be used in the modeling analysis are summarized in Table 4-1. Primary standards provide public health protection. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. PSD increments protect air quality in Class I and Class II areas from significant deterioration.

Table 4-1: National Ambient Air Quality Standards (μg/m^3)

Criteria Pollutant	Averaging Time	Primary NAAQS	Secondary NAAQS	PSD Class I Increments	PSD Class II Increments
Nitrogen Dioxide	Annual	100	100	2.5	25
	1-hour	187	---	---	---
PM_{10}	24-hour	150	150	8	30
	Annual	---	---	4	17
$PM_{2.5}$	24-hour	35	35	2	9
	Annual	12	15	1	4
SO_2	1-hour	200	---	---	---
	3-hour	---	1,300	25	512
	24-hour	---	---	5	91
	Annual	---	---	2	20
CO	1-hour	40,000	---	---	---
	8-hour	10,000	---	---	---

The purpose of PSD increments is to protect public health and welfare, and to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value. The goal of this program is to prevent significant deterioration of air quality in areas that meet the NAAQS. Areas in the U.S. have been classified in two categories for the purpose of this program. Class I areas include national wilderness areas, parks and memorial parks of a certain size, and international parks. In these areas, which include Wind Cave National Park, the allowable increase in criteria pollutant concentrations is less than in Class II areas, which includes most of the country.

4.3. Presentation of Modeling Results

The purpose of the dispersion modeling outlined in this protocol is to predict ambient air quality impacts from emissions at the Dewey-Burdock Project. These predictions will be compared to relevant NAAQS and PSD increments in the Class II area surrounding the project site and at the nearby Class I area, Wind Cave National Park. The final impact analysis will include all the information necessary for this comparison. It will include: (a) maximum impacts for each pollutant in the format of the applicable standard for each averaging period; (b) locations of the model receptors where these impacts are predicted to occur; (c) an emission source location map; (d) a complete list of source parameters; (e) complete modeling input and output files; and (f) graphic presentations of the modeling results for each pollutant, showing top receptor concentrations and isopleth maps based on predicted project impacts.

4.4. Summary

The AERMOD model with Newcastle meteorological data and maximum project emissions will be used to assess the ambient air quality impact of the criteria pollutants associated with the Dewey-Burdock Project. The model will be run with regulatory default options. A refined model run will be conducted for 24-hour PM_{10} impacts using the dry depletion option in AERMOD. Emissions of PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_x associated with the proposed emission sources will be modeled. NO_x impacts will be converted to NO_2 impacts and maximum modeled concentrations of all five pollutants will be compared to NAAQS and (where applicable) PSD increments.

5 AIR QUALITY RELATED VALUES (AQRV) MODELING METHODOLOGY

5.1. Introduction

The purpose of AQRV modeling is to identify and disclose impacts on Class I area resources (i.e., visibility, flora, fauna, etc.) by the projected emissions from a proposed project. AQRVs are resources which may be adversely affected by a change in air quality. Based on its proximity to the Wind Cave National Park, a federally mandated Class I area, the Dewey-Burdock Project will be modeled to determine its potential AQRV impacts at Wind Cave. Species to be modeled are PM_{10}, $PM_{2.5}$, SO_2, SO_4, NO_x, $NHNO_3$ and NO_3. Elemental carbon (EC) and secondary organic aerosol (SOA) will also be enabled in the model, but with zero project-related emissions. This is needed for background visibility calculations and to comply with the latest Federal Land Manager protocol (FLAG 2010).

Figure 5-1 depicts the Dewey-Burdock Project boundary and the Wind Cave National Park, approximately 50 km to the east-northeast of the project. Badlands National Park lies approximately 120 km to the east of the project and is not included in this modeling exercise. Based on relative distances and prevailing wind directions, the Dewey-Burdock Project is expected to have less impact on AQRVs at Badlands National Park than at Wind Cave National Park.

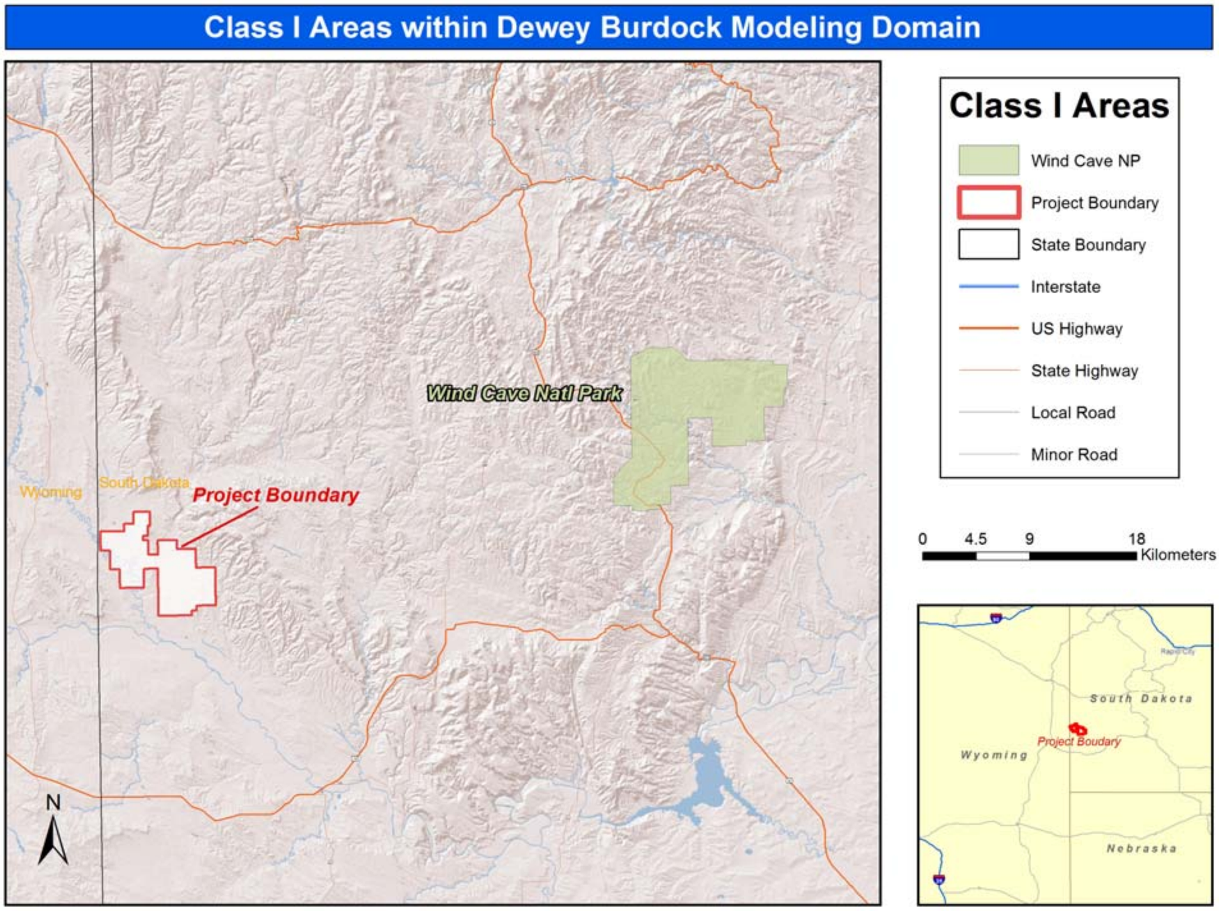
This protocol has been developed following applicable portions of the U.S. Environmental Protection Agency (EPA) guidance document: Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report And Recommendations for Modeling Long Range Transport Impacts, December 1998 (IWAQM 1998). It makes adjustments based on the findings of EPA's draft Reassessment of the Phase 2 Summary Report published in May 2009 (EPA 2009). It also reflects certain elements of the Western Regional Air Partnership BART protocol (WRAP 2006).

AQRVs that are generally evaluated for the federal mandatory Class I areas include:

- Visibility – Visual Plume
- Visibility – Regional Haze
- Acid Deposition

Visibility can be affected by plume impairment or regional haze. Plume impairment results from a contrast or color difference between a plume and a viewed background such as the sky or a terrain feature. Regional haze occurs at distances where the plume has become evenly dispersed in the atmosphere and is not definable. The primary causes of regional haze are sulfates and nitrates, which are formed from SO_2 and NO_X through chemical reactions in the atmosphere. Impacts at distances greater than 30 to 50 km are generally referred to as regional haze. Given that Wind Cave National Park is roughly 50 km from Dewey-Burdock and the project will not generate a singular plume of emissions, it is assumed that any visibility impacts at Wind Cave National Park will be in the form of regional haze.

Figure 5-1: Dewey-Burdock Project and Nearest Class I Area



5.2. Model Selection and Justification

Evaluation of the impacts on Air Quality Related Values (AQRVs) from the proposed Dewey-Burdock Project at Wind Cave will be conducted using CALPUFF, which is the recommended model for long range transport applications (EPA 2005a). CALPUFF is also recommended by the Federal Land Managers (FLM) for AQRV analyses, to simulate visibility and deposition impacts on a Class I area (FLAG 2010). The most recent, EPA-approved version of CALPUFF is Version 5.8. IML Air Science will use the commercial version of CALPUFF 5.8 and CALMET 5.8 from Lakes Environmental, supplemented with CALPOST Version 6.4 to take advantage of recent visibility post-processing improvements. With its latest release, Lakes Environmental provides the option to combine CALPOST 6.4 (TRC Version 6.292) with CALPUFF Version 5.8 in order to conform to FLAG 2010 post-processing guidelines. The version of CALPOST is not tied to the version of CALPUFF.

