From: John Mays
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Subject: Final Air Modelling Report and Protocol (2 of 3)
Date: Thursday, July 11, 2013 3:50:47 PM
Attachments: Dewey-Burdock Final Modeling Protocol and Results Part 2.pdf

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Mr. Burrows,

Part 2 of 3. Part 2 of the Report text.

John

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6.3. $PM_{2.5}$ Modeling Analysis

Particulate matter in the form of $PM_{2.5}$ emissions were modeled in a similar fashion to PM_{10} emissions. The primary source of $PM_{2.5}$ emissions will be the smaller fugitive dust particles generated by traffic on unpaved roads, road maintenance, drilling and construction activities, and wind erosion on disturbed areas. A small fraction of the total $PM_{2.5}$ emissions will be generated by internal engine fuel combustion.

The maximum yearly $PM_{2.5}$ 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). The 24-hour design value was computed for each receptor as the three-year average of the 8th high (98th percentile) concentration.

6.3.1. $PM_{2.5}$ Modeling Results

Results from the AERMOD model run are presented below. The model predicted NAAQS compliance for all receptors and averaging intervals. All receptor concentrations were predicted to be less than the applicable (Class I or Class II) PSD increments. Table 6-6 lists the top 20 receptors ranked by predicted annual average concentrations. Table 6-7 lists the top 50 receptors ranked by predicted 24-hour maximum concentrations. Figure 6-8 is an isopleth, or contour plot of the predicted annual concentrations attributable to the Dewey-Burdock Project. Figure 6-9 is an isopleth map of the predicted, maximum 24-hr impacts attributable to the Dewey-Burdock Project.

Table 6-6: Top 20 Receptors, Annual Average $PM_{2.5}$ Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
577137	4815932	1.02	5.82	12
577067	4815933	0.94	5.74	12
577139	4815832	0.94	5.74	12
582358	4810210	0.92	5.72	12
577058	4815910	0.92	5.72	12
582258	4810310	0.88	5.68	12

576967	4815934	0.88	5.68	12
590758	4801610	0.87	5.67	12
583158	4809110	0.87	5.67	12
582158	4810410	0.86	5.66	12
586258	4806010	0.86	5.66	12
582558	4809910	0.86	5.66	12
576958	4815910	0.85	5.65	12
590758	4802110	0.85	5.65	12
577058	4815810	0.85	5.65	12
582131	4810420	0.84	5.64	12
577141	4815732	0.84	5.64	12
590758	4802010	0.82	5.62	12
590758	4801710	0.82	5.62	12
582858	4809510	0.82	5.62	12

Table 6-7: Top 50 Receptors, 98th percentile of 24-Hr Maximum $PM_{2.5}$ Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
577137	4815932	6.90	17.80	35
582358	4810210	6.69	17.59	35
583158	4809110	6.65	17.55	35
582158	4810410	6.55	17.45	35
582131	4810420	6.47	17.37	35
577139	4815832	6.45	17.35	35
590758	4801610	6.45	17.35	35
577067	4815933	6.45	17.35	35
582258	4810310	6.42	17.32	35
582558	4809910	6.38	17.28	35
577058	4815910	6.33	17.23	35
583258	4808810	6.27	17.17	35
589158	4803410	6.20	17.10	35
589158	4803310	6.15	17.05	35
585658	4806610	6.10	17.00	35
584458	4807710	6.07	16.97	35
586258	4806010	6.03	16.93	35
590758	4802010	5.98	16.88	35
583358	4808710	5.98	16.88	35

583458	4808610	5.94	16.84	35
589358	4802210	5.93	16.83	35
577141	4815732	5.92	16.82	35
590758	4802110	5.91	16.81	35
577058	4815810	5.91	16.81	35
576967	4815934	5.89	16.79	35
589158	4803510	5.89	16.79	35
582458	4810010	5.87	16.77	35
590758	4801910	5.86	16.76	35
582058	4810410	5.84	16.74	35
583058	4809210	5.84	16.74	35
590758	4801510	5.84	16.74	35
576958	4815910	5.84	16.74	35
582158	4810310	5.78	16.68	35
589258	4802410	5.78	16.68	35
585758	4806510	5.76	16.66	35
590458	4802110	5.76	16.66	35
582758	4809610	5.75	16.65	35
584558	4807610	5.75	16.65	35
590758	4801810	5.74	16.64	35
582858	4809510	5.74	16.64	35
583158	4809010	5.73	16.63	35
585858	4806410	5.73	16.63	35
582031	4810418	5.73	16.63	35
583158	4808910	5.72	16.62	35
584258	4807910	5.72	16.62	35
587558	4805410	5.72	16.62	35
584158	4808010	5.71	16.61	35
582258	4810210	5.69	16.59	35
585558	4806710	5.69	16.59	35
577143	4815632	5.69	16.59	35

Table 6-6 shows that all receptor concentrations are predicted to comply with the annual NAAQS (12 μg/m^3) and all modeled concentrations are below the PSD Class II increment (4 μg/m^3). The highest predicted receptor concentration, with background added, is less than 50% of the NAAQS. Modeled concentrations are shown in Figure 6-8. Table 6-7 shows that all receptor concentrations are predicted to comply with the 24-

hour NAAQS (35 μg/m^3) and all modeled concentrations are below the PSD Class II increment (9 μg/m^3). The highest predicted receptor concentration, with background added, is approximately 50% of the NAAQS. AERMOD also predicts that all receptor concentrations at Wind Cave National Park will comply with the NAAQS and that modeled concentrations will be below the Class I PSD increment (2 μg/m^3). This is confirmed graphically in Figure 6-9.

Figure 6-8. Annual $PM_{2.5}$ Concentrations (Without Background)

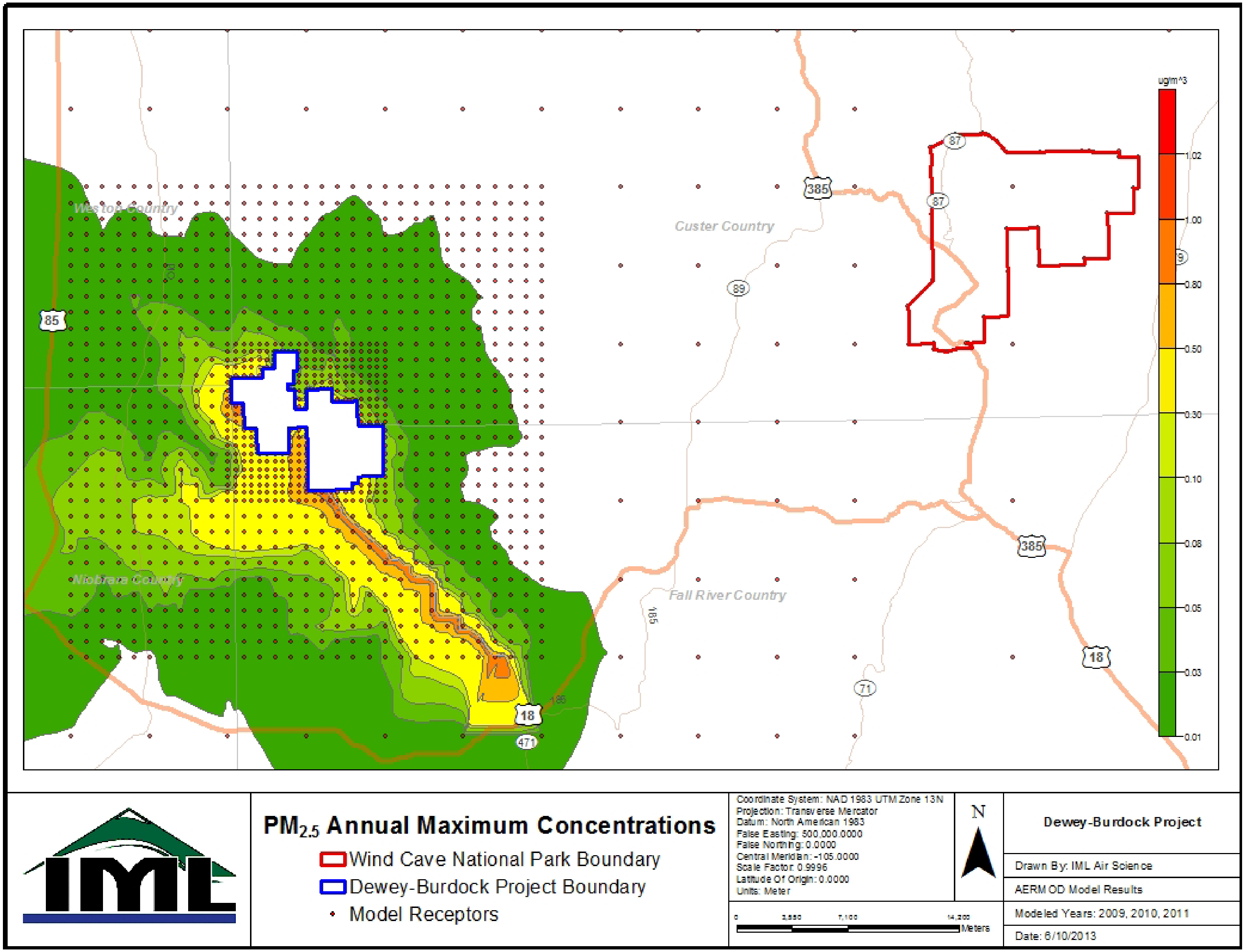


Figure 6-9. Maximum 24-Hour $PM_{2.5}$ Concentrations (Without Background)

