Appendix D:

Recommendation for Representative Meteorological Data Set for Labadie Energy Center

MEMORANDUM

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TO: File

FROM: Stacy Allen

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SUBJECT: Recommendation for representative meteorological data set for Labadie Energy Center

The APCP is conducting analyses of meteorological data to select the most representative data to be used in air pollution modeling for specific sources in Missouri. The choice of a meteorological data set is to be used in State Implementation Plan (SIP) modeling evaluations, including but not limited to 2010 SO_2 NAAQS modeling. The following is an analysis of the data and recommendations for the Ameren Missouri Labadie Energy Center located in Franklin County, Missouri.

Background: When states are required to complete air pollution modeling exercises to fulfill SIP obligations, various EPA regulatory guidance documents are consulted. When refined dispersion modeling is required, states choosing to use EPA's preferred model AERMOD must select surface and upper-air meteorological datasets for model input. Guidance on the choice of meteorological datasets comes from 40 CFR Part 51, Appendix W, the Guideline on Air Quality Models (November 2005), and various pollutant-specific documents like the SO_2 NAAQS Designations Modeling Technical Assistance Document.

There is no site-specific upper air dataset available for most locations because it is cost-prohibitive. Because upper air data does not depend on surface characteristics which change over short distances, the representativeness of upper air data extends over a broader region. The spacing of the readily-available National Weather Service (NWS) upper air network is several hundred kilometers to capture the larger upper air pattern, and the nearest station is generally chosen for the area to be modeled.

Surface meteorological data is highly dependent on the local surface conditions and terrain. Appendix W section 8.3 states that meteorological input data should be selected that is representative of the area of concern. Representativeness is dependent on (1) the proximity of the meteorological monitoring site to the area under consideration, (2) the complexity of the terrain, (3) the exposure of the meteorological monitoring site, and (4) the period of time during which data are collected. EPA's emphasis on these representativeness criteria is echoed in the draft SO2 NAAQS Designations Modeling Technical Assistance Document (May 2013), section 7, Meteorological Data. EPA's Modeling TAD discusses representativeness in depth, especially regarding the choice of off-site data to model the area of concern. The immediate area surrounding the meteorological collection site influences the low level

wind pattern and the depth of atmospheric mixing that can be expected. The variables that capture these characteristics are surface roughness, albedo, and Bowen ratio. Since these three variables are required inputs for the AERSURFACE meteorological data processor that is a required part of the AERMOD modeling, it is critical that any off-site surface weather data must be as closely representative of these variables as possible.

When site-specific surface weather data is not available, the most commonly used off site source of data is the NWS. These data sets are readily available, quality assured, and generally meet data completeness requirements. The most representative meteorological surface weather station, usually at an airport, must be chosen for the 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. In a few cases, meteorological monitoring data at nearby industrial facilities can be used if it is closer than the nearest NWS site and meets representativeness criteria. The meteorological inputs needed for EPA's model of choice, AERMOD, are evaluated using the AERMOD pre-processor AERSURFACE. AERSURFACE calculates surface roughness, albedo, and Bowen Ratio 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 surface 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 Labadie location of interest does not have at least one year of current site-specific meteorological data as of July 2015. Site specific meteorological data is to be collected beginning December 31, 2015 or sooner according to a consent agreement between Ameren and the Missouri Department of Natural Resources (No. APCP-2015-034). According to Appendix W 8.3.3.1.a, representative meteorological data may be collected from locations not immediately "on-property". Until such data is collected for use in dispersion modeling exercises, nearby National Weather Service sites are considered for representativeness.

Representativeness considerations include those factors that influence the dispersive characteristics of the atmosphere. Surface roughness, Bowen ratio, and albedo are determining factors for vertical dispersion away from the source of interest according to surface characteristics and land use. Consideration of other meteorological parameters, including wind speed and direction as influenced by terrain, must also be used when choosing a representative meteorological site according to the AERMOD Implementation Guide, section 3.1.1.

National Weather Service Meteorological Data:

For upper air data, the Lincoln, IL National Weather Service upper air station is closest to Labadie at 214 km and best represents the vertical atmospheric characteristics of the region.

The following discussion describes the process of choosing an appropriate surface meteorological NWS location and dataset.

Surface characteristics are examined using EPA's AERSURFACE. 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. 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 conditions of nearby meteorological stations are not deemed representative.

Meteorological parameters are considered due to the siting of Labadie in the Missouri river floodplain. The elevation changes that occur outside of the floodplain, combined with the orientation of the floodplain relative to compass north, influence the wind flow patterns due to channeling. When possible, representative meteorological data will be chosen from an offsite location that is also located in a similarly sized and oriented river valley.

<u>Labadie:</u>

For surface data, the Spirit of St. Louis (19 km), Lambert (46 km), and St. Charles (54 km) airport weather reporting stations are the closest to the Labadie facility. Ten other surface weather stations are within 200 km of Labadie.