CALPUFF is a non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain. The CALPUFF model calculates the change in light extinction caused by a source (or group of sources) as part of the regional haze calculations. The EPA has proposed the use of CALPUFF for applications involving long-range transport, which is typically defined as transport over distances beyond 50 km (IWAQM 1998).

The CALPUFF model accounts for chemical transformations that occur during plume transport using algorithms to calculate the conversion of SO_2 to sulfates and NO_x to nitrates. The IWAQM Phase 2 report (IWAQM 1998) recommended the use of the MESOPUFF II scheme, which requires the user to select additional species to be modeled, e.g., sulfates (SO_4), nitrates (NO_3) and nitric acid (HNO_3). It also requires the input of background ozone and ammonia concentrations. Although the CALPUFF model provides default values for background concentrations, values specific to the Class I area being modeled are recommended given the sensitivity of the model to these parameters (see Section 5.5.1 below). For visibility calculations, site-specific relative humidity data are also recommended in the post processing step. Monthly average relative humidity values from Wind Cave National Park will be used for the Dewey-Burdock Project modeling.

The CALPUFF Modeling System includes three main components: CALMET, CALPUFF, CALPOST, and a large set of preprocessing and postprocessing programs designed to interface the model with standard, routinely available meteorological and geophysical datasets.

5.2.1. CALMET

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. Associated two-dimensional fields such as mixing heights, surface characteristics, and dispersion properties are also included in the file produced by CALMET.

5.2.2. CALPUFF

CALPUFF is a transport and dispersion model that advects “puffs” of material emitted from modeled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by CALMET, or as an option, it may use simpler non-gridded meteorological fields explicitly incorporated in the resulting distribution of puffs throughout a simulation period. In this case it will use CALMET-generated meteorological data. The primary output files from CALPUFF contain either hourly concentrations or hourly deposition fluxes evaluated at selected receptor locations.

5.2.3. CALPOST

CALPOST is used to process these files, producing tabulations that summarize the results of the simulation (concentrations at each receptor, for example). When performing visibility related modeling, CALPOST uses concentrations from CALPUFF to compute extinction coefficients and related measures of visibility, reporting these for selected averaging times and locations.

5.3. Meteorological, Terrain and Land Use Data

Preprocessed data will be acquired for incorporation into CALMET. This will include three dimensional mesoscale data (MM5), hourly surface observations from weather stations in the modeling domain, upper air data from the National Weather Service (NWS) station at Rapid City, precipitation data, terrain elevations, and land use classifications.

5.3.1. Time Period

According to 40 CFR Part 51 Appendix W, the length of the modeled meteorological period should be long enough to ensure that the worst-case meteorological conditions are adequately represented in the model results. EPA recommends that consecutive years from the most recent, readily available 5-year period are preferred, but when mesoscale meteorological data are used (i.e., MM5) three years of modeling is acceptable (WRAP BART Modeling Protocol).These mesoscale meteorological fields should be used in conjunction with available standard NWS or comparable meteorological observations within and near the modeling domain. Therefore this modeling analysis will be conducted using 3 years (2009, 2010, 2011) of mesoscale meteorological model output data coupled with observational data from nearby surface, upper air and precipitation stations.

5.3.2. Prognostic Meteorological Data

The CALMET/CALPUFF modeling system currently includes the capability to incorporate 3-dimensional prognostic meteorological data from a mesoscale wind field model (MM5) into the processing of meteorological data through the CALMET Diagnostic Wind Model (DWM). This is most commonly accomplished by using the MM5 data as the initial guess for the wind field in CALMET. The MM5 data used in this modeling effort will span a 200 km by 200 km modeling domain centered at the Dewey-Burdock Project site, with 12-km horizontal resolution and 18 vertical layers. This data set will be obtained from Lakes Environmental.

5.3.3. CALMET Diagnostic Meteorological Data

EPA recommends using a “hybrid” CALMET, to include MM5 and weather station data (EPA 2009). EPA recommends against the use of the “no-observation” methods for CALMET (NOOBS=1, 2). The CALMET NOOBS mode is less conservative; therefore meteorological observations will be blended with the MM5 data as input to the CALMET/CALPUFF modeling system. These will include three years of hourly meteorological data from the Dewey-Burdock on-site station, the Newcastle station, and the NWS station at Chadron, NE. Three years of upper air data will be obtained from Rapid City, the only upper air station in the region. Precipitation data will be supplied by a collection of 18 weather stations in the modeling domain. Traditionally, the FLMs have recommended a CALMET grid resolution of approximately 4 km. There is concern that the increased structural detail in the horizontal wind fields resulting from application of CALMET at higher grid resolutions may lead to spurious effects on plume dispersion which may not be obvious (WRAP 2006). EPA studies show little, if any, sensitivity to the increase in grid resolution within CALMET relative to the MM5 grid resolution (EPA 2009). Therefore, a 4 km grid resolution will be used for CALMET.

5.3.4. CALMET Approach

CALMET uses a two-step approach to calculate wind fields. In the first step, an initial guess field is adjusted for slope flows and terrain blocking effects, for example, to produce a step 1 wind field. In the second step, an objective analysis is performed to introduce observational data into the Step 1 wind field. EPA recommends elimination of CALMET diagnostic adjustments to first-guess wind field (EPA 2009). EPA recommends continuation of incorporation of surface observations for radii of influence (RMAX1, RMAX2, RMAX3, R1, R2, R3) set to minimal values to preserve the integrity of prognostic meteorological data used as the first-guess wind field. These recommendations will be followed in modeling the Dewey-Burdock Project.

5.3.5. CALMET Parameter Settings

The maximum mixing height (ZIMAX) has an EPA default value of 3000 m AGL. All the other parameters are set on a case by case basis taking the terrain surrounding the observation stations into consideration.

5.3.6. Terrain Data

Gridded terrain elevations for the modeling domain are derived from 3 arc-second digital elevation models (DEMs) produced by the United States Geological Survey (USGS). The files cover 1-degree by 1-degree blocks of latitude and longitude. The elevations are in meters relative to mean sea level and have a resolution of about 90 meters. These data will be processed to generate 4 km average terrain heights that will be input into CALMET.

5.3.7. Land Use Data

Surface properties such as albedo, Bowen ratio, roughness length and leaf area index are computed proportionally to the fractional land use. The land use data is based on the Composite Theme Grid format (CTG) using Level I USGS land use categories. The 4 km land use grid will be mapped into the 14 primary CALMET land use categories.

5.3.8. CALMET Switch Settings

Most of the default switch settings for CALMET will be used. Several parameters do not have default values. Table 5-1 lists some of these key parameter settings as proposed, and as implemented in the WRAP Protocol (WRAP 2006). Appendix H documents the rationale for adjusting these switch settings from their original February 2013 values.

Table 5-1: CALMET Switch Settings

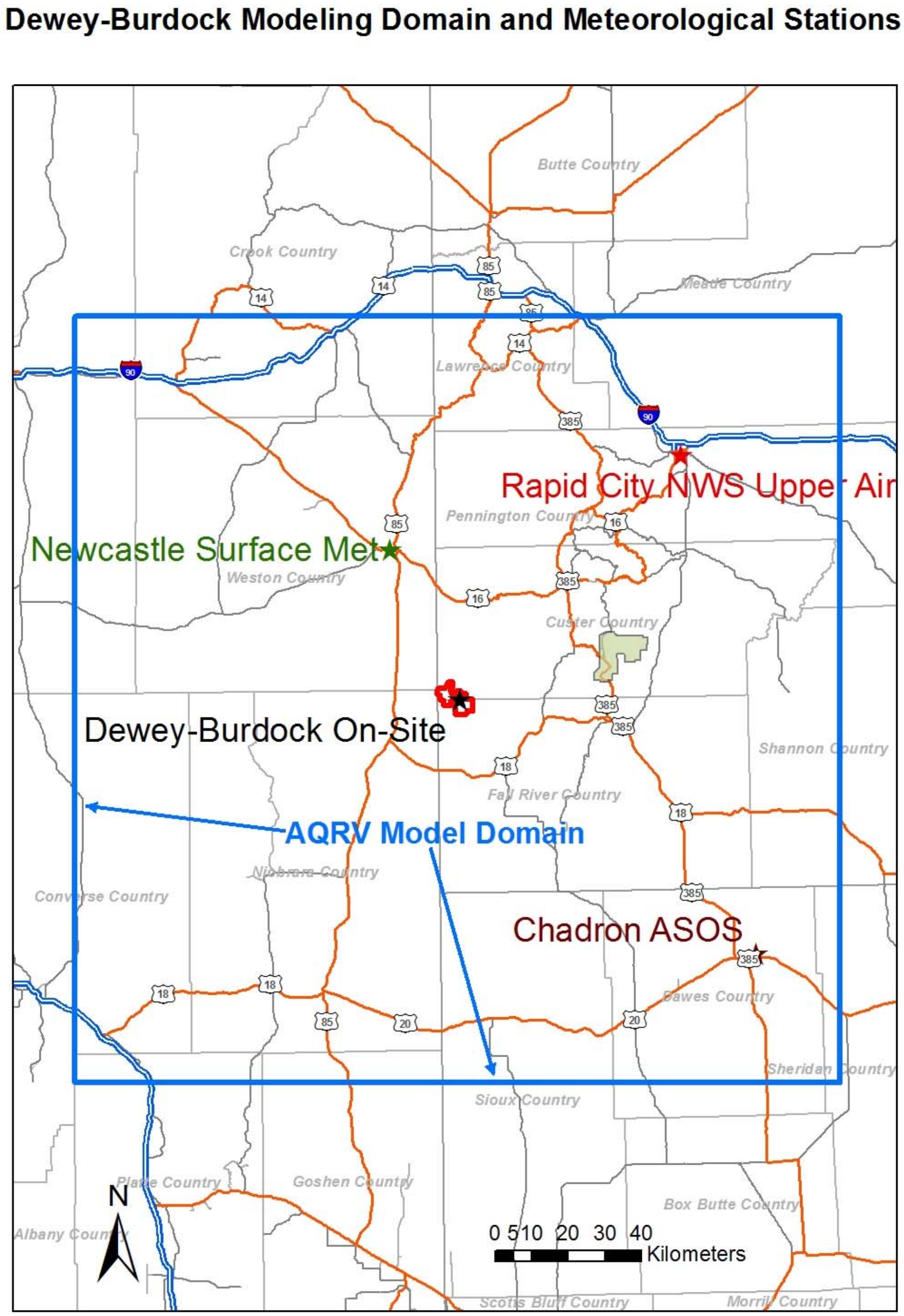
Parameter	WRAP Setting	Proposed Setting
R1MAX	50 KM	60 KM
R2MAX	100 KM	100 KM
R3MAX	100 KM	100 KM
R1	100 KM	30 KM
R2	200 KM	50 KM
ZIMAX	4500 m AGL	3000 m AGL
TERRAD	10 KM	16 KM