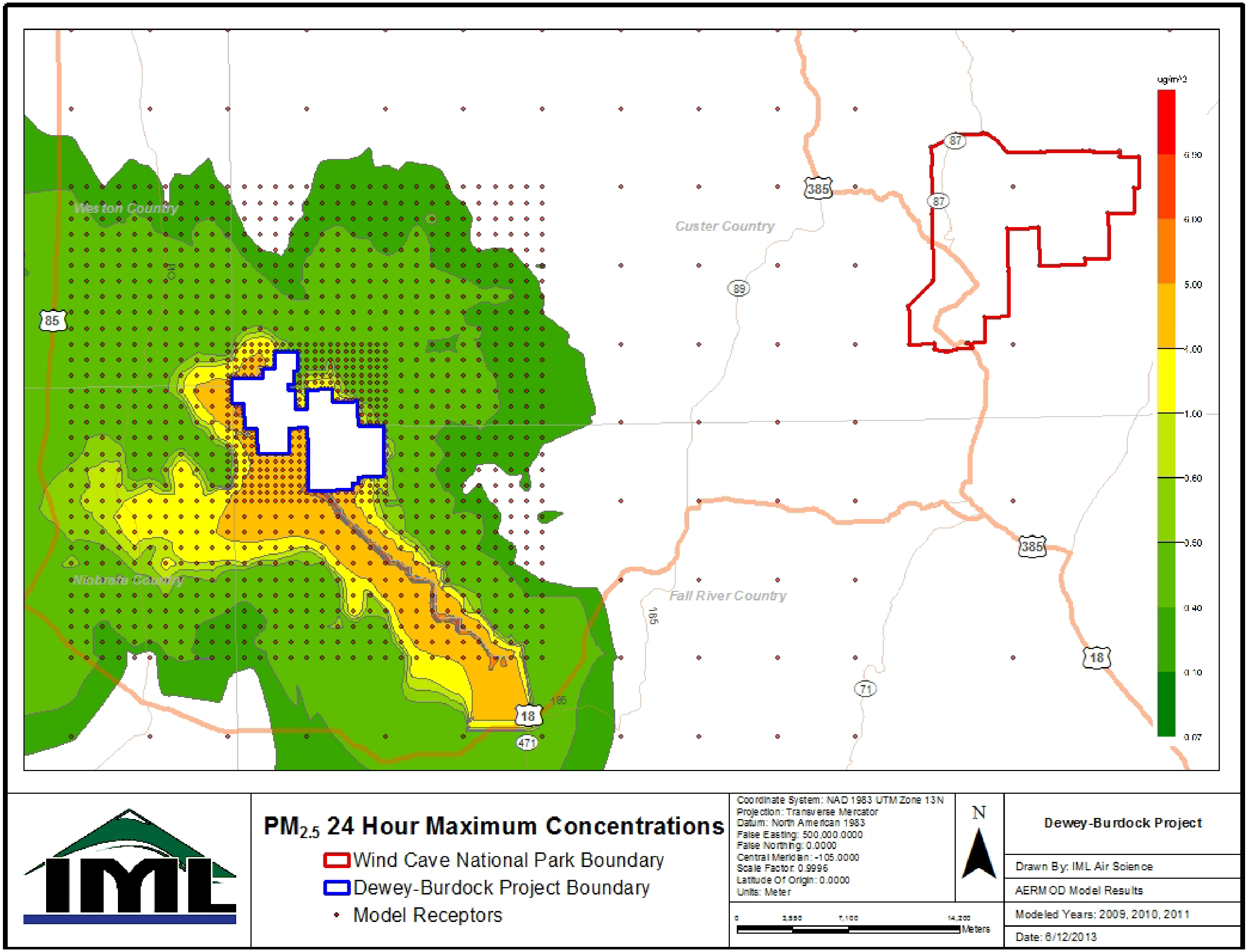
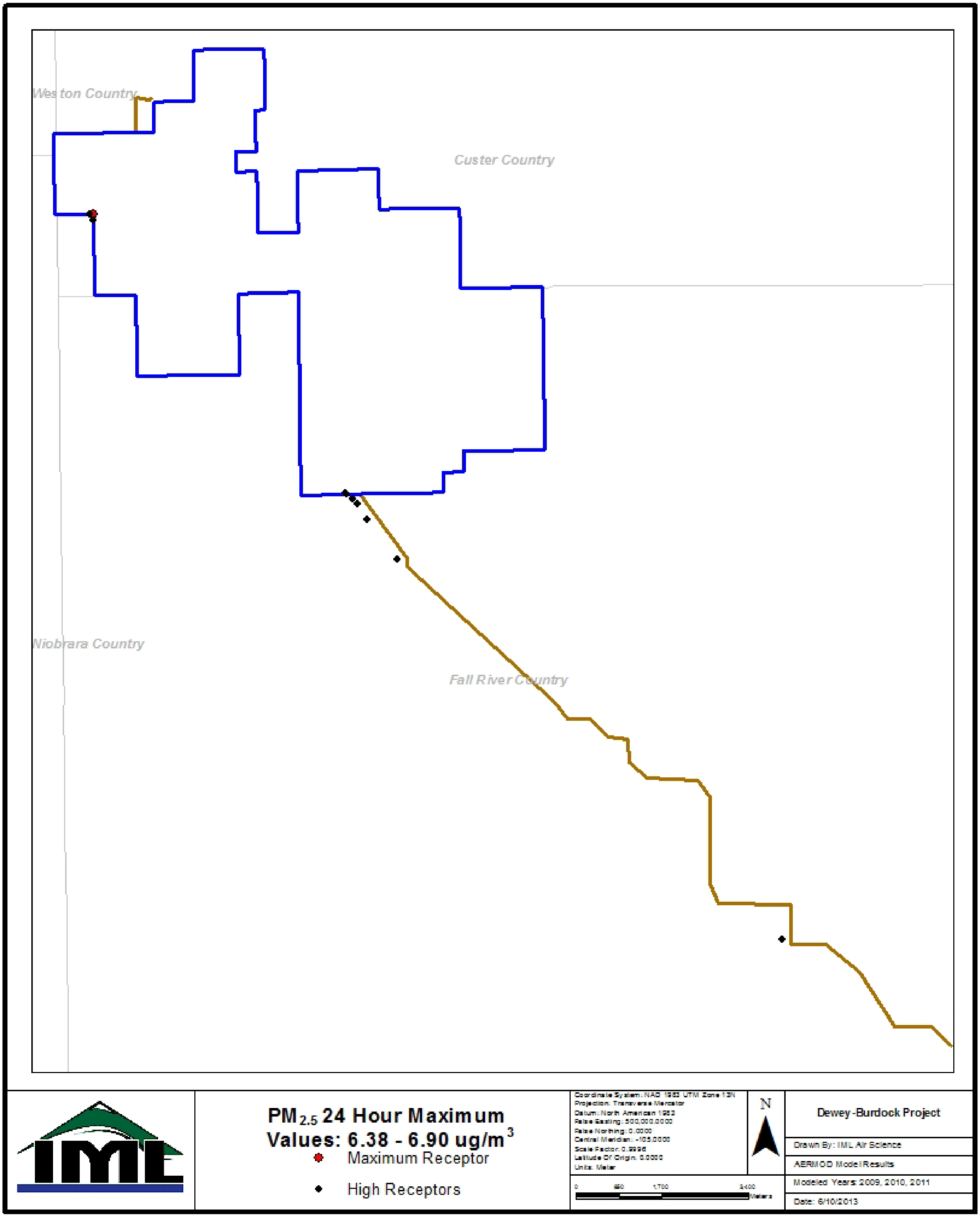


Figure 6-10. Modeled 24-Hour $PM_{2.5}$ (Top 10 Receptors, Without Background)



6.4. NO_2 Modeling Analysis

NO_2 emissions are derived from oxides of nitrogen (NO_x), at an assumed conversion ratio of 75%. The primary source of NO_x emissions will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly NO_x 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 predicted maximum hourly receptor concentrations by calendar day, the 98th percentile of these daily maxima for each year, and the three-year average of the 98th percentiles. It also predicted the average receptor concentrations for the entire modeling period (annual average).

Results from the NO_2 AERMOD model run are presented below. The model predicted NAAQS compliance for all receptors and averaging intervals. Table 6-8 lists the top 20 receptors ranked by annual average concentrations. The highest receptor concentration, with background added, was predicted to be 1.5% of the annual NAAQS. Table 6-9 lists the top 50 receptors ranked according to the 1-hr design value. The highest receptor concentration, with background added, was predicted to be 87% of the 1-hour NAAQS. Figure 6-11 is an isopleth, or contour plot of the predicted annual concentrations attributable to the Dewey-Burdock Project. Figure 6-12 is an isopleth map of the predicted, 98th percentile 1-hr concentrations attributable to the Dewey-Burdock Project. Figure 6-13 shows the locations of the top ten 1-hr receptor concentrations, which occurred within a small area along the project boundary. AERMOD predicted that all receptor concentrations will be below the relevant PSD increments.

The NO_2 model was re-run for the top 50 receptors, with the NO_2/NO_x ratio increased from 0.10 to 0.15. Predicted concentrations for these receptors were identical to the initial model predictions, at an accuracy of two decimal places.

Table 6-8: Top 20 Receptors, Annual Average NO_2

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
577137	4815932	1.08	1.48	100
577139	4815832	1.02	1.42	100
577067	4815933	0.98	1.38	100
577058	4815910	0.96	1.36	100
577141	4815732	0.94	1.34	100
577058	4815810	0.91	1.31	100
577143	4815632	0.89	1.29	100
576967	4815934	0.88	1.28	100
577058	4815710	0.87	1.27	100
576958	4815910	0.86	1.26	100
576958	4815810	0.83	1.23	100
577058	4815610	0.82	1.22	100
576958	4815710	0.82	1.22	100
577144	4815532	0.79	1.19	100
576958	4815610	0.77	1.17	100
576867	4815935	0.77	1.17	100
576858	4815910	0.76	1.16	100
576858	4815810	0.76	1.16	100
577058	4815510	0.75	1.15	100
576858	4815710	0.75	1.15	100

Table 6-9: Top 50 Receptors, 98th percentile of Daily Maximum 1-Hr NO_2 Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
577137	4815932	156.85	162.45	187
577139	4815832	151.35	156.95	187
577067	4815933	142.05	147.65	187
577141	4815732	138.49	144.09	187
577058	4815910	138.28	143.88	187
577058	4815810	132.67	138.27	187
577143	4815632	131.58	137.18	187
577058	4815710	128.67	134.27	187
576967	4815934	128.45	134.05	187
576958	4815910	125.09	130.69	187

577058	4815610	123.79	129.39	187
577144	4815532	122.47	128.07	187
576867	4815935	118.35	123.95	187
576958	4815810	118.20	123.80	187
577058	4815510	118.08	123.68	187
576958	4815710	117.01	122.61	187
576958	4815610	116.58	122.18	187
576858	4815910	113.70	119.30	187
576958	4815510	112.65	118.25	187
576858	4815710	107.63	113.23	187
576958	4815410	105.71	111.31	187
576858	4815810	103.57	109.17	187
576858	4815510	103.56	109.16	187
576858	4815410	102.67	108.27	187
576767	4815935	102.12	107.72	187
576758	4815910	101.78	107.38	187
577146	4815432	101.68	107.28	187
576858	4815610	101.52	107.12	187
577058	4815410	100.81	106.41	187
577148	4815332	100.01	105.61	187
576758	4815410	96.17	101.77	187
576758	4815510	96.04	101.64	187
576758	4815610	94.22	99.82	187
576758	4815710	93.59	99.19	187
576858	4815310	93.40	99.00	187
576358	4816310	93.16	98.76	187
576358	4816410	93.03	98.63	187
576667	4815936	92.75	98.35	187
577058	4815310	92.66	98.26	187
576758	4815310	92.43	98.03	187
576362	4816349	92.30	97.90	187
576758	4815810	92.13	97.73	187
577149	4815232	91.21	96.81	187
576361	4816449	90.68	96.28	187
576958	4815310	89.91	95.51	187
576658	4815310	89.60	95.20	187
576567	4815937	89.12	94.72	187
576658	4815410	89.07	94.67	187

576658	4815910	88.39	93.99	187
577151	4815132	88.25	93.85	187

Figure 6-11. Annual NO_2 Concentrations (Without Background)

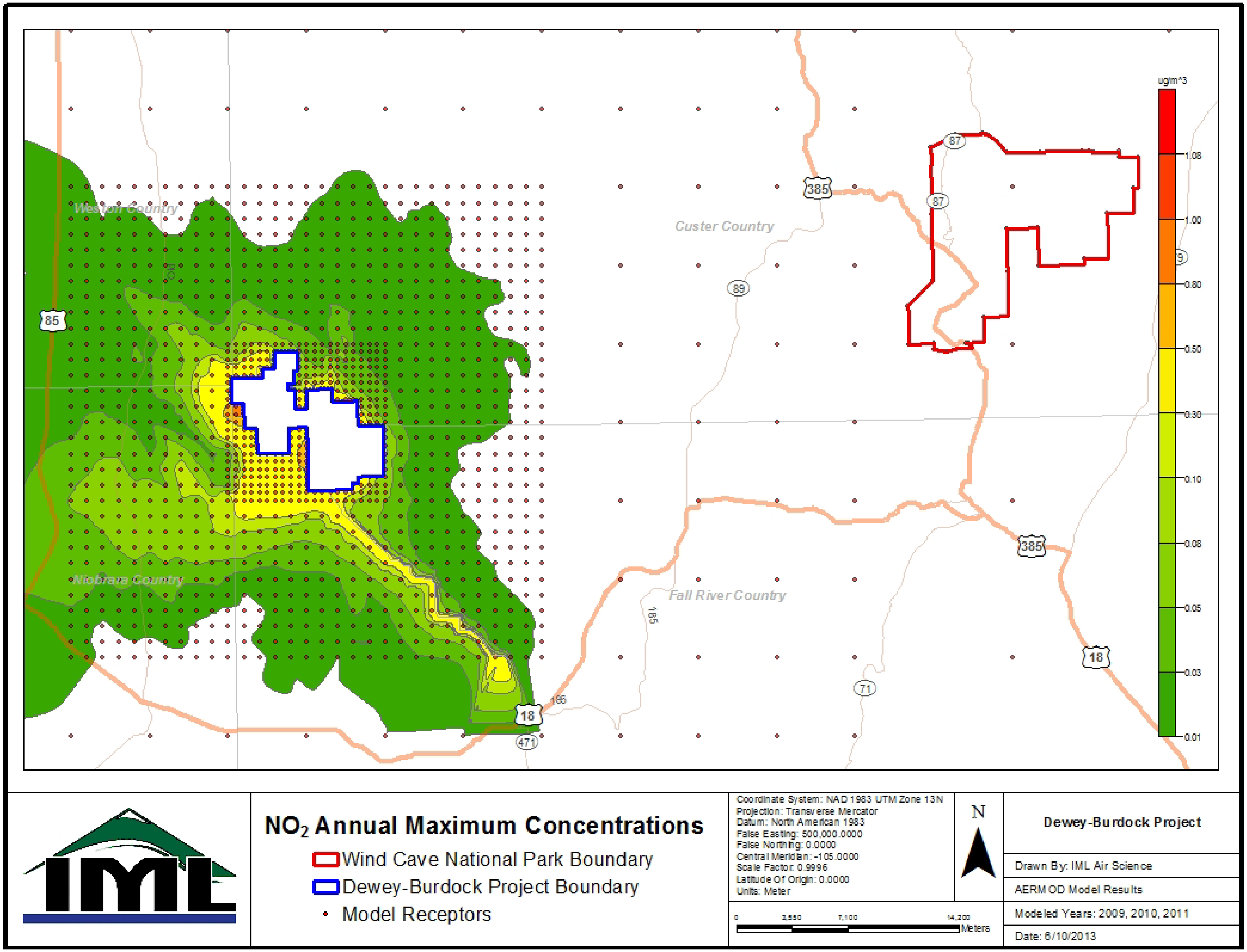


Figure 6-12. Modeled 98th Percentile 1-Hr NO_2 Concentrations (Without Background)

