Appendix C:

Recommendation for Representative Meteorological Data Sets for KCP&L Sibley, Montrose, and Hawthorn

MEMORANDUM

DATE: September 23, 2014

TO: File

FROM: Stacy Allen

Environmental Specialist, SIP Unit, Planning Section

SUBJECT: Recommendation for representative meteorological data sets for KCP&L Sibley, Montrose, and Hawthorn

The APCP was contacted by Kansas City Power and Light (KCP&L) to identify meteorological data sets to be used for the next round of SO2 modeling. The three KCP&L coal-fired electric generating stations of Sibley, Montrose, and Hawthorn require SO2 modeling. The following is an analysis of the data and recommendations.

Background: The EPA-required dispersion model requires surface and upper-air meteorological datasets, and these three facilities do not have on-site measured data. National Weather Service (NWS) data will be used for the modeling exercises because it is readily available, quality assured, and generally meet data completeness requirements. Upper air data is chosen to represent the region-wide conditions above the surface. Since upper-air locations are spaced several hundred kilometers to capture the regional upper-air pattern, the choice of representative upper-air data is based on the proximity of the facility of interest. The most representative meteorological surface weather station, usually at an airport, must be chosen for each facility. Most airport meteorological data is collected via an Automated Surface Weather System (ASOS) station that will meet EPAs modeling requirements for complete data elements over the time period. However, exceptions to ASOS data collection do exist for Missouri observation stations, and their data is further analyzed to ensure it meets quality and completeness goals. The meteorological inputs needed for EPA's model of choice, AERMOD, are evaluated using the AERMOD pre-processor AERSURFACE. AERSURFACE calculates surface roughness, reflectance, and convective instability at the facility of interest because these local characteristics influence pollutant dispersion patterns. AERSURFACE is run for both the facility of interest and the meteorological weather station so that the results can be compared, and the most similar weather station is chosen to represent the facility of interest. Because EPA is not prescriptive on how states are to choose representative meteorology, the AERMOD Implementation Guide (last revised March 19, 2009, http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf) is followed in the following documentation.

Technical Analysis: The National Land Cover Database (1992) is used to create a 1km radius circle around the center of the facility for surface roughness, and a 10 km square for reflectance (albedo) and convective instability (Bowen ratio). The 1 km and 10 km radii are the recommended values from the AERMOD Implementation Guide, section 3.1.2. There is no indication that surface characteristics at the three facilities of interest require further site-specific analysis because of significant surface discontinuities. Using these land cover characteristics, AERSURFACE is run three times to account for possible wet, dry and average precipitation conditions when compared to actual meteorological station observations. The precipitation scheme affects the convective instability (Bowen ratio) by providing more or less moisture available for latent heat transfer due to vapor to liquid phase transitions. The AERSURFACE outputs are loaded to the "MetSiteSelection.xlsm" spreadsheet that allows comparison of the facility with meteorological stations. The spreadsheet tool has pre-loaded the AERSURFACE characteristics for Missouri surface weather stations, and displays them side-by-side with the facility characteristics. The tool also provides graphical displays of surface cover information, and allows for satellite image comparisons. In general, meteorological stations within 200 km of the facility of interest are preferred as their prevailing weather conditions would be most similar to the facility. However, locations more than 200 km from the facility of interest can be considered when surface conditions of nearby meteorological stations are not deemed representative.

Sibley:

For upper air data, the Topeka upper air station is closest to Sibley at 125 km and best represents the vertical atmospheric characteristics of the region surrounding Sibley.

For surface data, the Lee's Summit (29km), KC Downtown (36 km), and Kansas City International (49 km) airports are the closest to the Sibley facility.

Lee's Summit: The surface roughness values by season do not compare favorably between Sibley and this airport. The summer and fall values differ almost 50%, and winter and spring values differ by 20-25%. This difference is primarily due to the surface cover at Sibley being dominated by water (28%) and planted cropland (43%), whereas Lee's Summit is designated over 85% planted cropland. The albedos agree within 15%. The Bowen ratios differ by 35-50% in spring due to the heat flux differences between cropland and water, but the ratios only differ by 5- 30% for other seasons.

Kansas City Downtown: The surface roughness values differ by around 45% for both summer and fall and differ by 15-25% for winter and spring. The land cover for the Downtown airport is 44% developed, whereas Sibley is only 5% developed. Though the KC Downtown airport is the location with the highest percentage of water within the 1 km radius at 13% compared to Sibley's 28%, the remaining land cover is a poor comparison. The albedos agree within 10%. The Bowen ratios differ by 35-50% in spring and 5-25% for other seasons.

Kansas City International: The surface roughness values differ by 25-35% across all seasons between Sibley and this airport. The land cover driving these differences includes planted cropland at 78% for the airport and 43% for Sibley, under 20% developed land for both locations, and under 15% forested land for both locations. Though the International airport location does not have open water

within the 1 km radius similar to Sibley, the remaining land cover produces similar surface roughness values. Albedo values agree within 10%. Bowen ratios are all within 40% for all seasons and precipitation schemes.

The next four closest airports (Whiteman 75 km, Chillicothe 88 km, Rosecrans 90 km, Sedalia 102 km) offered no improvement to the comparison of combined surface roughness, albedo, or Bowen ratios than the three closest surface weather stations. Though the International Airport is farther away from Sibley than either Lees' Summit or Downtown, it offers a better match to the surface roughness values due to similar surface cover. Because of the relative similarity across the three meteorological input parameters between the Sibley location and the Kansas City International airport meteorological station, the weather data for Kansas City International will be used to represent conditions at Sibley.