5.4. Modeling Domain and Receptors

Figure 5-2 shows the proposed AQRV modeling domain. In order to adequately characterize potential AQRV impacts to Wind Cave National Park, the modeling domain will extend 100 km in all directions from the Dewey-Burdock Project (200 km by 200 km grid). IWAQM recommends modeling 50 km beyond the relevant Class I boundary to provide a buffer and to account for any potential wind circulation. For Dewey-Burdock, the proposed buffer width meets this criterion.

Receptor locations and elevations for the Wind Cave National Park Class I area will be obtained from the National Park Service database in order to generate visibility data compatible with and comparable to previous modeling exercises.

Figure 5-2: Dewey-Burdock Project CALPUFF Modeling Domain and Surface Meteorological Stations



5.5. CALPUFF Model Inputs

5.5.1. Background Concentrations

CALPUFF requires ozone and ammonia background concentrations in order to characterize atmospheric chemistry. These species influence the rates of formation of sulfates and nitrates, aerosols that affect visibility.

Although a uniform background value for ozone may be adequate for small modeling domains, this modeling exercise will incorporate a time varying background. Accordingly, monthly ozone concentrations will be calculated using data from the Clean Air Status and Trends Network, or CASTNet.

For ammonia background, IWAQM recommends 1 ppb for forested lands, 10 ppb for grasslands, and 0.5 ppb for arid lands (IWAQM 1998). The relevant ammonia background is at Wind Cave National Park, not the entire modeling domain. Since the predominant land use at Wind Cave is forest, a conservative value of 1 ppb will be used in the model.

5.5.2. Chemistry Modeling

The MESOPUFF II pseudo-first-order chemical reaction mechanism (MCHEM=1) will be used for the conversion of SO_2 to sulfate (SO_4) and NO_x to nitrate (NO_3) as recommended by EPA (WRAP 2006). MESOPUFF II is a 5-species scheme in which all emissions of nitrogen oxides are simply input as NO_x. In the MESOPUFF II scheme, the conversion of SO_2 to sulfates and NO_x to nitrates is dependent on relative humidity (RH), with an enhanced conversion rate at high RH. This modeling exercise will therefore incorporate an adjustment factor for RH. Aqueous phase oxidation is currently not modeled, leading to an underestimation of sulfate formation in clouds or fog.

5.5.3. Particle Size Distribution

The dominant pollutant emitted from the Dewey-Burdock Project will be fugitive PM_{10}. Calpuff models the atmospheric dispersion and attempts to model the settling of particulate matter based on an input particle size distribution. This modeling exercise will use a PM_{10} size distribution for haul road dust taken from the Rosemont Copper Project protocol (Rosemont 2009) and based on AP-42 Section 13.2.4 (EPA 1995c). Table 5-2 lists the corresponding size distribution.

Table 5-2: Fugitive PM_{10} Particle Size Distribution

Particle Size (µm)	Fraction
2.2	0.069
3.17	0.128
6.1	0.385
7.82	0.224
9.32	0.194

All tailpipe particulate emissions will be modeled as $PM_{2.5}$.

5.5.4. CALPUFF Switch Settings

Most of the default switch settings for CALPUFF will be used, with the exception of the number of pollutants emitted and the number of chemical species modeled. Table 5-3 lists the default values and proposed values for some of the key parameter settings. The increase in number of species emitted accounts for NO_x, SO_2, PM_{10} and $PM_{2.5}$ emissions.

Table 5-3: CALPUFF Switch Settings

Parameter	Description	Default Value	Proposed Value	Notes
Group 1 – General Options				
NSPEC	Number of chemical species	5	9	
NSE	Number of species emitted	3	4	
METFM	Meteorological data format	1	1	1 = CALMET file
PGTIME	Pasquill-Gifford (PG)	60	60	Minutes
MGAUSS	Near-field vertical distribution	1	1	1 = Gaussian
MCTADJ	Terrain adjustments to plume path	3	3	3 = Partial plume path adjustment
MCHEM	Chemical mechanism	1	1	1 = MESOPUFF II chemistry
MDISP	Method for dispersion coefficients	3	3	3 = PG for rural and McElroy-Pooler (MP) for urban
MREG	Regulatory default checks	1	1	1 = Technical options must conform to EPA Long Range Transport guidance
SYTDEP	Equations used to determine sigma-y and -z	550	550	Puff size (m) beyond which equations (Heffter) are used to determine sigma y and z
MHFTSZ	Heffter equation for sigma z	0	0	0 = Not use Heffter

5.6. CALPUFF Model Outputs, Calculations and Evaluation Methods

5.6.1. CALPOST and POSTUTIL

The CALPUFF results will be post-processed using the CALPOST and POSTUTIL processors. POSTUTIL is a post processing program used to process the concentrations generated by CALPUFF. POSTUTIL occurs prior to the visibility processing in CALPOST and allows the user to sum the contributions of sources from different CALPUFF simulations into a total concentration file. Monthly RH adjustment factors will be applied directly to the background and modeled sulfate and nitrate concentrations in CALPOST.

5.6.2. Visibility Impact Determination

The general theory for performing visibility calculations with the CALPUFF modeling system is described in the Interagency Workgroup on Air Quality Modeling Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts (IWAQM 1998). The theory is also summarized in Section 5.6.4 below. Change of light extinction is the preferred metric for assessing visibility impairment. Visibility impact on a Class I area is considered significant if the source's contribution to visibility impairment, modeled as the 98th percentile of the daily (24-hour) changes in deciviews (dv), is equal to or greater than the contribution threshold of 0.5 dv (FLAG 2010). Stated differently, a source can be reasonably anticipated to cause or contribute to an impairment of visibility if the 98th percentile of the distribution of modeled changes in light extinction is greater than 0.5 dv. Changes in visibility at Wind Cave National Park will be calculated from the Dewey-Burdock Project model outputs and reported in terms of the 98th percentile change in dv at each modeled receptor, as well as the total light extinction at each receptor.

5.6.3. Comparison to Existing AQRV Status

Assessing some Air Quality Related Values (e.g., crop injury, or visibility effects) is fundamentally tied to knowing the current stress being exerted on the system. This is reflected in the current background visibility. Assessing the response of a resource is related to the cumulative effects of all the current existing stresses (IWAQM 1998). The evaluation of the Dewey-Burdock modeling results will therefore consider the current visual resource and visibility impairment at Wind Cave National Park. Studies conducted by the National Park Service and the Western Regional Air Partnership (WRAP) will provide references for current conditions.

5.6.4. Calculation of Light Extinctions

The calculation of regional visibility impacts in CALPUFF takes into account the scattering of light caused by several particulate matter (PM) constituents in the atmosphere. This scattering of light is referred to as extinction. The PM constituents that are accounted for in the visibility calculations include ammonium sulfate, ammonium nitrate, organic carbon, elemental carbon, soil, and coarse and fine PM. The CALPUFF model calculates the light extinction attributable to a source's emissions and compares it to the extinction caused by the background constituents to estimate a change in extinction.

The extinction caused by a source's emissions is affected by several factors. One such factor is the formation of light scattering constituents by chemical transformation during plume transport, e.g., conversion of SO_2 to sulfates and NO_x to nitrates. These chemical transformations are dependent on the level of available gaseous ammonia and ozone in the atmosphere, i.e., the higher the ammonia and ozone concentration in the air, the greater the transformation, and hence the greater the light extinction. Since sulfates and nitrates are hygroscopic in nature, the light extinction caused by these constituents is also affected by relative humidity (RH). The other PM constituents are considered to be non-hygroscopic. The visibility analysis will be conducted using monthly average relative humidity adjustment factors, or f(RH) values.