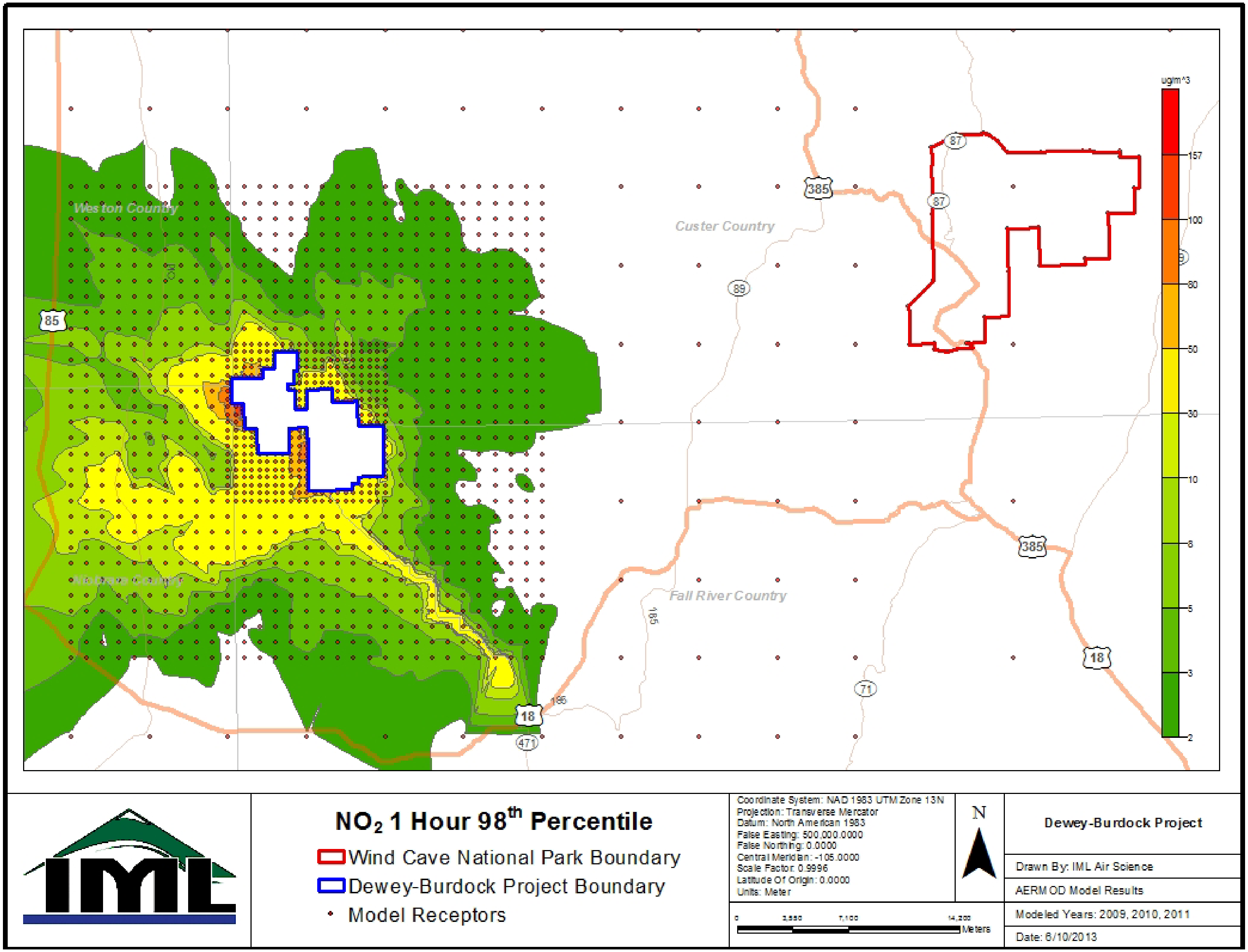
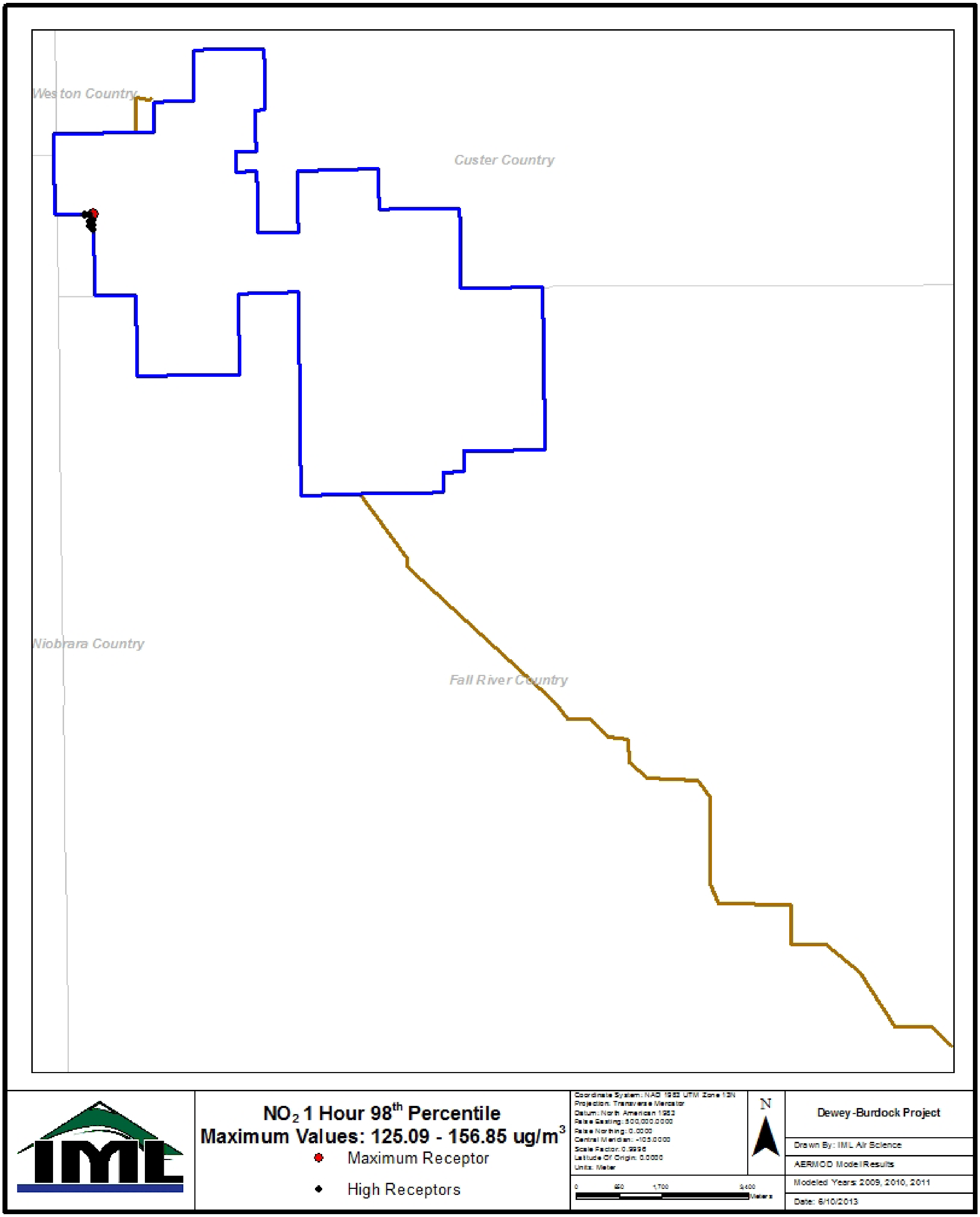


Figure 6-13. Modeled 1-Hour NO_2 (Top 10 Receptors, No Background)



6.5. SO_2 Modeling Analysis

The primary source of SO_2 emissions from the Dewey-Burdock project will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly SO_2 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 hourly receptor concentrations by calendar day, the 99th percentile of these daily maxima by year, and the three-year average of the 99th percentiles. It also produced 3-hr maxima, 24-hr maxima, and the average receptor concentrations for the entire modeling period (annual average).

Results from the SO_2 AERMOD model run are presented below. All receptor concentrations, including those at Wind Cave National Park, were predicted to comply with the appropriate NAAQS. The 24-hr and annual average values were all very near zero. Table 6-10 lists the top 20 receptors ranked by 3-hr average concentrations. The highest receptor concentration, with background added, was predicted to be 9.5% of the 3-hr NAAQS. Table 6-11 lists the top 50 receptors ranked by 3-year average of the 1-hour maximum (99th percentile) concentrations. The highest receptor concentration, with background added, was predicted to be 32% of the 1-hr NAAQS. Figure 6-14 is an isopleth, or contour plot of the predicted annual concentrations attributable to the Dewey-Burdock Project. Figure 6-15 is an isopleth map of the predicted maximum 24-hr concentrations attributable to the Dewey-Burdock Project. Figure 6-16 is an isopleth map of the predicted maximum 3-hr concentrations attributable to the Dewey-Burdock Project. Figure 6-17 is an isopleth map of the predicted, 99th percentile 1-hr concentrations attributable to the Dewey-Burdock Project. AERMOD predicts that all receptor concentrations will be less than the relevant PSD increments.

Table 6-10: Top 20 Receptors, 3-Hr Maximum SO_2

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
576358	4816510	100.08	120.98	1300
576359	4816549	95.83	116.73	1300
576258	4816510	94.30	115.20	1300
576361	4816449	89.64	110.54	1300
576058	4816610	87.18	108.08	1300
576158	4816510	86.73	107.63	1300
576158	4816610	86.73	107.63	1300
576258	4816610	82.47	103.37	1300
576358	4816610	82.47	103.37	1300
575958	4816610	81.97	102.87	1300
576358	4816410	80.79	101.69	1300
576058	4816510	78.35	99.25	1300
575858	4816610	77.22	98.12	1300
576358	4816649	75.45	96.35	1300
575858	4816710	74.59	95.49	1300
581227	4810706	72.73	93.63	1300
576258	4816410	71.61	92.51	1300
581158	4810710	71.35	92.25	1300
581226	4810806	70.92	91.82	1300
575958	4816710	70.63	91.53	1300

Table 6-11: Top 50 Receptors, 99th percentile of Daily Maximum 1-Hr SO_2 Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	Maximum Concentration with Background (µg/m^3)	NAAQS Concentration (µg/m^3)
577137	4815932	48.26	63.96	200
577139	4815832	46.23	61.93	200
577067	4815933	43.74	59.44	200
577058	4815910	43.43	59.13	200
577143	4815632	42.55	58.25	200
577141	4815732	41.90	57.60	200
577058	4815810	40.90	56.60	200
576967	4815934	40.49	56.19	200
577058	4815710	39.75	55.45	200
576958	4815910	38.99	54.69	200
576358	4816610	38.80	54.50	200
576958	4815710	38.55	54.25	200

577058	4815610	38.30	54.00	200
576258	4816610	38.30	54.00	200
576867	4815935	37.78	53.48	200
576958	4815810	37.46	53.16	200
577144	4815532	36.86	52.56	200
576359	4816549	36.72	52.42	200
576858	4815910	36.59	52.29	200
576958	4815610	35.92	51.62	200
576858	4815710	35.23	50.93	200
577058	4815510	35.19	50.89	200
576358	4816649	35.03	50.73	200
576958	4815510	34.05	49.75	200
576767	4815935	33.84	49.54	200
576858	4815810	33.51	49.21	200
576758	4815910	33.50	49.20	200
576858	4815610	33.37	49.07	200
577146	4815432	32.72	48.42	200
577148	4815332	32.66	48.36	200
576858	4815510	32.17	47.87	200
577058	4815410	31.63	47.33	200
576958	4815410	31.34	47.04	200
577058	4815310	31.27	46.97	200
576758	4815610	31.14	46.84	200
576358	4816510	31.04	46.74	200
576758	4815510	30.89	46.59	200
576858	4815410	30.82	46.52	200
576958	4815310	30.62	46.32	200
576758	4815810	30.51	46.21	200
576361	4816449	30.45	46.15	200
576158	4816610	30.22	45.92	200
575958	4816710	29.80	45.50	200
576058	4816710	29.68	45.38	200
576158	4816710	29.37	45.07	200
576958	4815210	29.16	44.86	200
576658	4815810	29.10	44.80	200
576758	4815710	29.07	44.77	200
576758	4815410	28.78	44.48	200

Figure 6-14. Modeled Annual SO_2 Concentrations (Without Background)

