Visibility Impact Modeling Results

Holcomb Station Expansion

prepared for:

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1.0 INTRODUCTION

This report briefly summarizes the results of Class I area dispersion modeling for the proposed expansion of Holcomb Station, located in western Kansas, west of Garden City. The proposed expansion would consist of two nominal 700 MW electric generating units and support equipment. Holcomb Station currently has one nominal 360 MW electric generating unit, with air emission controls consisting of lo-NO_X burners for nitrogen oxide (NO_X) control, a lime spray dryer (dry scrubber) for sulfur dioxide (SO_2) control and a fabric filter (baghouse) for particulate matter control. The proposed new units at the site would use state-of-the-art emission controls to minimize NO_X, SO_2 and other acid gases, particulate matter, and mercury.

The analysis presented in this report was requested by the Kansas Department of Health & Environment (KDHE), which is the agency responsible for issuance of a construction (Prevention of Significant Deterioration) air permit, in consultation with US Environmental Protection Agency (EPA) Region 7 staff, and US Fish & Wildlife Service (FWS) staff.

EPA's New Source Review (NSR) guidance (DRAFT, October 1990 New Source Review Workshop Manual) states that Class I impact analysis are necessary for major sources locating within 100 km of a Class I area. While the proposed project, which will be a major modification of the facility, is located much farther away from any Class I area, the EPA NSR guidance states that sources more distant than 100 km should be considered for analysis if they are large and considered to have a potential for adverse impact at Class I areas. At the request of FSW and KDHE, Sunflower Electric has completed a Class I visibility impact analysis with the assistance of HDR Engineering, Inc.

The proposed project is quite distant from the nearest Class I areas, at nearly 400 km from Great Sand Dunes National Monument in Colorado, and slightly over 400 km from Wichita Mountains National Wildlife Refuge in south-central Oklahoma. While the Wichita Mountains area is slightly farther away from the plant site than the Great Sand Dunes, Wichita Mountains is in a more predominant wind direction. This analysis focuses primary on Wichita Mountains because of higher expected impacts than at Great Sand Dunes, but the impacts at both areas are summarized in this report.

2.0 METHODOLOGY

The atmospheric dispersion and atmospheric chemistry modeling for estimating visibility impacts was accomplished with the current regulatory versions of the CALPUFF modeling system, which is an EPA-guideline approach for estimating visibility impacts at distances beyond 50 km and up to a few hundred km from a Class I area. CALPUFF has generally been recognized as being applicable up to 300 km downwind, and is considered to become over-conservative (high) in its impact predictions beyond 300 km. Given that the Class I areas analyzed here are nearly 400 km away, the CALPUFF visibility impacts presented here are considered to be overestimates of the impacts that should be expected from the proposed facility.

The methodology for estimating impacts with the CALPUFF system (CALMET meteorological preprocessor, CALPUFF model, POSTUTIL postprocessor and CALPOST postprocessor) is detailed in the attached, final modeling protocol. This protocol was the subject of two review cycles over the past months with staff from KDHE, EPA Region 7, and FWS providing comment on the protocol. Changes recommended by these agencies have been incorporated into the final protocol, which included as Attachment 1 of this report.

3.0 RESULTS

3.1 Model Input and Results Summary

The results of the CALPUFF visibility analysis are presented in this section. This analysis is based on the emissions factors and rates shown in Table 1 as input to CALPUFF. These emission rates are based on a maximum heat input rate, for both units combined, of 13,002 mmBtu/hour.

Table 1. Emission Rates Input to CALPUFF Visibility Analysis

Pollutant	Emission Factor (lb/mmBtu)	Emission Rate (lb/hr, both units)
Sulfur dioxide	0.101	1313.2
Nitrogen oxides (as NO2)	0.05	650.1
Coarse Particulate Matter	0.00384	49.9
Fine Particulate Matter	0.0103	129.2
Elemental Carbon PM	0.000382	5.0

Tables 2 and 3 present the CALPUFF (actually CALPOST postprocessor) results for visibility impact at the Great Sand Dunes and Wichita Mountains Class I areas, respectively.