The CALPOST postprocessor will be used for the calculation of the impact from the modeled source's primary and secondary particulate matter concentrations on light extinction. The formula that is used is the existing IMPROVE/EPA formula, which is applied to determine a change in light extinction due to increases in the particulate matter component concentrations. Using the notation of CALPOST, the formula is the following:

B_{ext} = 2.2 x fS(RH) x [Small Sulfates] + 4.8 x fL(RH) x [Large Sulfate]
+ 2.4 x fS(RH) x [Small Nitrates] + 5.1 x fL(RH) x [Large Nitrates]
+ 2.8 x [Small Organic Mass] + 6.1 x [Large Organic Mass]
+ 10 x [Elemental Carbon]
+ 1 x [Fine Soil]
+ 0.6 x [Coarse Mass]
+ 1.7 x fSS(RH) x [Sea Salt]
+ [Rayleigh Scattering]
+ 0.33 x [NO2 (ppb)]

The concentrations, in square brackets, are in $\mu g/m^3$ and b_{ext} is in units of inverse megameters or Mm-1. The Rayleigh scattering term will be set to the value of 10 Mm-1, the default value recommended in EPA guidance for tracking reasonable progress (WRAP 2006).

Each hour's source-caused extinction is calculated by first using the hygroscopic components of the source caused concentrations, due to ammonium sulfate and nitrate, and monthly f(RH) values specific to Wind Cave National Park. The contribution to the total source-caused extinction from ammonium sulfate and nitrate is then added to the other, non-hygroscopic components of the particulate concentration to yield the total hourly source caused extinction. The terms fS(RH), fL(RH) and fSS(RH) are relative humidity adjustment factors for small particles, large particles and sea salts respectively. These values will be taken from the Federal Land Managers Air Quality Related Values Workgroup Phase 1 Report Revised Draft Table V.1-2, V.1-3 and V1.-4 (FLAG 2008) which list f(RH) values for each Class I area.

5.6.5. Deposition Analysis

Atmospheric deposition includes wet and dry fluxes of the pollutants modeled ($g/m^2/sec$), represented as sulfur and nitrogen calculated in pollutant-specific runs of CALPOST. Modeled fluxes are for the modeled species and do not directly represent the mass flux of either sulfur or nitrogen. Adjustments are therefore made for the ratio of molecular weight of S and N vs. the molecular weight of the species modeled (SO_2, SO_4, NO_x, HNO_3, NO_3). The deposition flux of sulfur includes contributions from any modeled sulfur compounds. The deposition flux of nitrogen includes contributions from any modeled nitrogen compounds.

The CALPUFF output files will contain the wet and dry deposition fluxes of both primary and secondary species. The wet and dry fluxes must be added to obtain the total flux of each species, at each receptor, each hour. The POSTUTIL processor will be configured to sum the wet and dry fluxes, and to compute the total sulfur and nitrogen contributed by the modeled species for subsequent CALPOST processing.

5.6.6. CALPOST Switch Settings

Table 5-4 lists default and proposed values for key parameters for CALPOST. The maximum relative humidity will be lowered from 98% to 95% based on recent FLM guidance (FLAG 2008). The default value for LVPMC is "True," indicating that coarse particulate matter ($PM_{10-2.5}$) is included in the visibility model. CALPOST will also be run with LVPMC set to "False." Both sets of results will be presented. The differences between these two modes and the rationale for evaluating both are discussed in conjunction with the visibility modeling results in Section 7.2.3.

5.7. Presentation of Modeling Results

The purpose of the AQRV modeling outlined in this protocol is to disclose impacts from emissions at the Dewey-Burdock Project to Air Quality Related Values (AQRV) at the nearby Class I area, Wind Cave National Park. The final impact analysis will present all predicted impacts from the project, and compare these predictions to background conditions. The visibility impact analysis will include the 98^{th} percentile of the 24-hour changes in haze index (deciviews), and an isopleth map of the total light extinction (background plus project-induced) at Wind Cave. It will also include an isopleth map showing maximum nitrogen and sulfur deposition at Wind Cave, with a table comparing modeled deposition rates to monitored conditions, significance thresholds and critical loads.

Table 5-4: CALPOST Switch Settings

Parameter	Description	Default Value	Proposed Value	Notes
Group 1				
ASPEC	Species to process	No Default	VISIB	Visibility processing
Group 2				
MFRH	Particle growth curve f(RH)	4	4	4 = IMPROVE (2006) f(RH) tabulations for sea salt and for sulfate and nitrate
RHMAX	Maximum relative humidity (%) in growth curve	98	95	FLAG (2008) guidance
Modeled Species				
LVSO4	Include sulfate	T	T	
LVNO3	Include nitrate	T	T	
LVNO2	Include nitrogen dioxide absorption	T	T	
LVOC	Include organic carbon	T	T	
LVPMC	Include coarse particulates	T	T	
LVPMF	Include fine particulates	T	T	
LVEC	Include elemental carbon	T	T	
Extinction Efficiency				
EEPMC	Particulate matter coarse	0.6	0.6	
EEPMF	Particulate matter fine	1.0	1.0	
EEPMCBK	Particulate matter coarse background	0.6	0.6	Background particulate species
EESO4	Ammonium sulfate	3.0	3.0	
EENO3	Ammonium nitrate	3.0	3.0	
EEOC	Organic carbon	4.0	4.0	
EESOIL	Soil	1.0	1.0	
EEEC	Elemental carbon	10.0	10.0	

6 AERMOD MODELING RESULTS AND ANALYSIS

6.1. Introduction

The stationary and fugitive emission sources at the Dewey-Burdock Project will produce particulate matter smaller than ten microns in size (PM_{10}) and particulate matter smaller than 2.5 microns in size ($PM_{2.5}$). Stationary and mobile sources will emit PM_{10}, $PM_{2.5}$, carbon monoxide (CO), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). It was assumed that 75% of NO_x emissions will be converted to NO_2. Thus, five criteria pollutants (PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2) were analyzed for compliance with the NAAQS using the AERMOD dispersion modeling software. For disclosure purposes four of these pollutants, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were further analyzed for comparison to the allowable PSD increments in Class I and Class II areas. For each scenario, emissions from all 34 on-site and off-site emission sources identified and quantified in the Dewey-Burdock Project emissions inventory (Figures 6-2 and 6-3), were modeled. Each model run, with the exception of a “dry depletion” run discussed in Section 6.2 below, produced maximum pollutant concentrations and related statistics at all 4,220 receptors in the 110-km by 110-km modeling domain (Figure 6-1).

Table 6-1 summarizes the results of the AERMOD model runs for all pollutants and relevant averaging intervals. All results are presented in the format of the applicable NAAQS, referred to as design values. Predicted total ambient concentrations are computed as the sum of the design-value project impacts and the background concentrations. The last three column headings are meant to be exclusive. For 24-Hr PM_{10}, the three columns correspond to the top 3 daily averages over the 3-year period. They do not necessarily fall in separate years. For the annual PM_{10} and all other pollutants, the columns correspond to design values in years 2009, 2010 and 2011. The separate contexts implied by the column headings reflect the way the overall statistic is calculated. For 24-Hr PM_{10}, the relevant statistic is the 4^{th} high over 3 years, so the top 3 values are of interest regardless of when they occurred. In all other cases, the relevant statistic is an average of the value from each year, so the 3 yearly values are of interest.

Sections 6.2 through 6.6 discuss results in detail for each of the five criteria pollutants listed in Table 6-1. All receptors were predicted to be in compliance with all NAAQS as reflected in Table 6-1. Receptors exceeding the 24-hour PM_{10} standard in the initial run were further modeled in a refined analysis, with the dry depletion option enabled in AERMOD. The refined analysis predicted compliance with the NAAQS at all receptors.

Table 6-2 compares model predictions with PSD Class I and Class II increments. Although the Dewey-Burdock Project is not a major source and therefore does not meet the criteria for PSD regulation, these results are presented for disclosure purposes. It can be seen from Table 6-2 that all potential Class I impacts fell below the associated PSD increment. In general, potential Class II impacts were also below the PSD increment throughout the modeling domain. However, limited exceedances of the 24-hour PM_{10} Class II increment were predicted in close proximity to project emission sources. Receptors with predicted values above the increment were confined to a narrow corridor along the public road and the northwestern portion of the project boundary (see Section 6.2).

Figures 6-2 and 6-3 show the source configuration for modeling Dewey-Burdock Project emissions in AERMOD. Section 6.2 discusses the initial and refined PM_{10} modeling results. Sections 6.3 through 6.6 discuss modeling results for $PM_{2.5}$, NO_2, SO_2 and CO.