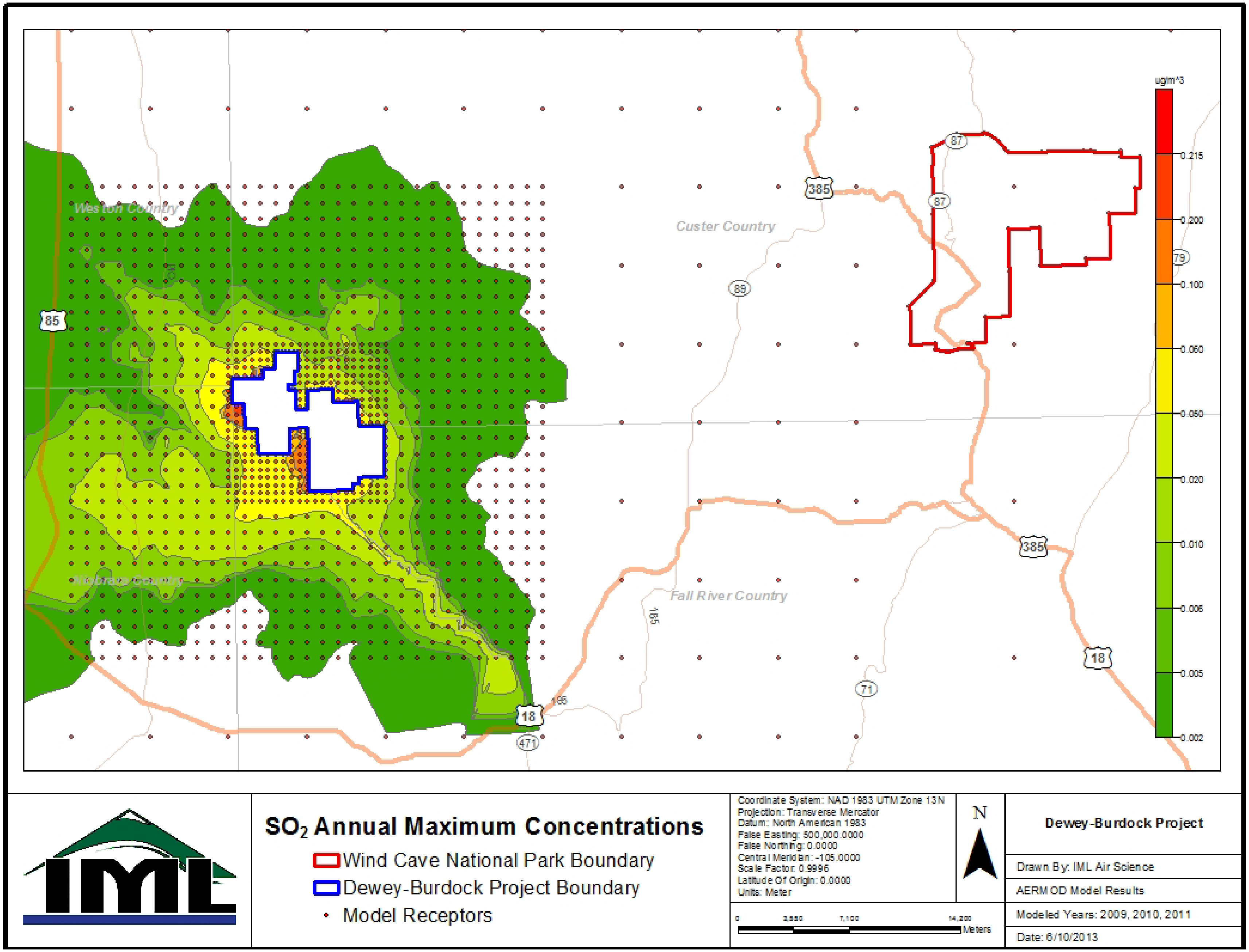


Figure 6-15. Modeled Maximum 24-Hour SO_2 Concentrations (Without Background)

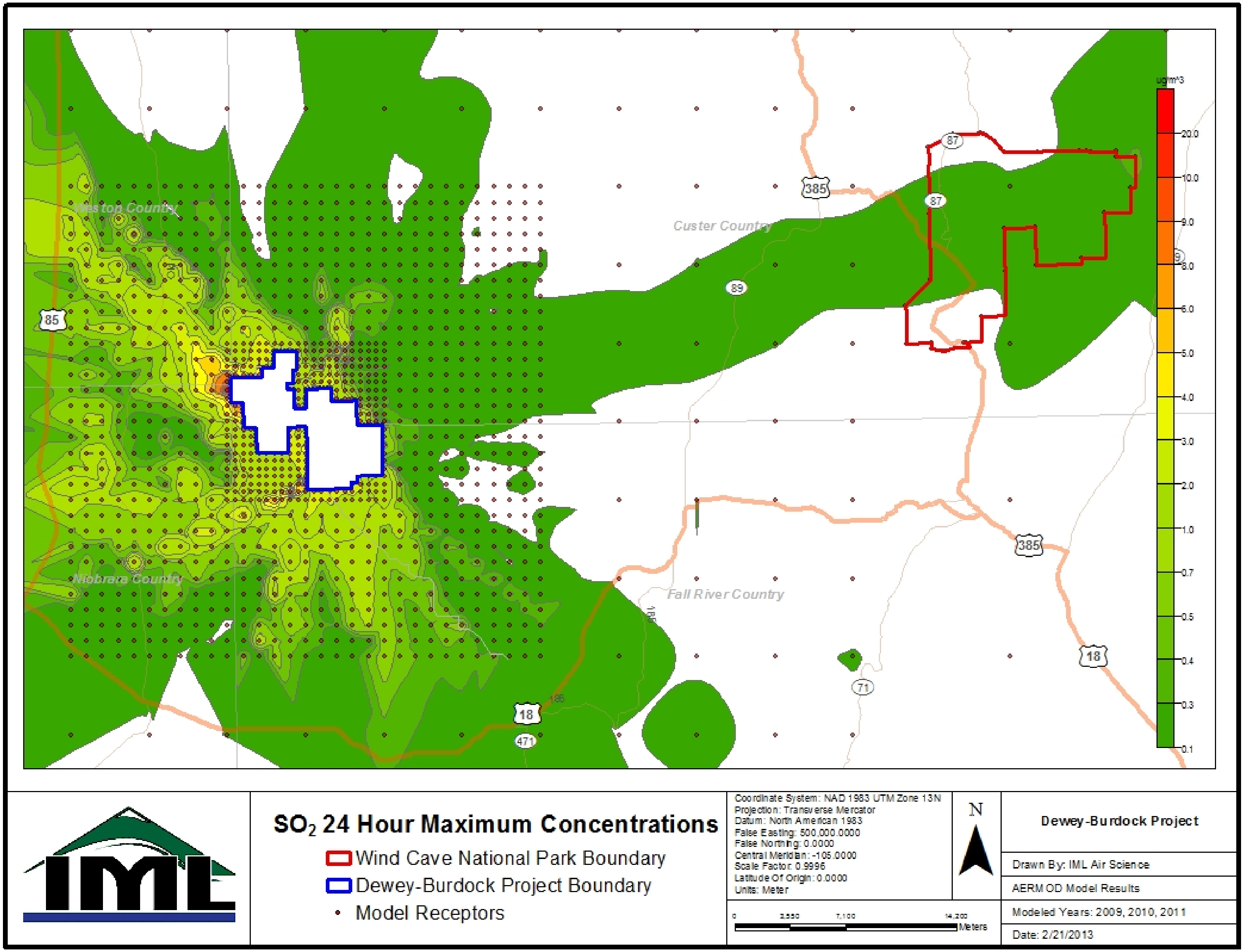


Figure 6-16. Modeled Maximum 3-Hour SO_2 Concentrations (Without Background)

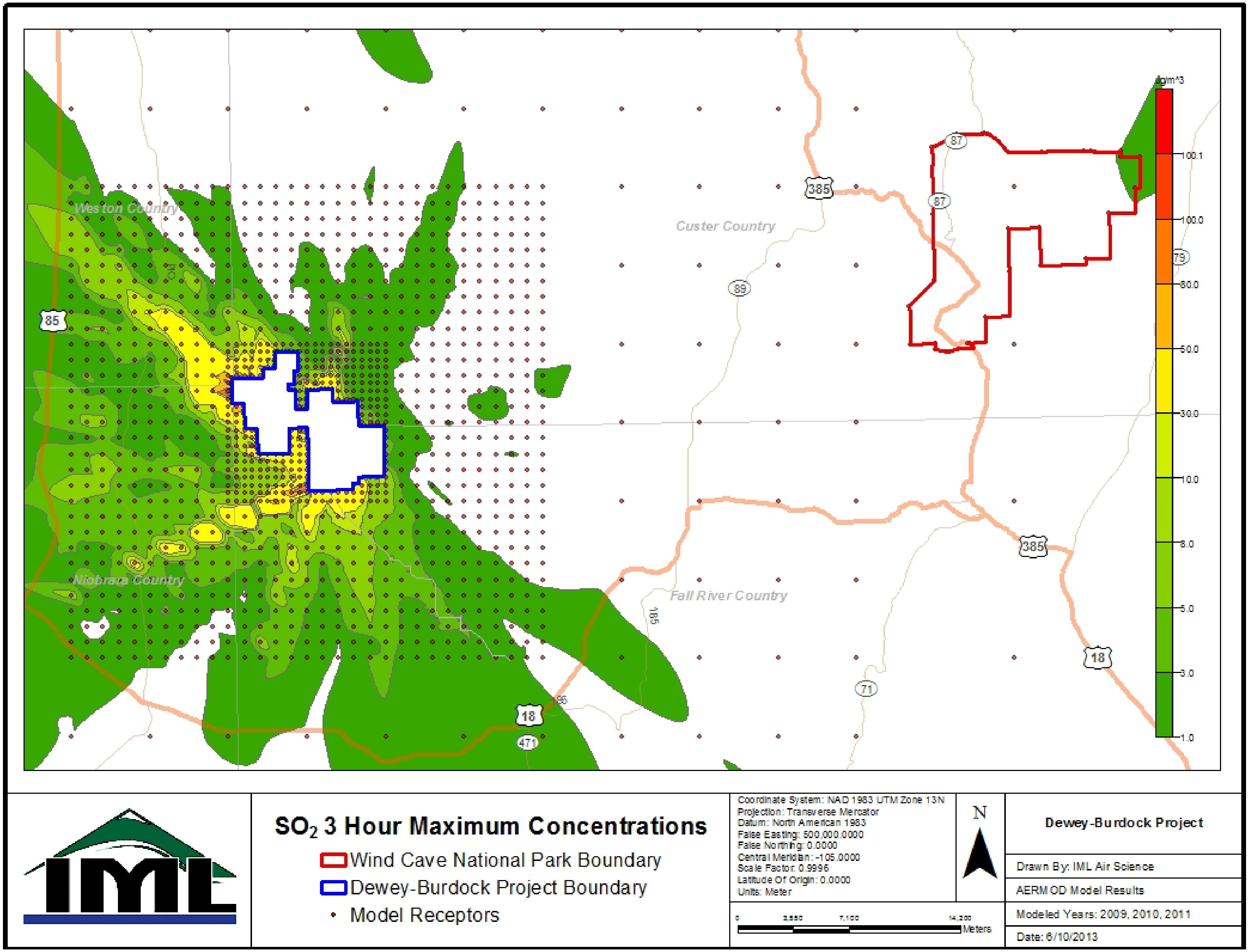
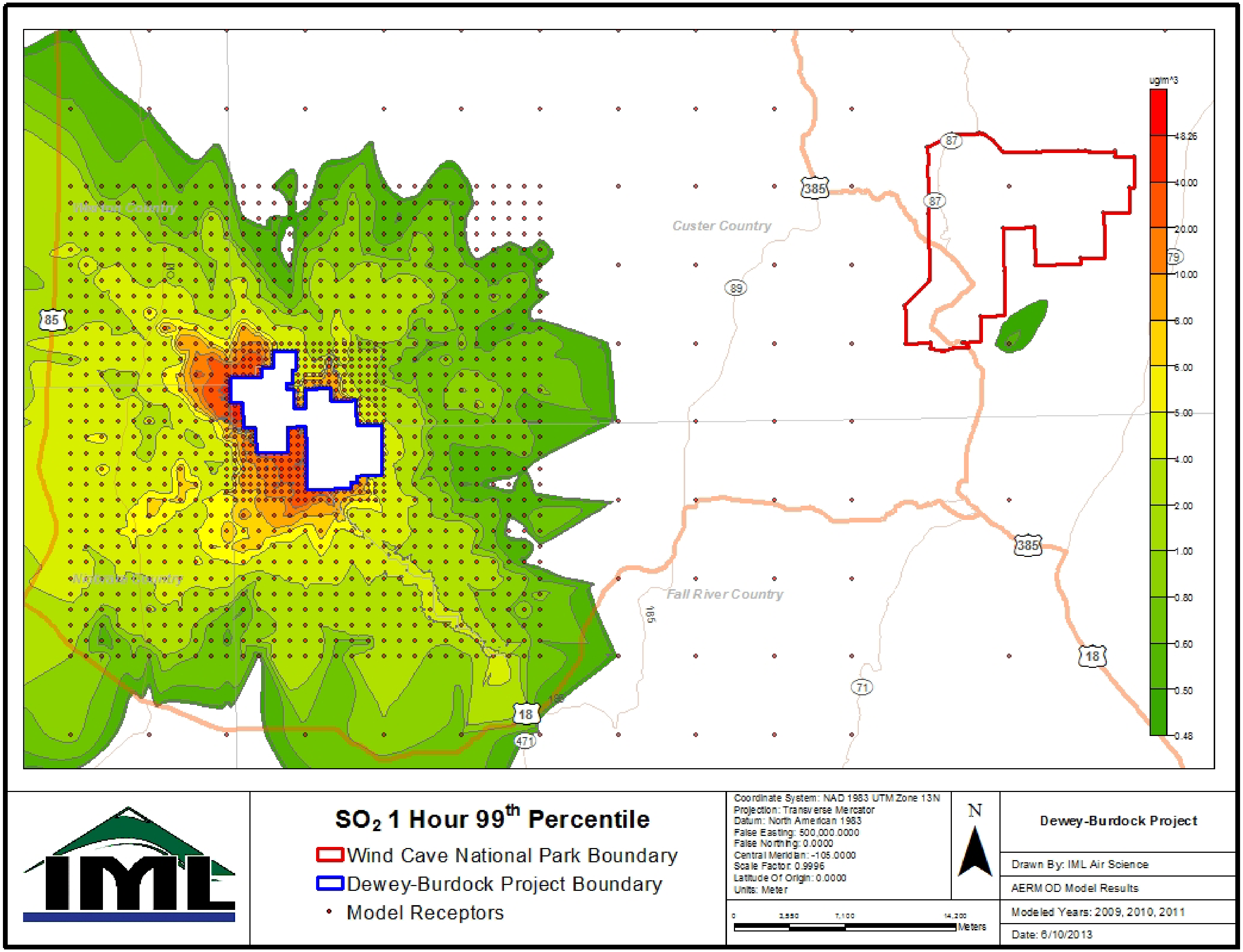