At Great Sand Dunes, there are three episodes (days) when modeled light extinction exceeded the Federal Land Managers' (FLMs) de-minimis threshold of 5%. This would normally be grounds for triggering a more refined analysis. Meteorological data for these days at the nearest weather site, Alamosa, Colorado, were reviewed to determine conditions in the area on these days. The numbers in parentheses next to the listed values over 5% represent the Julian Day number of the subject episode. For all three of the days over 5% visibility modeled impact, the weather conditions were generally clear at the Alamosa observing station.

While the FLMs' guidance for visibility modeling has for the past few years specified light extinction as the metric for assessing visibility impact, they are drafting guidance to soon change this to a deciview metric, based on a 98th percentile impact. This would be consistent with EPA's recommended visibility metric for Best Available Retrofit Technology (BART) analyses. In general, states and EPA have been using a 0.5 deciview impact level (98th percentile, for a refined analysis) as a basis for assessing whether a source is exempt from BART retrofits. At the request of the FWS, the "Method 6" results in the above table are presented for comparison with the anticipated new FLM metric. The results in Table 2 show that for Great Sand Dunes, the 98th percentile impacts would be well below the 0.5 deciview threshold.

Thus, there appears little potential for adverse impact at Great Sand Dunes, especially when considering the more statistically robust 98th percentile deciview metric, and there does not appear to be a need for refined analysis. Also, considering that CALPUFF likely significantly overestimates the impacts, there does not appear to be cause for concern at Great Sand Dunes.

Table 2. Summary of Great Sand Dunes Visibility Impact Results, in Percent Light Extinction Increase, and in Deciview Increase

Background Visibility Method	Rank	Great Sand Dunes		
		2001	**2002**	**2003**
Method 2 (all values in % light extinction)	**1**	2.60	**11.17** (307)	**8.27** (311)
	2	1.60	**8.12** (296)	4.08
	3	1.40	4.00	3.59
	4	1.11	3.18	2.90
	5	0.78	2.92	1.59
	6	0.67	2.76	1.40
	7	0.56	2.66	1.20
	8	0.49	2.62	1.10
Method 6 (all values in deciviews)	**1**	0.171	0.549	0.572
	2	0.153	0.404	0.361
	3	0.146	0.234	0.261
	4	0.096	0.216	0.200
	5	0.093	0.212	0.118
	6	0.062	0.203	0.093
	7	0.057	0.190	0.092
	8	0.048	0.138	0.091

At Wichita Mountains, the model predicted higher exceedances of the FLMs' 5% light extinction de-minimis threshold, especially for 2001 meteorology. A review of meteorology at Lawton, Oklahoma, for the episodes (days) of these predicted impacts (Julian Day in parentheses), shows that all three days were affected by very high humidity, fog and precipitation. These conditions would not only make it difficult to see great distances, but there is concern in the scientific community that the calculations of visibility impacts on such days are not accurate.

For the 2002 and 2003 episodes that are over 5% light extinction (more marginally than for 2001), there was less precipitation than for the 2001 episodes, and two of the episodes in 2002 and 2003 had no reported precipitation at Lawton on the subject days.

Using the newer metric of deciviews, assessed on a 98th percentile basis (see "Method 6" results above), the impacts at Wichita Mountains are all below the 0.5 deciview threshold commonly being used to determine a potentially adverse visibility impact in BART analyses nationwide. The 98th percentile impacts at Wichita Mountains are higher than at Great Sand Dunes, which is expected, given the greater predominance of winds from Holcomb Station toward Wichita Mountains. However, even at Wichita Mountains, the 98th percentile deciview values for each year are significantly lower than the 0.5 deciview BART threshold. As explained above, the tendency of CALPUFF to overestimate impacts beyond 300 km means that there is little potential for adverse visibility impact from the proposed facility at the Wichita Mountains.