Table 6-1: Summary of Predicted Pollutant Concentrations (AERMOD)

Pollutant	Averaging Interval and Statistic	Ambient Impact (µg/m^3)	Back-ground (µg/m^3)	Total Ambient Concentration (µg/m^3)	NAAQS Limit (µg/m^3)	Receptor (UTM Easting, Northing)	1st Year Statistic (1st High for 24-Hr PM_{10})	2nd Year Statistic (2nd High for 24-Hr PM_{10})	3rd Year Statistic (3rd High for 24-Hr PM_{10})
PM_{10} Initial Run (No Dry Depletion)	Annual Average	8.8	--	--	--	582358, 4810210	--	--	--
	4th High 24-Hr Maximum	187.2	41.0	228.2	150	590758, 4801610	263.1	217.9	194.4
PM_{10} Final Run (Top 50 Receptors With Dry Depletion)	Annual Average	5.8	--	--	--	590758, 4802110	5.5	6.1	6.0
	4th High 24-Hr Maximum	83.6	41.0	124.6	150	589258, 4802410	116.1	94.9	84.2
$PM_{2.5}$	Annual Average	1.0	4.8	5.8	12	577137, 4815932	--	--	--
	24-Hr High	6.9	10.9	17.8	35	577137, 4815932	7.9	7.5	5.3
NO_2	Annual Average	1.1	0.4	1.5	100	576358, 4816510	--	--	--
	98th Percentile of Daily 1-Hr Highs	156.9	5.6	162.5	187	577137, 4815932	191.6	159.8	119.2
SO_2	Annual Average	0.2	--	--	--	577137, 4815932	--	--	--
	24-Hr	12.6	--	--	--	576358, 4816510	--	--	--
	3-Hr	100.1	20.9	121.0	1300	576358, 4816510	--	--	--
	99th Percentile of Daily 1-Hr Highs	48.3	15.7	63.9	200	577137, 4815932	58.5	50.1	36.2
CO	8-Hr High	262.6	315.5	578.1	10000	576358, 4816510	--	--	--
	1-Hr High	2101.1	1097.3	3198.4	40000	576358, 4816510	--	--	--

Table 6-2: Summary of PSD Increment Comparisons (AERMOD)

Pollutant	Averaging Interval and Statistic	Class I Impact	Allowable Class I PSD Increment	Class II Impact	Allowable Class II PSD Increment
PM_{10} Initial Run (No Dry Depletion)	Annual Average	0.05	4	8.8	17
	4th High 24-Hr Maximum	1.95	8	187.2	30
PM_{10} Final Run (Top 50 Receptors With Dry Depletion)	Annual Average	--	4	5.8	17
	4th High 24-Hr Maximum	--	8	83.6	30
$PM_{2.5}$	Annual Average	0.01	1	1.0	4
	24-Hr High	0.05	2	6.9	9
NO_2	Annual Average	0.01	2.5	1.1	25
	98^{th} Percentile of Daily 1-Hr Highs	1.16	--	156.9	--
SO_2	Annual Average	0.00	2	0.2	20
	24-Hr	0.25	5	12.6	91
	3-Hr	1.64	25	100.1	512
	99^{th} Percentile of Daily 1-Hr Highs	0.51	--	48.3	--
CO	8-Hr High	4.12	--	262.6	--
	1-Hr High	19.48	--	2101.1	--