Figure 6-17. Modeled 99th Percentile 1-Hour SO_2 Concentrations (Without Background)



6.6. CO Modeling Analysis

The primary source of CO emissions from the Dewey-Burdock project will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly CO 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 1-hr and 8-hr receptor concentrations over the 3-year modeling period.

Results from the CO AERMOD model run are illustrated below. Modeled concentrations at all receptors, including those at Wind Cave National Park, were predicted to be below the applicable standards. As shown in Table 6-1, all modeled concentrations of CO constituted a small fraction of the NAAQS, and are therefore not tabulated separately. Figure 6-18 is an isopleth, or contour plot of the predicted maximum 8-hr concentrations attributable to the Dewey-Burdock Project. Figure 6-19 is an isopleth map of the predicted maximum 1-hr concentrations attributable to the Dewey-Burdock Project.

Figure 6-18. Modeled Maximum 8-Hr CO Concentrations (Without Background)

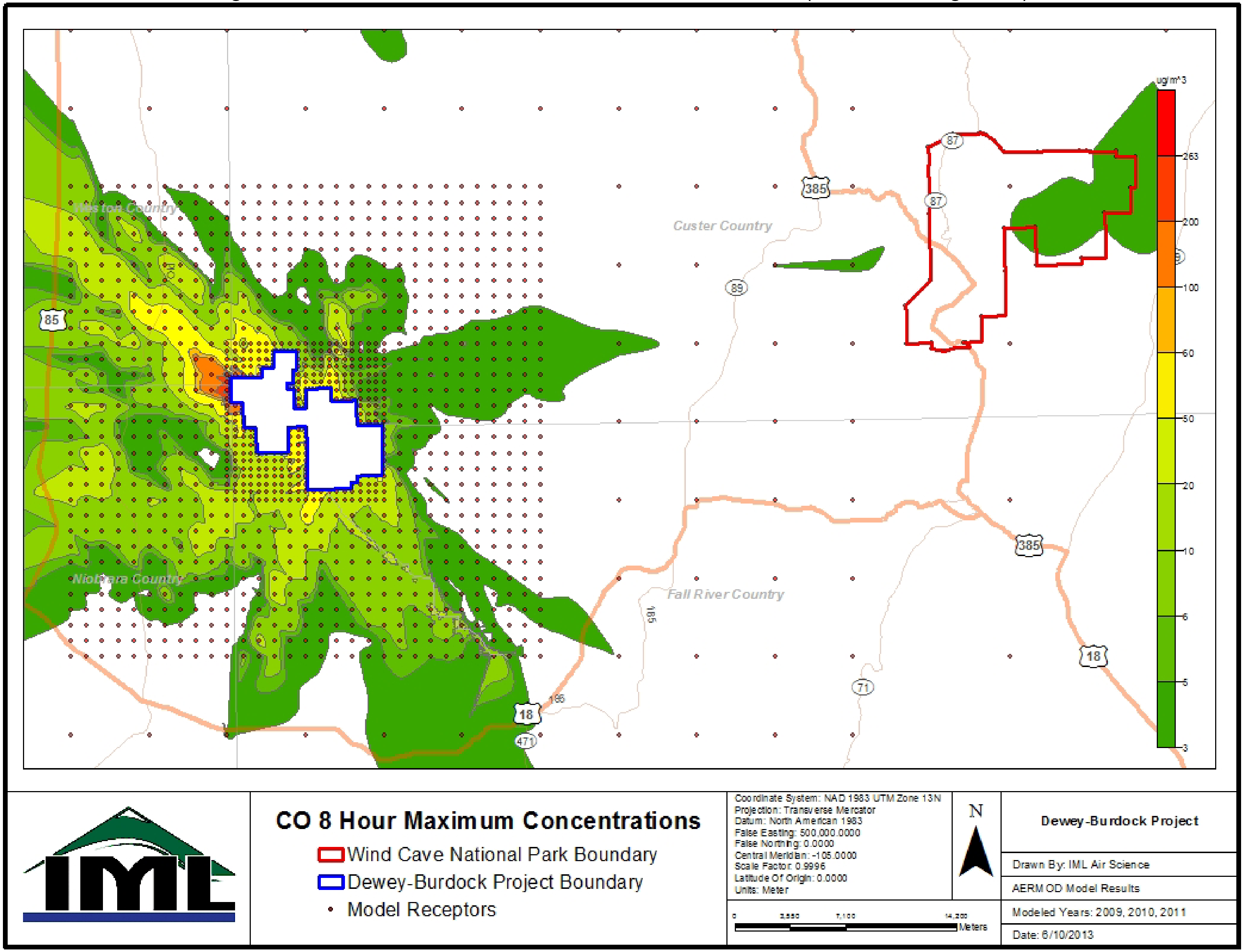
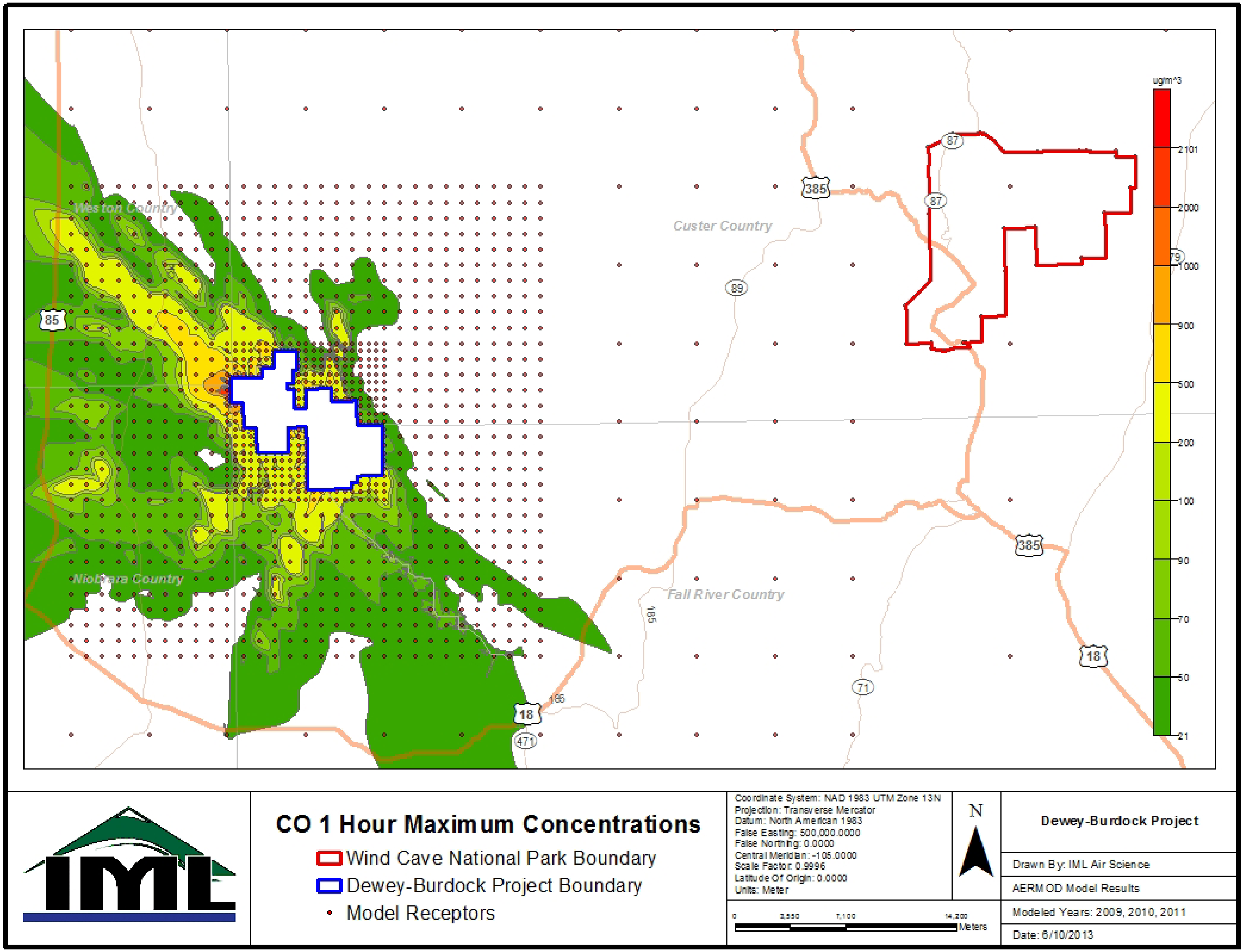


Figure 6-19. Modeled Maximum 1-Hr CO Concentrations (Without Background)



7 CALPUFF MODELING RESULTS AND ANALYSIS

7.1. 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 was modeled to determine its potential AQRV impacts at Wind Cave. Species modeled included PM_{10}, $PM_{2.5}$, SO_2, NO_x, SO_4, $NHNO_3$ and NO_3. The first four of these would be emitted by the project, while the other three may form in the atmosphere.

The model selected for AQRV impact analysis (recommended by EPA and the Federal Land Managers) is CALPUFF, along with its companion models CALMET and CALPOST. In addition to the above seven species, elemental carbon (EC) and secondary organic aerosol (SOA) were enabled in the model to accommodate Visibilty Method 8.1. Visibility model outputs included daily background light extinction at receptors in Wind Cave National Park, to which the project impacts were added. By contrast, the modeled atmospheric deposition rates were attributable only to project emissions. Background deposition rates and significance thresholds were obtained from sources outside the model.

The CALPUFF modeling domain was selected to include the project area, Wind Cave National Park, and a 50-km buffer to provide meteorological model continuity. This resulted in a 200-km by 200-km modeling grid (Figure 7-1). A total of 192 model receptor locations were obtained for Wind Cave from the National Park Service (Figure 7-2). Modeled emission sources and emission rates were identical to those configured in the AERMOD model (Figure 7-3).

Visibility impacts from the Dewey-Burdock Project at Wind Cave were modeled under two scenarios. The first one included coarse particulate matter (PM_{10}) in computing total light extinction, which resulted in a 98^{th} percentile of 24-hour changes in visibility (relative to background) of 3.5%. This level of change in visibility is less than the 5% change considered barely perceptible by 50% of the viewers. The second scenario excluded PM_{10} from this computation, resulting in a 98^{th} percentile of 24-hour changes in visibility of 1.1%, well below the 5% threshold. Section 7.2 presents evidence and precedent for the validity of the second scenario, due to CALPUFF's lack of accounting for deposition of most PM_{10} particles within a short distance of the emission source.

Atmospheric deposition (also known as acid deposition), another measure of AQRV impact, is modeled by CALPUFF as the deposition of a variety of species containing nitrogen and sulfur. SO_2 and NO_x emissions from the Dewey-Burdock Project constitute potential sources of acid deposition at Wind Cave National Park. The modeled deposition rates predicted by CALPUFF were first compared to measured deposition rates at Wind Cave. Second, the modeled deposition rates were compared to estimated critical loads at Wind Cave, below which no harmful impacts to the ecosystem would be expected to occur. Third, the modeled deposition rates were compared to the deposition analysis thresholds established by the U.S. Forest Service, below which deposition impacts are considered negligible. Section 7.3 presents these comparisons and predicts that annual deposition impacts from the Dewey-Burdock Project will be less than the deposition analysis thresholds for nitrogen and sulfur. This section also shows that historical deposition rates are substantially lower than the estimated critical loads for both sulfur and nitrogen.