Montrose:

For upper air data, the Springfield upper air station is closest to Montrose at 128 km and best represents the vertical atmospheric characteristics of the region surrounding Montrose.

For surface data, the Whiteman (56 km), Sedalia (80 km), and Lee's Summit (81 km) stations are the closest to the Montrose facility.

Whiteman: The surface roughness values differ by 40 to 50% in summer and fall, and 25-30% in winter and spring. The main difference in land cover is the 52% water cover within 1km of Montrose, with remaining majorities of 28% planted/cultivated and 11% developed cover. Whiteman is 74% planted/cultivated and 21% developed, with no significant water. Albedo agrees within 10%. Bowen ratio differ by 45 to 80% for dry conditions, 30-65% for average conditions, and 25-40% for wet conditions.

Sedalia: The surface roughness values differ by over 110% in summer and fall, and by 10-30% for winter and spring. The land cover at Sedalia is mainly planted/cultivated at 88%, compared to Montrose at 52% water and 28% planted. Albedo agrees within 6-7% for all seasons. Bowen ration differs by 70-90% for dry conditions, 40-60% for average conditions, and 30-45% for wet conditions.

Lee's Summit: The surface roughness values differ by around 90% for summer and fall, and 10-25% for winter and spring. The surface cover responsible for the surface roughness difference includes the 87% planted/cultivated area around Lee's Summit, and 52% water and 28% planted/cultivated area around Montrose. Albedo agrees within 10% for all seasons. Bowen ratio differs by 40-70% for dry conditions, 35-70% for average conditions, and 35-55% for wet conditions.

The next closest airport (Kansas City Downtown 107 km) offered no improvement to the comparison of combined surface roughness, albedo, or Bowen ratios than the three closest surface weather stations. The influence of water surface cover near the Montrose facility strongly impacts the surface roughness comparisons with meteorological stations. Of the three locations, Whiteman shows the closest surface roughness values and Bowen ratios across the seasons and precipitation conditions. Because of the

relative similarity across the three meteorological input parameters between the Montrose location and the Whiteman meteorological station, the weather data for Whiteman will be used to represent conditions at Montrose.

Whiteman is not currently an ASOS station; it is an AWOS (Automated Weather Observing System) station, which means it does not collect minute level data for use in AERMINUTE. Prior to choosing this station, AERMET Stage 1 was run to determine the data completeness for the years of interest. The results range from 98-99.9% complete which are all above EPA's recommended completeness criteria of 90%; therefore, the data is deemed suitable for use in the modeling exercise.

SURFACE DATA		|------VIOLATION SUMMARY------|				|-----TEST VALUES-----|	
	TOTAL # OBS	# MISSING	LOWER BOUND	UPPER BOUND	% ACCEPTED	MISSING FLAG	LOWER BOUND	UPPER BOUND
TMPD	43512	5	0	15	99.95	999.0,	-300.0,	400.0
WDIR	43512	787	0	0	98.19	999.0,	0.0,	36.0
WSPD	43512	6	0	0	99.99	999.0,	0.0,	500.0

NOTE: Test values were also multiplied by the same factors applied to the data (see Appendix B of the AERMET User's Guide)

Hawthorn:

For upper air data, the Topeka upper air station is closest to Hawthorn at 100 km and best represents the vertical atmospheric characteristics of the region surrounding Hawthorn.

For surface data, the Kansas City Downtown (10 km), Lee's Summit (21 km), and Kansas City International (29 km) airports are the closest to the Hawthorn facility.

Kansas City Downtown: The surface roughness values for Hawthorn and Kansas City Downtown are most similar. The driver for similar surface roughness is the similar land cover, with 30% developed cover at Hawthorn and 44% at Downtown. Similarly, Hawthorn has 21% water within the 1 km radius, and Downtown has 13%. Albedo's agree within 7% for each season.

Lee's Summit: The surface roughness values differ by 70% in winter and spring, but only differ by 14% in summer and fall. Surface cover is majority planted/cultivated within 1 km of Lee's Summit, but land cover is a distributed mix of water, developed, wetland, and planted/cultivated land cover at Hawthorn. Albedo's agree within 10% for each season. Bowen ratios agree within 10 to 30% for all precipitation conditions.

Kansas City International: The surface roughness values differ by 75% in winter and spring, and 45% in summer and fall. Surface cover differences include the majority planted/cultivated cover (78%) at KC International, versus a distributed mix of water, developed, wetland, and planted/cultivated land cover at Hawthorn. Albedo's differ by up to 12%. Bowen ratios differ 10-20% in dry conditions, 10-40% in average conditions, and 20-40% in wet conditions.

The next closest airports (Rosecrans 80 km, Whiteman 93 km) offered no improvement to the comparison of combined surface roughness, albedo, or Bowen ratios than nearby locations. The

influence of developed land cover on the 1 km diameters surrounding both Hawthorn and the Kansas City Downtown airport shows these locations to be comparable for meteorological parameters. Therefore, the Kansas City Downtown airport dataset will be used to represent conditions at the Hawthorn facility.

Recommendation: The following meteorological data sets are recommended for the facilities of interest:

Facility of Interest	Upper Air Location	Surface Data Location
Sibley	Topeka	Kansas City International
Montrose	Springfield	Whiteman
Hawthorn	Topeka	Kansas City Downtown