Figure 6-1: AERMOD Modeling Domain and Receptors

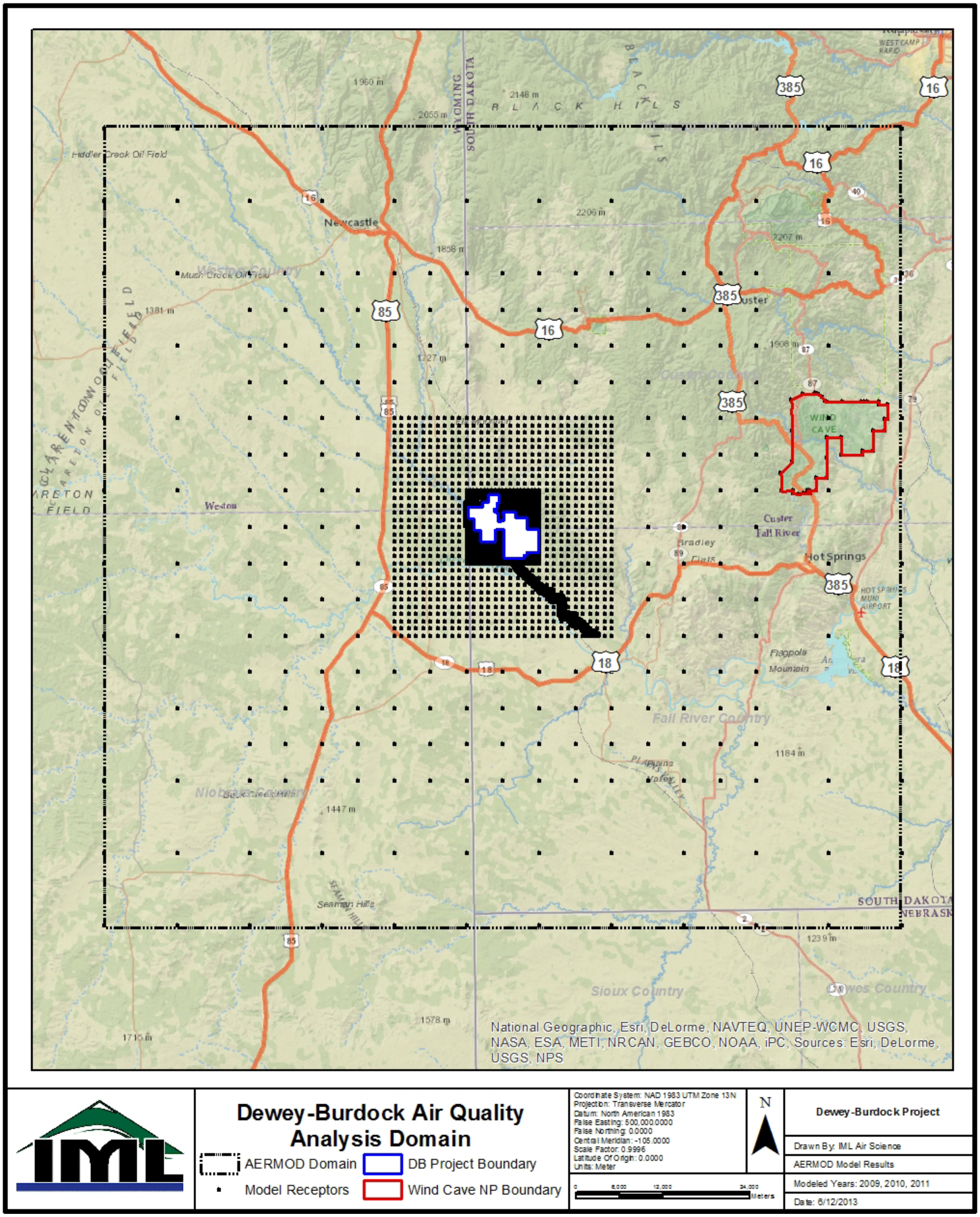


Figure 6-2: Dewey-Burdock Project Modeled Emission Sources

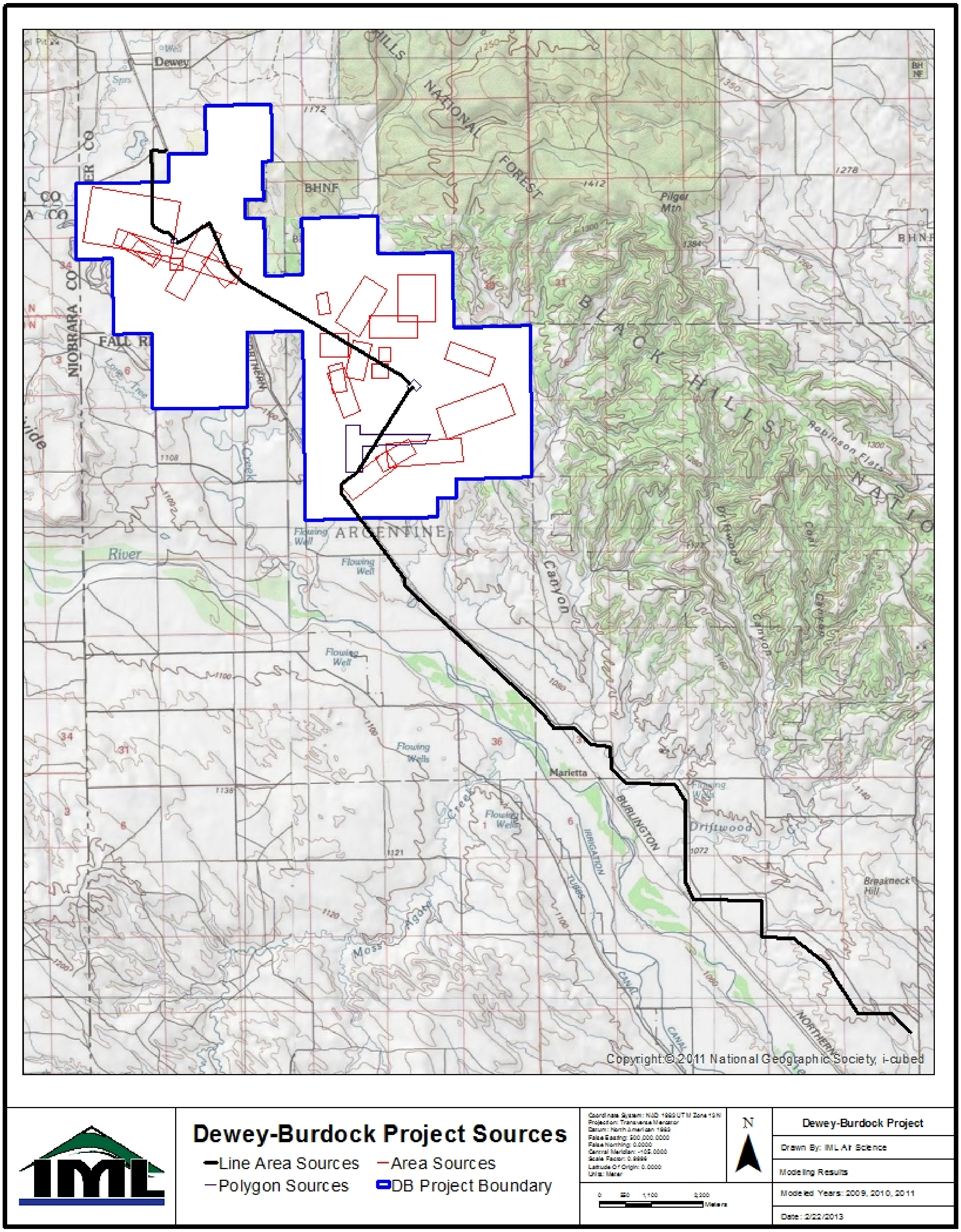
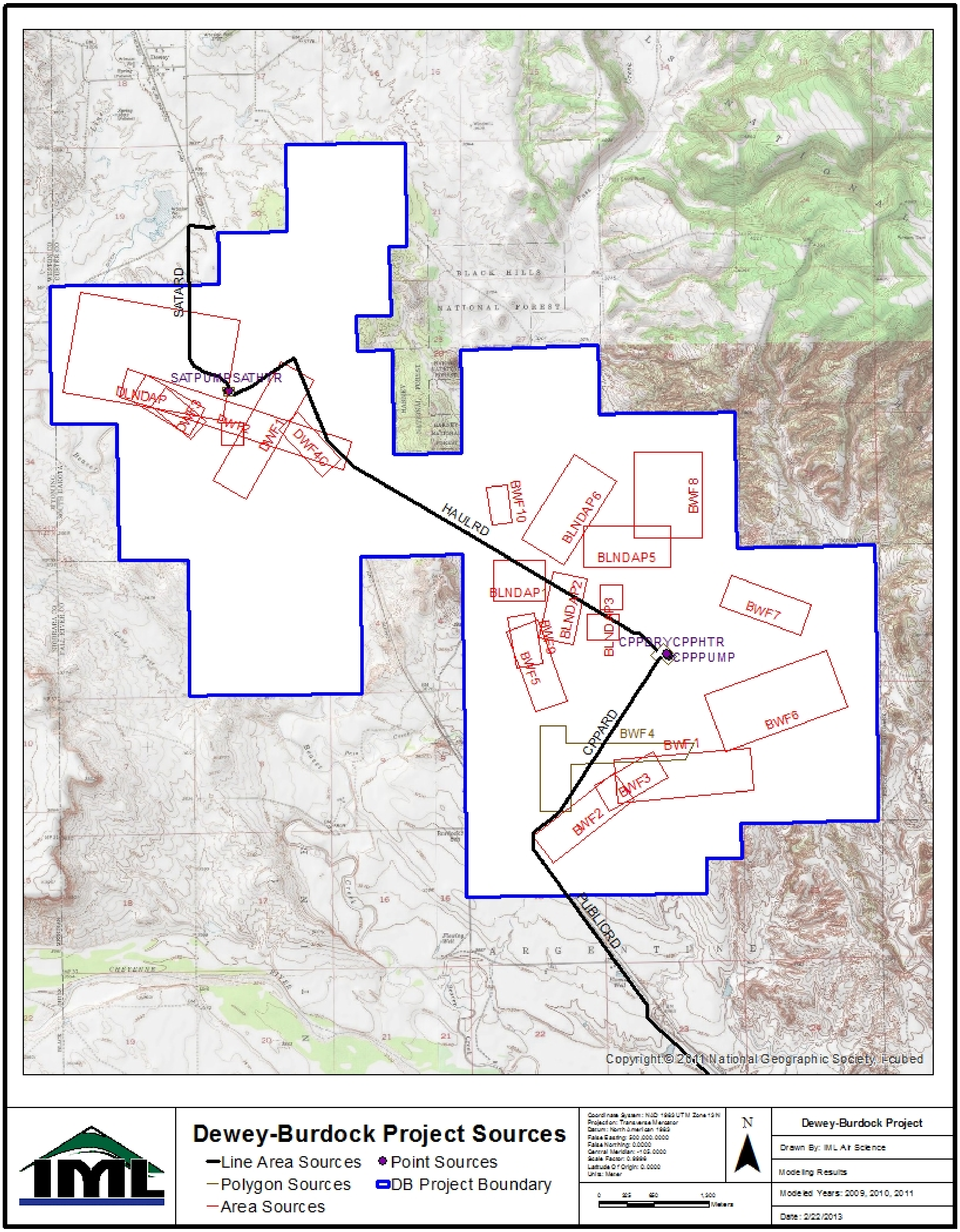


Figure 6-3: Dewey-Burdock Project Modeled Emission Source Detail



6.2. PM_{10} Modeling Analysis

Particulate matter in the form of PM_{10} emissions will constitute the single largest air pollutant from the proposed Dewey-Burdock Project. The primary source of PM_{10} emissions will be fugitive dust generated by traffic on unpaved roads, road maintenance, drilling and construction activities, and wind erosion on disturbed areas. A small fraction of the total PM_{10} emissions will be generated by internal engine fuel combustion. Nearly all of these combustion emissions will also qualify as $PM_{2.5}$ (particles with aerodynamic diameter less than 2.5 microns). Accordingly, the outcome of this PM_{10} modeling study is driven by ground-level sources of fugitive dust.

The maximum yearly PM_{10} emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used, based on month, day and hour. The model produced maximum receptor concentrations for any calendar day (24-hr average) and for the entire modeling period (annual average). In order to characterize worst-case, short-term impacts, the modeling period spanned three years of hourly meteorological conditions.

6.2.1. Initial PM_{10} Modeling Results

PM_{10} results from the initial AERMOD run are presented below. Table 6-3 lists the top 20 receptors ranked by annual average concentrations. Table 6-4 lists the top 50 receptors ranked by 4th high, 24-hour concentrations (consistent with the NAAQS format). Figure 6-4 is an isopleth, or contour plot of the predicted annual concentrations attributable to the Dewey-Burdock Project. Figure 6-5 is an isopleth map of the predicted maximum 24-hr concentrations attributable to the Dewey-Burdock Project.

Table 6-3 shows all receptors were well below the previous annual NAAQS of 50 $\mu g/m^3$ (standard no longer exists). None of the 4,220 receptors had modeled concentrations above the annual, Class II PSD increment of of 17 $\mu g/m^3$. None of the Wind Cave receptors were above the annual Class I PSD increment (Table 6-2). Table 6-4 shows the top 50 receptors which, with a background of 41 $\mu g/m^3$ added to modeled impacts, exceeded the 24-hr NAAQS of 150 $\mu g/m^3$. Figure 6-6 illustrates the proximity of the top 10 receptors to the fugitive PM_{10} emission sources. All of the modeled values above 109 μg/m^3 (150 μg/m^3 with background) occurred at receptors less than 500 meters from the Dewey-Burdock Project boundary and the public road over which commuter traffic would access the project. All receptor concentrations at Wind Cave National Park were in compliance with the 24-hr NAAQS and were below the 24-hr, Class I PSD increment (Tables 6-1 and 6-2).

Table 6-3: Top 20 Receptors, Annual Average PM_{10} Concentrations

UTM Easting	UTM Northing	Maximum Modeled Concentration (μg/m^3)	PSD Class II Increment (μg/m^3)
582358	4810210	8.77	17
590758	4801610	8.61	17
583158	4809110	8.45	17
586258	4806010	8.43	17
590758	4802110	8.40	17
582258	4810310	8.26	17
582558	4809910	8.21	17
590758	4802010	8.06	17
590758	4801710	8.03	17
582158	4810410	8.02	17
589258	4802410	7.91	17
577137	4815932	7.89	17
582858	4809510	7.88	17
586958	4805710	7.86	17
585658	4806610	7.85	17
585358	4806910	7.82	17
585558	4806710	7.80	17
582131	4810420	7.80	17
587558	4805410	7.78	17
584458	4807710	7.77	17

Table 6-4: Top 50 Receptors, 24-Hr Maximum PM_{10} Concentrations (Initial Run)

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
590758	4801610	187.22	228.22	150
589258	4802410	165.46	206.46	150
583158	4809110	159.01	200.01	150
586158	4806110	145.93	186.93	150
589158	4802510	145.34	186.34	150
587558	4805110	145.07	186.07	150
590758	4801710	144.29	185.29	150
586258	4806010	142.54	183.54	150
590658	4801610	142.13	183.13	150
589158	4802610	138.31	179.31	150
586058	4806210	135.01	176.01	150
585958	4806210	134.80	175.80	150
590658	4801710	134.65	175.65	150
586958	4805710	132.62	173.62	150
586058	4806110	131.81	172.81	150
589058	4802610	130.61	171.61	150
576358	4816649	128.57	169.57	150
590558	4801610	128.56	169.56	150
587658	4804910	125.31	166.31	150
590758	4801810	124.54	165.54	150
583158	4809010	123.62	164.62	150
587358	4805010	122.61	163.61	150
589158	4802410	122.38	163.38	150
590558	4801710	122.19	163.19	150
576358	4816610	121.24	162.24	150
587558	4805210	119.96	160.96	150
587458	4805210	119.52	160.52	150
585958	4806310	118.34	159.34	150
586858	4805710	117.47	158.47	150
577139	4815832	117.42	158.42	150
587558	4805010	117.39	158.39	150
590758	4802110	117.10	158.10	150
587458	4805310	116.32	157.32	150
576158	4816710	115.42	156.42	150