In summary, atmospheric deposition and visibility model results predict impacts below the AQRV standards, with no significant impacts to any portions of the Class I area at Wind Cave National Park.

Figure 7-1. CALPUFF Modeling Domain

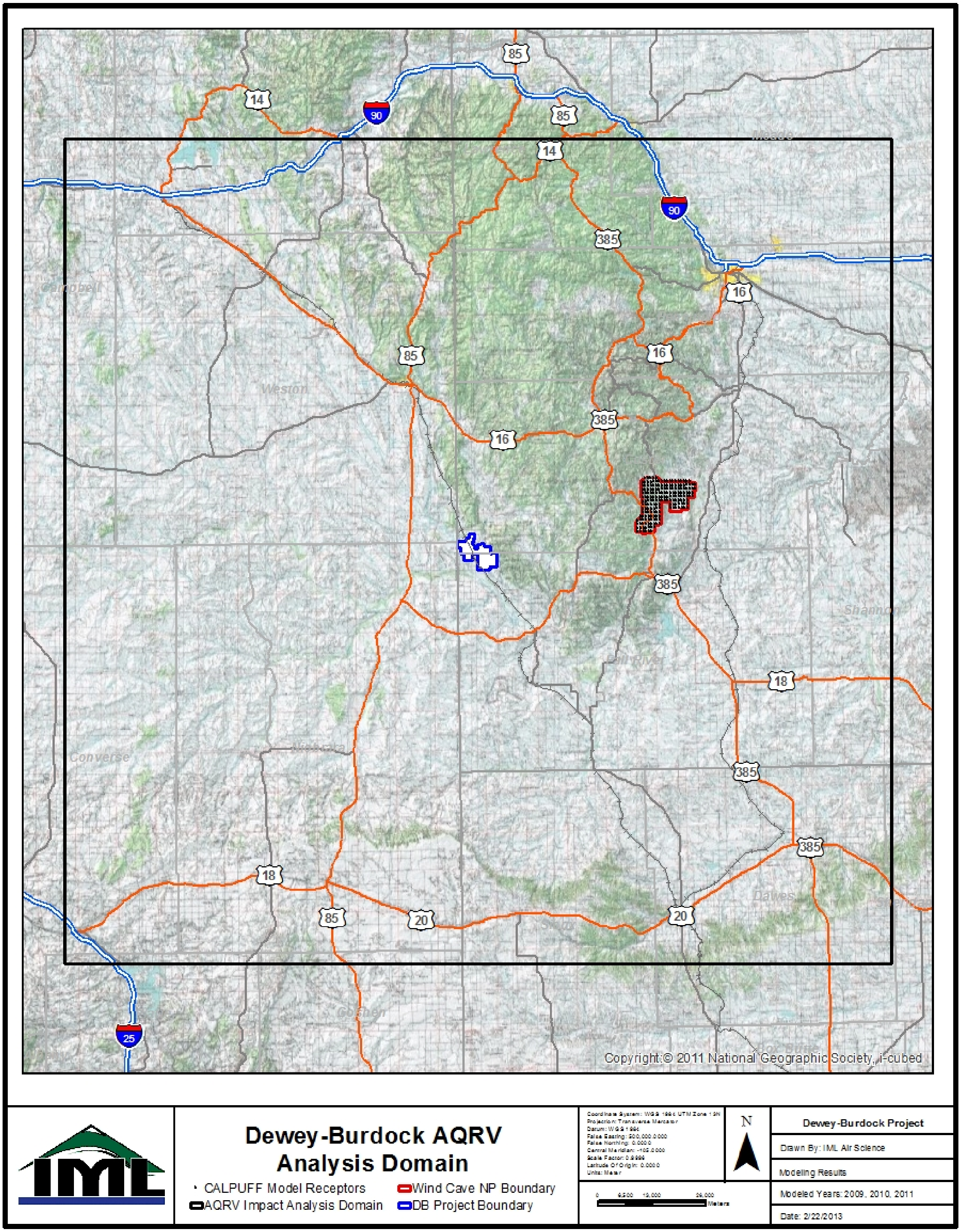


Figure 7-2. CALPUFF Model Receptors

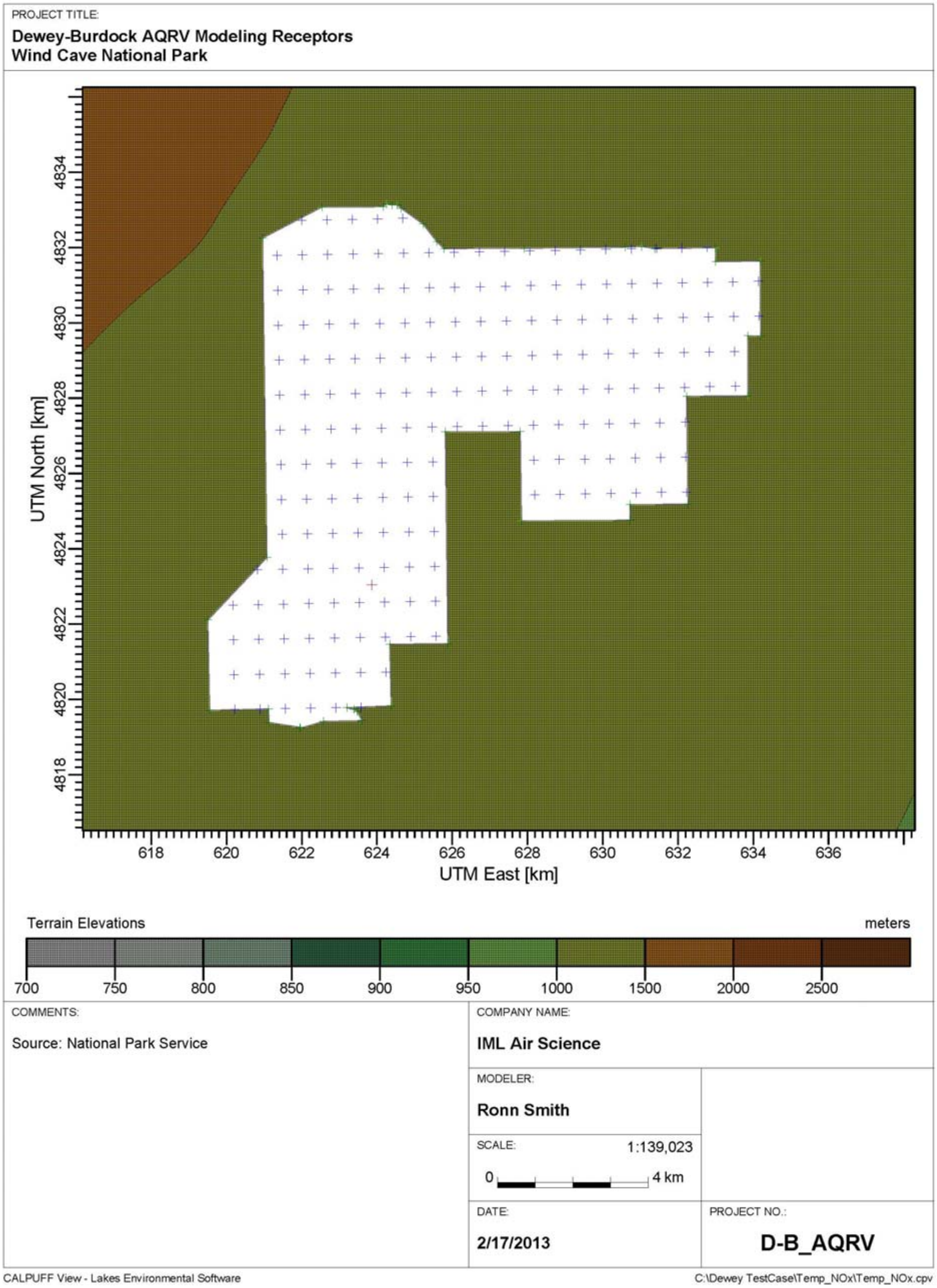
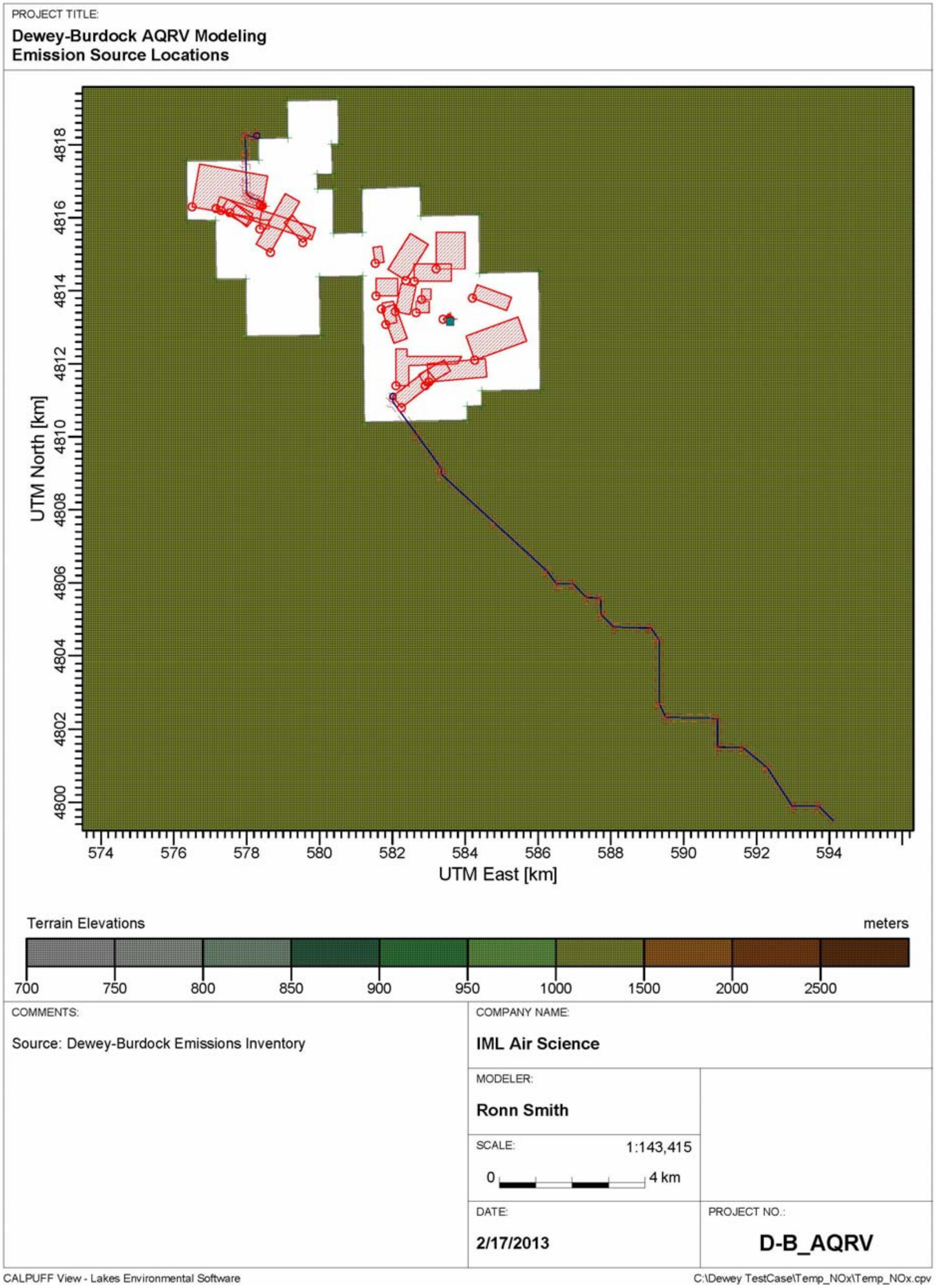


Figure 7-3. CALPUFF Modeled Emission Sources



7.2. Visibility Analysis

7.2.1. Basis for Analysis

In August 1977, the federal Clean Air Act was amended by Congress to establish the following national goal for visibility protection:

> "Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from man-made air pollution."

To address this goal for each of the 156 mandatory federal Class I areas across the nation, the U.S. Environmental Protection Agency (EPA) developed regulations to reduce the impact of large industrial sources on nearby Class I areas.

The 1977 Clean Air Act Amendments also established the Prevention of Significant Deterioration (PSD) permit program, which included consultation with federal land managers on visibility impacts and public participation in permitting decisions. The PSD permit program was delegated to South Dakota on July 6, 1994, and later approved in South Dakota's State Implementation Plan on January 22, 2008.