Table 3. Summary of Wichita Mountains Visibility Impact Results, in Percent Light Extinction Increase, and in Deciview Increase

Background Visibility Method	Rank	Wichita Mountains		
		2001	2002	2003
Method 2 (all values in % light extinction)	1	**30.58** (47)	**7.20** (19)	**6.36** (62)
	2	**18.36** (46)	**5.99** (38)	**5.43** (61)
	3	**13.48** (347)	**5.71** (270)	4.78
	4	4.76	**5.01** (342)	4.43
	5	4.48	3.83	3.63
	6	3.77	3.43	3.54
	7	2.45	3.07	3.39
	8	2.26	2.93	3.32
Method 6 (all values in deciviews)	1	1.107	0.487	0.614
	2	0.921	0.486	0.524
	3	0.517	0.468	0.312
	4	0.369	0.427	0.299
	5	0.229	0.418	0.268
	6	0.216	0.366	0.229
	7	0.212	0.363	0.222
	8	0.212	0.331	0.213

3.2 Analysis of Worst-Case Modeled Episodes

At the request of the FWS, this section of the report presents the results of an analysis to estimate impacts at receptors intermediate between Holcomb Station and Wichita Mountains, on the two days (Julian Days 46 & 47, or February 15 & 16, 2001) that generated the maximum impacts. For this analysis, receptors were placed ever 25 km from 250 km downwind to the nearest point of the Wichita Mountains Class I area, just over 400 km downwind. Table 4 presents the results of this analysis for both days.

The two sets of results in Table 4 are somewhat different for these episodes, although they are both reasonable based on the CALPUFF model design, depending on atmospheric chemistry and dispersion. For Day 46, the impacts decrease uniformly with downwind distance. This is not unusual with dispersion models not including any chemistry interactions and this pattern can typically be attributed simply to increasing dispersion with distance. For Day 47, modeled impacts increase up to 325 km downwind, and then begin decreasing uniformly. Such a pattern could be caused by multiple effects simulated by the model, including:

1) meandering plume with transport downwind,
2) simple dispersion of an elevated, stable, plume down to the ground, thus peaking the impact at 325 km, with increasing dispersion thereafter,
3) chemistry & dispersion interactions, wherein chemical conversion using background constituents is "exhausted" at 325 km, and then dispersion takes over, or
4) elevation changes with distance.

Any of these factors could affect predicted concentration patterns with downwind distance. However, it is clear that the impact data in Table 4 are consistent with the reported worst-case impacts at Wichita Mountains.

Table 4. Visibility Impacts in 2001 at Intermediate Receptors Located Between Holcomb Station and Wichita Mountains

			Day 46		Day 47	
	Bkgd. Light Ext. ($1/10^6$ m) =>		**18.495**		**19.185**	
	Receptor Location					
	Distance	**Elevation**	**Total Ext.**		**Total Ext.**	
Receptor ID	**(km)**	**(m)**	**1/mega-m**	**ΔExt. (%)**	**1/mega-m**	**ΔExt. (%)**
1235	250	643	26.900	45.44	24.832	29.43
1236	275	564	26.409	42.79	25.465	32.73
1237	300	522	25.558	38.19	25.828	34.63
1238	325	546	24.648	33.27	25.965	35.34
1239	350	500	23.779	28.57	25.913	35.07
1240	375	433	22.891	23.77	25.658	33.74
Wichita Max.	400+	606	21.891	18.36	25.052	30.58

4.0 CONCLUSIONS

Modeled visibility impacts at both the Great Sand Dunes National Monument in Colorado, and the Wichita Mountains National Wildlife Refuge in Oklahoma areas, assessed according to the 98^{th} percentile deciview metric, are below the threshold of 0.5 deciviews. This threshold is now being used in regulatory reviews of existing sources to determine if they are potentially subject to retrofit emissions controls. The FWS and other FLMs are expected to soon begin using a similar approach to Class I analysis for purposes of PSD/New Source Review permits.

This analysis of Class I area visibility impacts has demonstrated that the proposed Holcomb Station expansion is not expected to adversely affect visibility at the Great Sand Dunes National Monument in Colorado, or the Wichita Mountains National Wildlife Refuge in Oklahoma.