585858	4806410	114.51	155.51	150
582958	4809210	114.36	155.36	150
576258	4816710	114.04	155.04	150
587558	4804910	112.00	153.00	150
592658	4800010	111.51	152.51	150
583058	4809110	111.25	152.25	150
582658	4810210	110.84	151.84	150
577137	4815932	110.73	151.73	150
589158	4802710	110.19	151.19	150
589058	4802710	110.10	151.10	150
585358	4806910	109.96	150.96	150
576958	4815710	109.95	150.95	150
587458	4805110	109.92	150.92	150
587458	4805010	109.85	150.85	150
591158	4801810	109.49	150.49	150
586658	4806210	109.31	150.31	150

Figure 6-4. Annual Average PM_{10} Concentrations (Without Background)

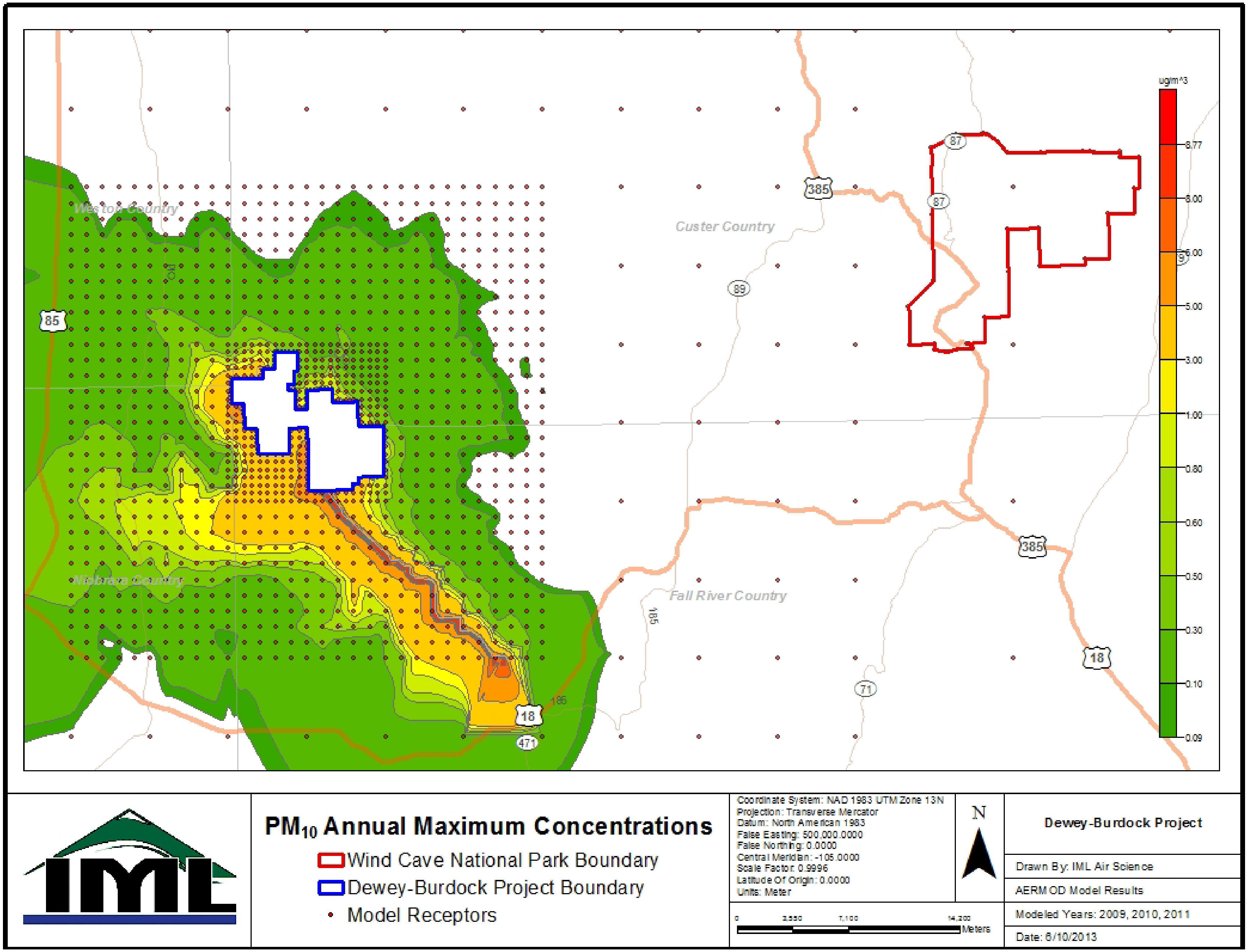


Figure 6-5. Maximum 24-Hour Average PM_{10} Concentrations (Without Background)

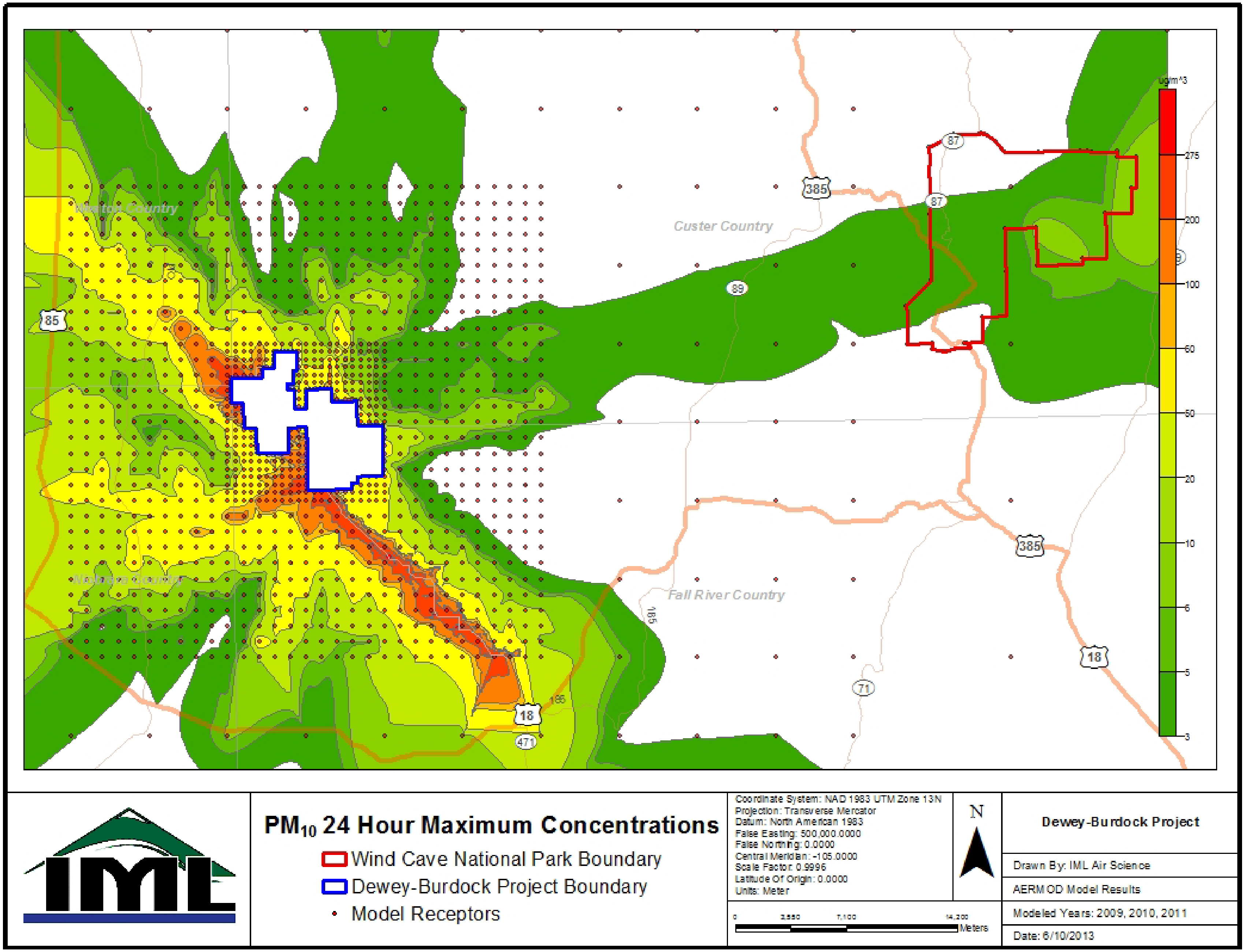
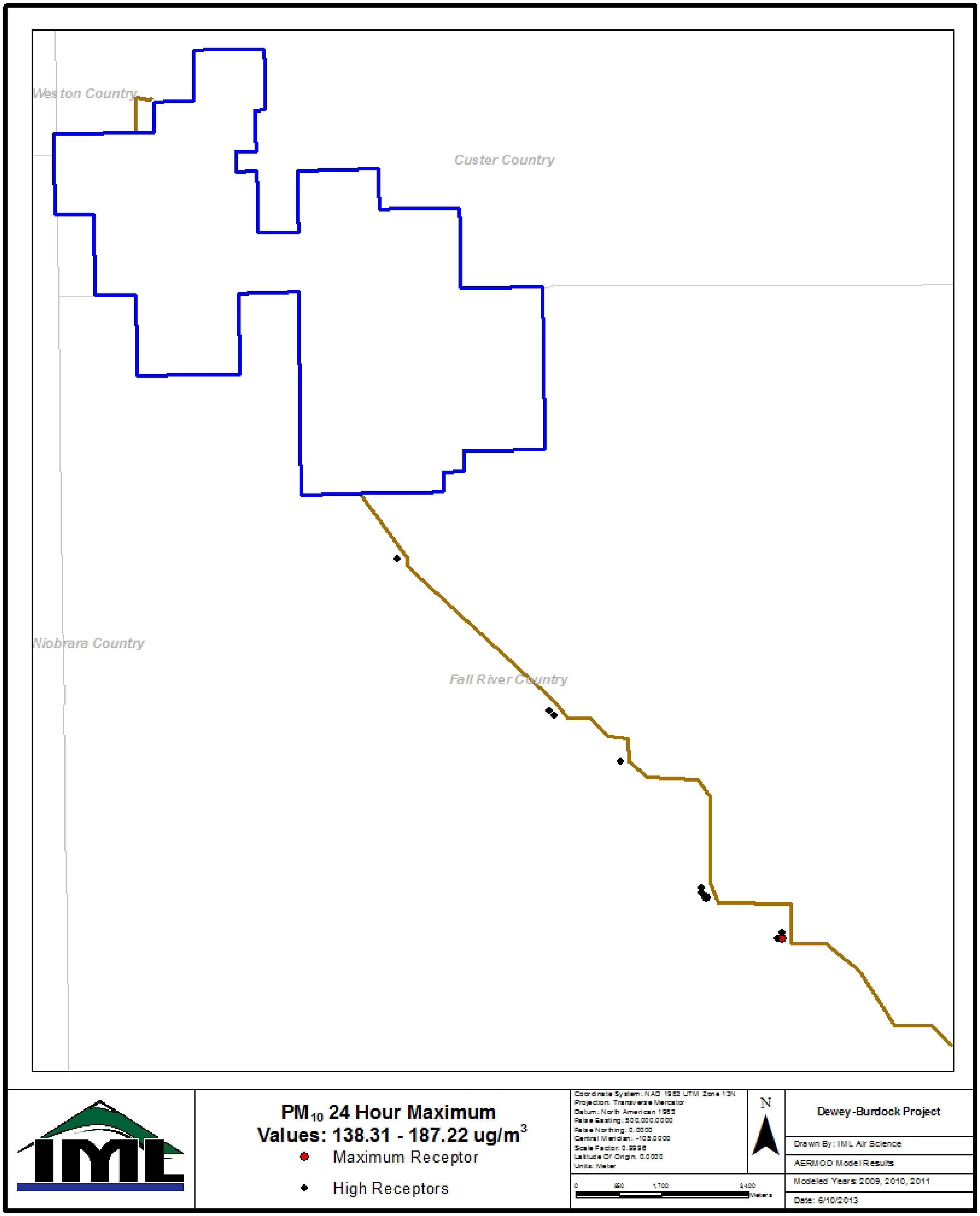