In 1980, EPA adopted regulations to address "reasonably attributable visibility impairment", or visibility impairment caused by one or a small group of man-made sources generally located in close proximity to a specific Class I area. Most visibility impairment occurs when pollution in the form of small particles scatters or absorbs light. Air pollutants are emitted from a variety of natural and anthropogenic sources. Natural sources can include windblown dust and smoke from wildfires. Anthropogenic sources can include motor vehicles, electric utility and industrial fuel burning, prescribed burning, and mining operations. More pollutants mean more absorption and scattering of light, which reduce the clarity and color of scenery. Some types of particles such as sulfates and nitrates scatter more light, particularly during humid conditions. Other particles like elemental carbon from combustion processes are highly efficient at absorbing light.

Commonly, visibility is observed by the human eye and the object may be a single viewing target or scenery. A common measure of visual resources is the haze index, expressed in deciviews (dv). The deciview is a metric used to represent normalized light extinction attributable to visibility-affecting pollutants.

The visibility threshold of concern is not exceeded if the 98th percentile change in light extinction is less than 5% for each year modeled, when compared to the annual average natural condition value for that Class I area (FLAG 2010). A 5% change in light extinction is equivalent to a 0.5 dv change in visibility (EPA 2005b). When assessing visibility impairment from regional haze, EPA guidelines indicate that for a source whose 98th percentile value of the haze index, evaluated on a 24-hour average basis, is greater than 0.5 dv is considered to contribute to regional haze visibility impairment.

7.2.2. Preliminary Modeled Visibility Impacts

Wind Cave National Park, located approximately 50 km east-northeast of the proposed Dewey-Burdock Project, is the nearest Class I area and the only one in the modeling domain. The maximum potential air emissions from the project were modeled for impacts on visibility at Wind Cave, using the CALPUFF software and modeling protocol discussed in Section 5 of this report. The modeling results, with and without consideration of coarse particulate matter (PM_{10}) emissions from the Dewey-Burdock Project, are summarized in Table 7-1. Project emissions of fine particulate matter ($PM_{2.5}$) were included in both model runs, along with oxides of nitrogen and sulfur. These three species, along with organic carbon, are the primary contributors to visibility impairment in the Wind Cave region (DENR 2010).

Table 7-1: Visibility Analysis Summary

Scenario	Statistic	3-Year	Significance Threshold	1st Year	2nd Year	3rd Year
Modeled With Coarse Particulate	98th pctile Δdv	0.35	0.50	0.33	0.31	0.40
	#Days > 0.5 Δdv	11	--	3	4	4
	#Days > 1.0 Δdv	0	--	0	0	0
	Maximum Δdv	0.83	--	0.55	0.83	0.58
Modeled Without Coarse Particulate	98th pctile Δdv	0.11	0.50	0.10	0.11	0.12
	#Days > 0.5 Δdv	0	--	0	0	0
	#Days > 1.0 Δdv	0	--	0	0	0
	Maximum Δdv	0.20	--	0.15	0.20	0.15

7.2.3. Effect of Coarse Particulate on CALPUFF Visibility Assessment

There is evidence and precedent that supports excluding ground-level, fugitive PM_{10} emissions from the assessment of project impacts on visibility at Wind Cave (see discussion below). Even without this exclusion, however, Table 7-1 shows the 98th percentile of the annual, 24-hour average changes in haze index to be less than the contribution threshold of 0.5 dv. With the PM_{10} exclusion, the modeled Δdv values fall well below this threshold.

A recent EIS for a gas development in southern Wyoming discussed the exclusion of fugitive PM_{10} emissions from visibility assessment (TRC 2006). Appendix F to the EIS states, "In post-processing the PM_{10} impacts at all far-field receptor locations, the PM_{10} impacts from Project alternative traffic emissions (production and construction) were not included in the total estimated impacts, only the $PM_{2.5}$ impacts were considered. This assumption was based on supporting documentation from the Western Regional Air Partnership (WRAP) analyses of mechanically generated fugitive dust emissions that suggest that particles larger than $PM_{2.5}$ tend to deposit out rapidly near the emissions source and do not transport over long distances (Countess et al. 2001). This phenomenon is not modeled adequately in CALPUFF; therefore, to avoid overestimates of PM_{10} impacts at far-field locations, these sources were not considered in the total modeled impacts. However, the total PM_{10} impacts from traffic emissions were included in all in-field concentration estimates."

Deposition is recognized as an important effect that can lead to rapid concentration depletion in a fugitive PM_{10} emissions plume generated at or near ground level. Physical measurements reported by the South Dakota Department of Natural Resources (DENR) and the Western Regional Air Partnership (WRAP) conclude that coarse mass particulates (i.e., PM_{10} and larger) contribute a small fraction toward visibility impairment at Wind Cave. DENR's Regional Haze State Implementation Plan states, "In the 1st quarter, ammonia sulfate and ammonia nitrate have the greatest impact on visibility impairment in the Wind Cave National Park. In the 2nd quarter, ammonia sulfate has the greatest impact on visibility impairment in the Wind Cave National Park in the last five years. In the 3rd quarter, organic carbon mass has the greatest impact on visibility impairment followed by ammonia sulfate. In the 4th quarter, ammonia sulfates and ammonia nitrate continue to contribute the greatest with one exception in 2005" (DENR 2010). In 2005, organic carbon dominated due to wild fires.

Despite the above findings and the fact that virtually all of the PM_{10} emissions from the Dewey-Burdock Project would be ground-level fugitive dust, initial CALPUFF modeling results showed PM_{10} emissions to be dominant in predicting changes in visibility at Wind Cave. On days with non-zero Δdv values, CALPUFF attributed on average about 70% of the change in visibility to PM_{10} emissions. Removing PM_{10} from the visibility analysis, as allowed for in the CALPUFF post-processor CALPOST, lowered these Δdv values proportionately.

To confirm the validity of excluding fugitive PM_{10} emissions from the visibility assessment, three test receptors were evaluated with CALPUFF. One was placed 80km east of the Dewey-Burdock Project and another 117 km northeast of the project, both near the edge of the modeling domain. At these large distances one would expect a diminished role for coarse particulate emissions from the project, in affecting overall visibility. A third receptor was placed near Wind Cave National Park as a control. CALPUFF was rerun with these test receptors, followed by post-processing in CALPOST with and without the PM_{10} option enabled. The results allowed the computation of that portion of Δdv attributable to PM_{10}, as shown in Table 7-2.

Table 7-2: Model Comparison Test, Coarse PM Contribution to Δdv

Receptor	Easting	Northing	Average PM_{10} Contribution	Distance from Source (km)
1	660,000	4,815,000	64%	80
2	660,000	4,900,000	75%	117
3	620,000	4,820,000	62%	40

7.2.4. Final Modeled Visibility Impacts

Table 7-2 illustrates that not only is PM_{10} the dominant contributor to modeled changes in visibility even at distant locations, but in this scenario its contribution actually increases with distance from the emission source. This runs counter to common sense, and raises questions concerning CALPUFF's handling of PM_{10} deposition near the source. For this reason the visibility modeling results that exclude PM_{10} are presented here in addition to results that include PM_{10} emissions.

The deciview haze index is derived from calculated light extinction measurements so that uniform changes in haziness correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to highly impaired. The deciview haze index is calculated directly from the total light extinction coefficient (b_{ext} expressed in inverse megameters [Mm^{-1}]) as follows:

$$dv = 10 \ln (b_{ext}/10\ Mm^{-1})$$

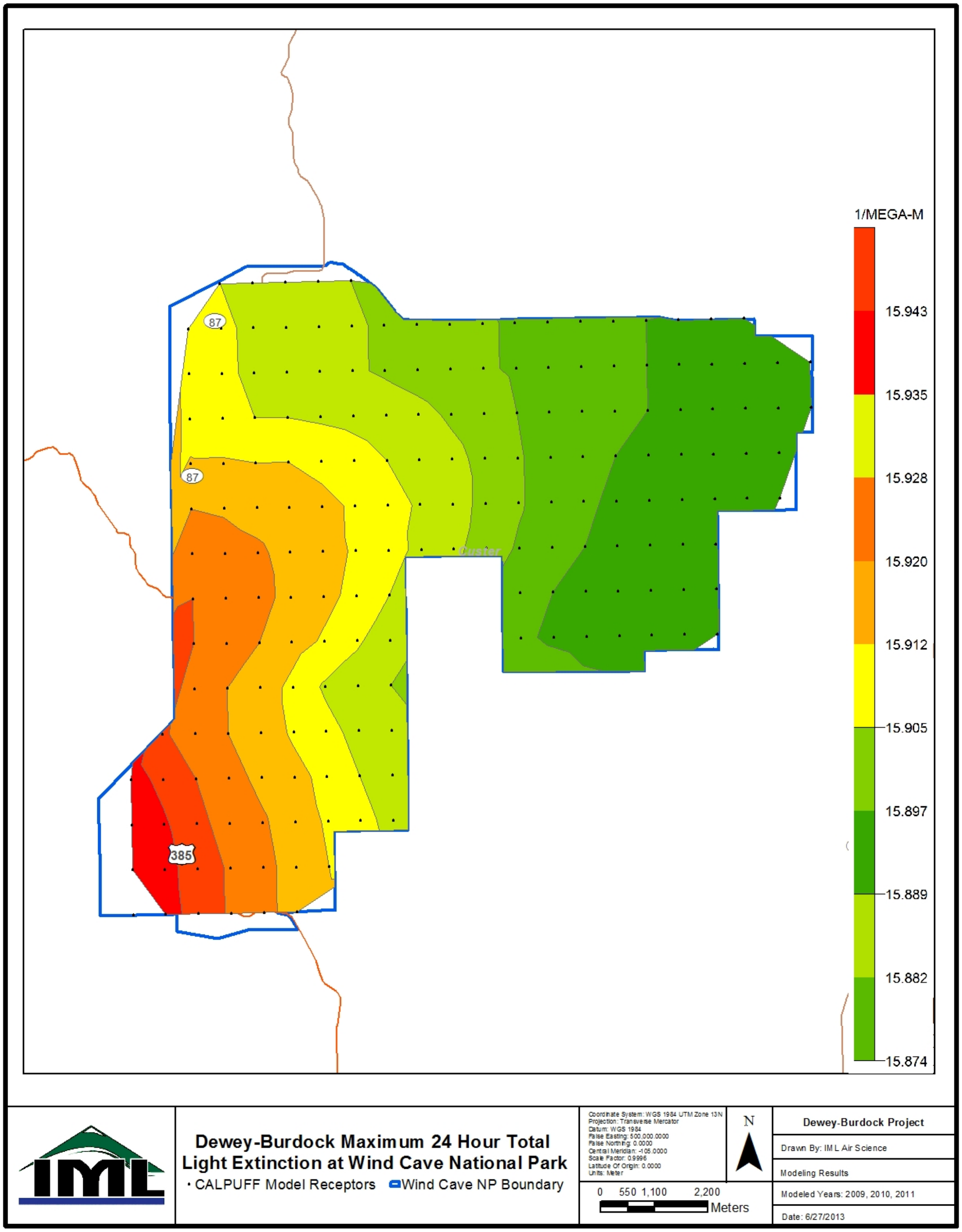
CALPOST produced maximum 24-hour light extinction values for each model receptor at Wind Cave National Park. The highest 24-hr total b_{ext} was 16.0 Mm^{-1}. The corresponding background extinction on that day (without Dewey-Burdock Project impacts) was 15.5 Mm^{-1}, providing a basis for the change in the haze index reported below.

With coarse particulate matter included in the visibility analysis, CALPUFF predicts the maximum change in haze index to be 0.83 dv. Figure 7-4 is a contour map of maximum total light extinction modeled at all receptors with PM_{10} included.

As shown in Table 7-1, the impacts with coarse particulate matter included in the model were approximately 70% of the 0.5 dv threshold of concern, or significance level. There were 11 days during the modeled three-year period with Δdv over the significance level. The maximum 24-hr Δdv was 0.83 dv.

The impacts without coarse particulate matter were approximately one fifth the 0.5 dv threshold of concern, or significance level. There were no days during the modeled three-year period with Δdv over the significance level. The maximum 24-hr Δdv was 0.20 dv.

Figure 7-4. Wind Cave 3-Yr Maximum 24-hr Light Extinction



7.3. Deposition Analysis

7.3.1. Basis for Analysis

Air pollution emitted from a variety of sources is deposited from the air into ecosystems. Of particular concern are compounds containing sulfur and nitrogen that deposit from the air into the soil or surface waters. These pollutants may cause ecological changes, such as long-term acidification, soil nutrient imbalances affecting plant growth, and loss of biodiversity.

The term critical load is used to describe the threshold of air pollution deposition that causes harm to sensitive resources in an ecosystem. A critical load is technically defined by the National Atmospheric Deposition Program as “the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur according to present knowledge.” Critical loads are typically expressed in terms of kilograms per hectare per year (kg/ha/yr) of wet or total (wet + dry) deposition. Critical loads are widely used to set policy for resource protection in Europe and Canada. They are presently emerging as guidelines to help in the protection of Class I areas in the United States. Recommended critical loads for nitrogen alone range from 1.5 kg/ha/yr at sensitive alpine regions such as Rocky Mountain National Park (Fenn 2003), to 8 kg/ha/yr at Mt. Rainier, to 10-25 kg/ha/yr in mixed and short-grass prairie systems (USFS 2010).

Due to the lower elevation and absence of lakes with low acid buffering capacity at Wind Cave and throughout the northern Great Plains, it is believed that conditions in Wisconsin and Minnesota are more representative than conditions in the Rocky Mountains. Based on the Acid Deposition Control Act passed by Minnesota, the sulfur (S) deposition limit that would protect the most sensitive lakes and streams from acidification was set at 11 kg/ha/yr for the Class I Boundary Waters Canoe Area Wilderness (USFS 2013). Total S plus 20% of nitrogen (N) deposition was set at 12 kg/ha/yr, implying a critical load for N of 5 kg/ha/yr. The Forest Service shows similar thresholds for the Rainbow Lake Wilderness in Wisconsin (7.5 kg/ha/yr each, for S and N). The combined critical loads (S + N) of 17 kg/ha/yr in Minnesota and 15 kg/ha/yr in Wisconsin are consistent with the 10-to-25 kg/hr/yr range cited above for N in mixed and short-grass prairie systems.

Another measure often applied to sulfur and nitrogen deposition is the Deposition Analysis Threshold, or concern threshold, below which estimated impacts from a source are considered negligible. In the Class I areas of Colorado, Wyoming and Montana where high mountain lakes often exhibit low acid neutralization capacity, this threshold has been set by the U.S. Forest Service at 0.005 kg/ha/yr for sulfur and the same for nitrogen. In the eastern U.S., including Wisconsin and Minnesota, the Class I thresholds are 0.010 kg/ha/yr (FLM 2011). To date, no concern threshold has been published for Class I areas in South Dakota. For conservatisim, the modeling results are compared to the 0.005 kg/ha/yr value.

7.3.2. Modeled Deposition Fluxes

In order to assess potential impacts of the Dewey-Burdock Project on atmospheric deposition at Wind Cave National Park, it is necessary to examine current conditions. Table 7-3 summarizes current atmospheric conditions at Wind Cave for the modeled years. Samples were collected and analyzed under the National Acid Deposition Program (NADP 2012). The combined (S + N) deposition rate or flux averaged just over 4 kg/ha/yr during the three-year period.

Table 7-3: Current Acid Deposition at Wind Cave National Park (kg/ha/yr)

Year	NH4	NO3	SO4	S (inferred)	N (inferred)	S + N
2009	2.14	4.68	3.00	1.00	2.72	3.72
2010	3.04	5.29	3.48	1.16	3.56	4.72
2011	2.30	4.78	2.70	0.90	2.87	3.77
Average				**1.02**	**3.05**	**4.07**

Source: National Atmospheric Deposition Program/National Trends Network, 2012

Table 7-4 presents the results of wet and dry deposition modeling of the Dewey-Burdock Project emissions using CALPUFF. The table compares these results to measured values, deposition analysis thresholds and critical loads.

Table 7-4: Acid Deposition Modeling Analysis at Wind Cave (Wet + Dry, kg/ha/yr)

Parameter	Sulfur	Nitrogen	Sulfur + Nitrogen
Modeled daily maximum μg/m^2/sec	0.0005188	0.0008392	0.0013580
Modeled 3-yr average μg/m^2/sec	0.0000031	0.0000051	0.0000083
Modeled 3-yr average kg/ha/yr	0.0010	0.0016	0.0026
Concern threshold (kg/ha/yr)	0.005	0.005	0.010
Measured 3-yr average kg/ha/yr	1.02	3.05	4.07
Estimated critical load (kg/ha/yr)	12	5	17

The results of the deposition analysis predict that impacts from the Dewey-Burdock Project on Wind Cave National Park will be insignificant. First, Table 7-4 shows that measured deposition flux for S and N are less than the estimated critical loads, by a significant margin. Second, Table 7-4 predicts that potential annual deposition impacts from the Dewey-Burdock Project will be less than the concern thresholds. Also listed are the predicted, peak 24-hr deposition rates, in μg/m^2/sec. Figures 7-5 and 7-6 provide contour plots of the modeled maximum 24-hour S deposition and N deposition fluxes, respectively.

Figure 7-5. Maximum 24-hr Sulfur Deposition Rates at Wind Cave National Park

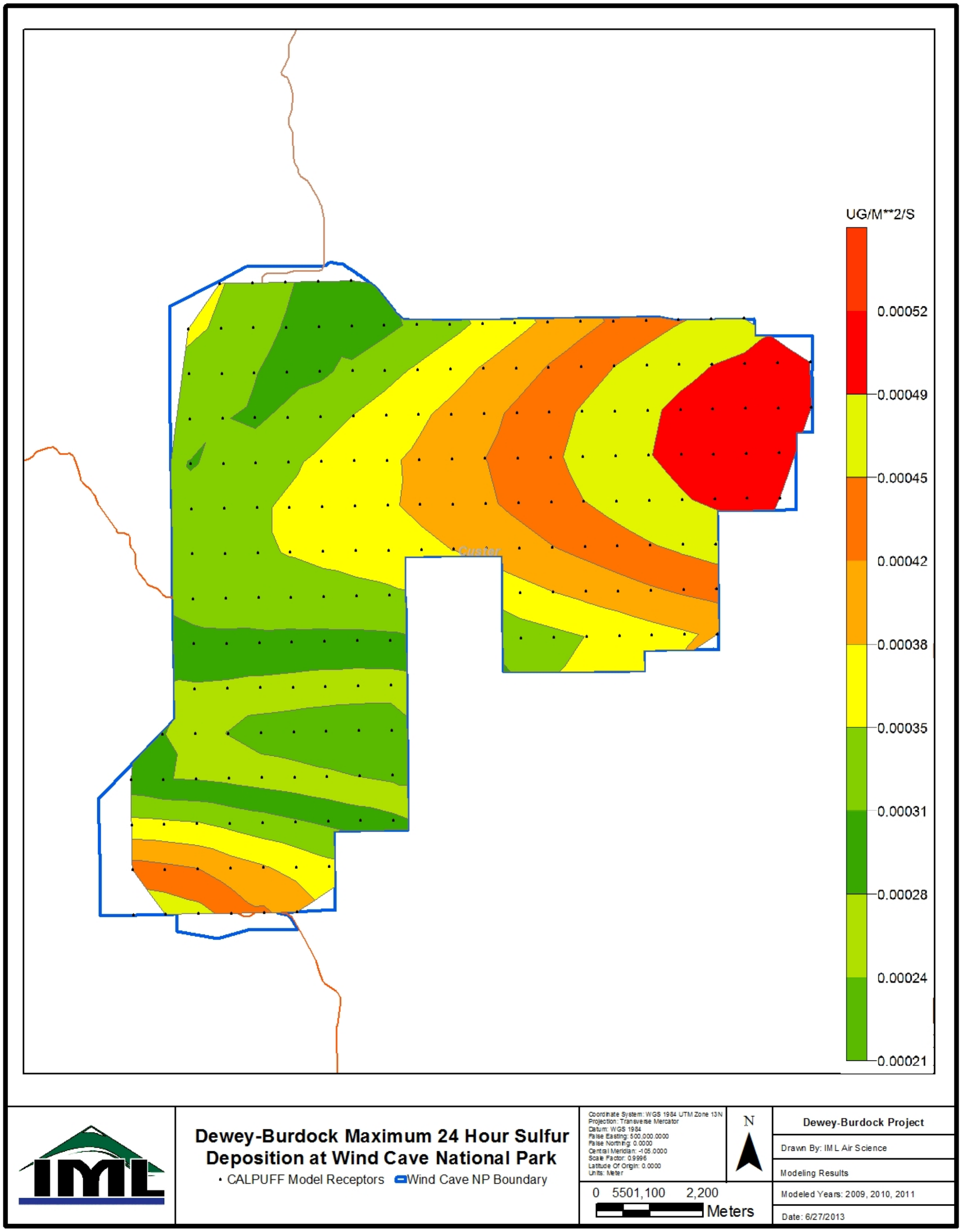
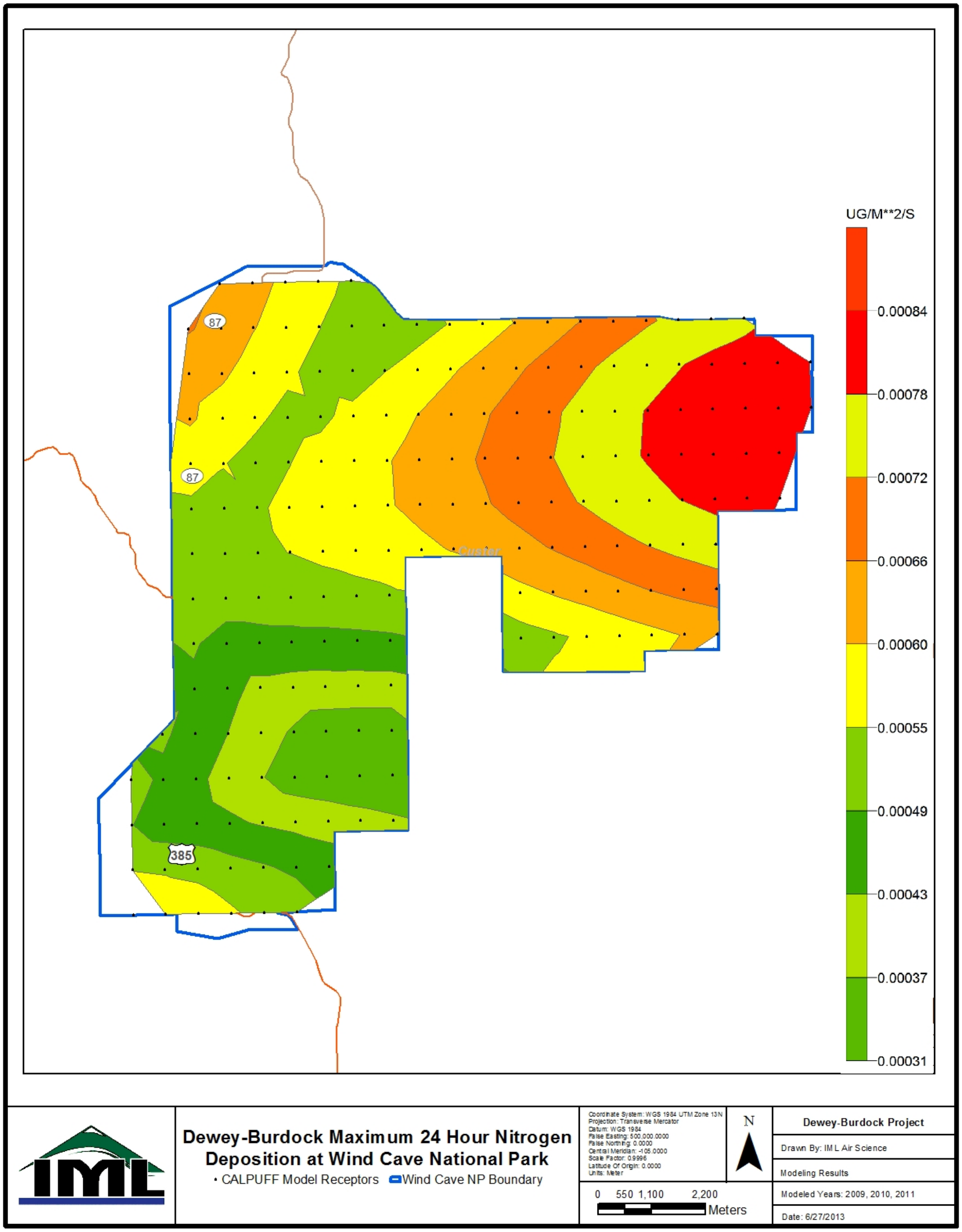


Figure 7-6. Maximum 24-hr Nitrogen Deposition Rates at Wind Cave National Park



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APPENDIX A

EMISSION INVENTORY CALCULATIONS

APPENDIX B

SOURCE APPORTIONMENT AND TIMING

APPENDIX C

BOUNDARY RECEPTOR STUDY

APPENDIX D

WATER TRUCK CONTROL EFFICIENCY

APPENDIX E

AERMOD LIST FILES

APPENDIX F

CALPUFF LIST FILES

APPENDIX G

CALPUFF RESULTS REPORT

APPENDIX H

HISTORY OF DEWEY-BURDOCK MODELING CHANGES