Figure 6-6. Modeled 24-Hour PM_{10} (Top 10 Receptors Without Dry Depletion, no Background)



6.2.2. PM_{10} Model Over-Prediction Problems

These modeling results reflect AERMOD's tendency to over-predict the transportability and the resultant air quality impacts of fugitive dust emissions (Cliffs 2011). Among several possible causes, predicted concentrations do not account for particle electrostatic agglomeration, enhanced gravitational settling and deposition near the point of release (AECOM 2012).

This tendency was exposed in ISCST3, the regulatory model that preceded AERMOD. Although AERMOD improved on many of ISCST3's features, these improvements were confined primarily to stationary sources and buoyant plumes. Even with the improvements to AERMOD, the problem of over-predicting 24-hr PM_{10} impacts from fugitive dust persists (Sullivan 2006). For low-level emission plumes, AERMOD has not been evaluated extensively by EPA for performance against measured data. In 2011 MMA conducted a modeling analysis to determine whether EPA's current model (AERMOD) would yield significant improvements over the ISC3 Short Term model in the prediction of short-term particulate concentrations for surface mining operations. The study found that AERMOD still over-predicts short-term PM_{10} concentrations, and even exceeds the predictions of ISCST3 at model receptors positioned from 100 to 500 meters from the sources of fugitive emissions (MMA 2011). The study concludes that AERMOD "consistently predicts concentrations higher than ISCST in the range of concentrations that would be critical decision points in the permitting process."

6.2.3. Refined PM_{10} Modeling Results

In an attempt to address the problem of over-predicting impacts from fugitive dust at the Dewey-Burdock project, AERMOD was re-run for impacts at select receptors using the dry depletion option. This option, also available with ISCST3, seeks to account for particulate deposition near the source. It requires the user to input particle densities and size distributions. The receptors modeled with dry depletion included all 50 receptors that, with background concentrations added, exceeded the 24-hr PM_{10} NAAQS in the initial model run. It was not realistic to use this option for the initial run, as modeling impacts on all receptors in the modeling domain would have required several hundred hours to execute.

With the dry depletion option enabled, AERMOD predicted significantly lower 24-hr PM_{10} impacts as summarized in Table 6-5. The highest design-value concentration was reduced from 187.2 to 83.6 μg/m^3. With background added, all 50 receptors were in compliance with the NAAQS. The refined model predicted 24-hour impacts greater than the Class II PSD increment of 30 μg/m^3 within 500 meters of the project boundary or the public road. Figure 6-7 shows the locations of these receptors.

To determine model sensitivity to PM_{10} source type segregation, an additional AERMOD model run was conducted for these same 50 receptors with only combustion sources of PM_{10}. The dry depletion option was disabled in this model run since these combustion sources are not fugitive dust sources and associated particle sizes are much smaller. The predicted increase in 24-hour PM_{10} concentration at the highest receptor was 1.27 μg/m^3, or 1% of the predicted total concentration at this receptor. This exercise confirmed the minor influence of combustion sources on predicted PM_{10} concentrations, and supported the aggregation of both source types into each modeled area source.

Although EPA decided to not make the dry deposition algorithm a regulatory default modeling option, it recommended its use in appropriate instances (EPA 2005a) as enumerated below:

1. Large number of PM_{10} fugitive sources
2. Source emissions can be quantified
3. Settling and deposition are anticipated to occur
4. A refined modeling analysis is being conducted

The Dewey-Burdock Project meets all of these criteria, as detailed in the modeling protocol (Section 3.9) above.

Notwithstanding the uncertainties in modeling short-term impacts from fugitive dust sources, Powertech intends to adopt several control strategies to reduce actual impacts:

1. Apply water spray frequently to project-area roads and exposed areas.
2. Reduce commuter traffic over the unpaved county road by providing company vans and incentivizing carpool arrangements.
3. Install particulate monitors as needed to determine background ambient air quality and downwind impacts from the project.

4. Assist Fall River County with maintenance and the application of dust suppressant on the unpaved public road. It is worth noting that a study conducted in December of 2012 by the Fall River County Highway Department found that existing traffic on the public road averages 225 vehicles per day (Fall River 2013). By comparison, the traffic count from the Dewey-Burdock Project during the modeled year is predicted to be 55 vehicles per day.

The modeling results reported here already incorporate the first two strategies. The third strategy will eventually enable the evaluation of short-term dispersion model performance. The fourth strategy has been initiated under a cooperative agreement between Powertech and the County.

Table 6-5: Top 50 Receptors, 24-Hr Maximum PM_{10} Values With Dry Depletion

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	Maximum Concentration with Background (µg/m³)	NAAQS Concentration (µg/m³)
589258	4802410	83.61	124.61	150
590758	4801610	74.48	115.48	150
582658	4810210	65.34	106.34	150
583158	4809110	63.91	104.91	150
590658	4801610	61.24	102.24	150
590758	4801710	59.36	100.36	150
592658	4800010	57.63	98.63	150
586258	4806010	54.52	95.52	150
589158	4802610	53.12	94.12	150
587558	4805210	52.85	93.85	150
583158	4809010	51.98	92.98	150
590758	4801810	51.54	92.54	150
589158	4802710	50.37	91.37	150
590658	4801710	49.92	90.92	150
586158	4806110	49.43	90.43	150
587558	4805110	48.00	89.00	150
583058	4809110	47.60	88.60	150
586658	4806210	47.38	88.38	150
589158	4802510	47.29	88.29	150
590758	4802110	47.10	88.10	150
586958	4805710	46.85	87.85	150
577137	4815932	46.30	87.30	150
587658	4804910	45.86	86.86	150
590558	4801610	44.77	85.77	150
585358	4806910	44.51	85.51	150
586058	4806110	43.94	84.94	150
586058	4806210	43.91	84.91	150
586858	4805710	42.19	83.19	150
589158	4802410	42.19	83.19	150
585958	4806310	42.12	83.12	150
587458	4805310	41.96	82.96	150
577139	4815832	40.60	81.60	150
585858	4806410	40.42	81.42	150
585958	4806210	40.23	81.23	150
590558	4801710	38.86	79.86	150
587558	4805010	38.64	79.64	150
589058	4802710	37.76	78.76	150

582958	4809210	37.27	78.27	150
591158	4801810	36.19	77.19	150
587558	4804910	35.64	76.64	150
587458	4805210	34.62	75.62	150
589058	4802610	33.87	74.87	150
587458	4805110	33.30	74.30	150
576958	4815710	32.48	73.48	150
587458	4805010	32.09	73.09	150
587358	4805010	28.80	69.80	150
576358	4816610	25.41	66.41	150
576358	4816649	24.41	65.41	150
576258	4816710	22.48	63.48	150
576158	4816710	20.99	61.99	150

Figure 6-7. Modeled 24-Hour PM_{10} (Top 45 Receptors With Dry Depletion, No Background)