Spirit of St. Louis: The Spirit of St. Louis airport surface weather observations are taken approximately 19 km east of Labadie. The airport and Labadie are located within the Missouri river valley. Though both locations are within the river valley, land cover around Labadie remains agricultural while development has occurred around the Spirit airport in the last 20 years. The National Land Cover file is from 1992 and does not reflect the current Spirit surface cover conditions, including airport structures located within the 1 km radius, or the commercial retail and residential development east to south of the airport within the 10 km radius. Surface roughness, Bowen ratio, and albedo calculated using AERSURFACE for Spirit do not reflect the current surface cover at the airport. The quantitative comparison of Spirit and Labadie surface characteristics using the "MetSiteSelection.xlsm" spreadsheet is inappropriate. Qualitatively, the areas do not have similar surface characteristics due to the higher surface roughness at Spirit from developed and forested land. Labadie's lower roughness values are due

to nearby water and planted/cultivated surface cover. Meteorological influences from the floodplain terrain do show some similarity between these sites. The Missouri river valley is approximately 2 miles wide at both locations, and is oriented from the WSW to the ENE. The Spirit airport is located within ½ of a mile of the southern floodplain higher terrain, whereas the Labadie facility is nearly 1 mile from the southern floodplain boundary. Despite the general terrain agreement between Spirit and Labadie which will capture the wind speed and direction influences on dispersion, the lack of agreement between surface characteristics between the sites will affect the vertical dispersion of pollutants away from the surface. Since vertical dispersion greatly influences the concentrations of pollutants expected at the surface, a better fit for surface characteristics should be identified to follow the representativeness goals.

Lambert: The Lambert St. Louis airport is located 46 km northeast of Labadie. The airport is not located within the Missouri river valley. The surface roughness values differ by 75% in winter, 60% in spring, and near 40% in summer and fall. Lambert surface cover within the 1 km radius is 66% developed and 33% planted/cultivated, compared to Labadie's 38% water, 35% planted/cultivated, and 15% wetland. Lambert's surface roughness values are higher overall due to the taller structures when compared to the relatively flat cover surrounding Labadie. Albedo values agree within 21%. Bowen ratios differ by up to 160% due to the dominant developed land cover type at Lambert, and the best agreement is a 68% difference under average precipitation schemes in fall and winter. Meteorologically, Lambert is not located within a floodplain and is not influenced by terrain in the same way as Labadie. The combination of poor surface characteristic agreement and lack of meteorological similarity mean Lambert does not meet the representativeness criteria for Labadie.

St. Charles: The St. Charles airport is located 54 km northeast of Labadie in the broad floodplain upstream of the confluence of the Missouri and Mississippi Rivers. Surface cover at the St. Charles airport is 97% planted/cultivated agricultural land which has not changed since 1992. The surface roughness values differ by as much as 91% in summer and fall between St. Charles and Labadie, and as little as 21% and 7% in winter and spring. The disagreement comes from the 38% water cover at Labadie that keeps lower surface roughness values throughout the growing season when planted land around St. Charles has taller plant heights. Albedo values differ by less than 6% across the seasons. Bowen ratios differ by almost 40% for dry conditions, 30% for average conditions, and 20% for wet conditions. Meteorologically, St. Charles is located within a floodplain, but the floodplain characteristics that influence wind speed and direction are different than Labadie. The floodplain at St. Charles is over 4 miles wide because it is near the confluence of the Missouri and Mississippi rivers where the floodplain widens out and becomes much shallower. The orientation of the floodplain is WSW to ENE, similar to Labadie, but the distance of over 2 miles to the higher elevations at the edge of the floodplain mean that the St. Charles airport is much less influenced by the terrain. The combination of poor surface characteristic and meteorological agreement mean St. Charles is not a representative site for Labadie.

Since the first three closest NWS surface weather stations are do not meet representativeness criteria, other NWS locations out to 200 km were examined. Of the ten additional NWS locations within 200km were examined for general surface characteristics and meteorological influences. The Downtown St. Louis, aka Cahokia, airport at 60 km from Labadie was considered initially. Its combination of developed land at the airport, and the north-south oriented Mississippi River flood rule it out for representativeness. The Alton (77 km), Rolla (94 km), Farmington (96 km) sites are not located in floodplains and do not have terrain-influenced winds as does Labadie.

The Jefferson City airport, at 115 km, is located within the Missouri river floodplain. Its surface characteristics are a better match to Labadie due to similar planted/cultivated land use around the airport. Surface roughness disagrees by only 45% in summer, 41% in fall, 11% in winter and 8% in spring. Albedo agrees within 8% across all seasons. Bowen ratio agrees within 30% for all seasons in wet conditions, 35% for average conditions, and 40% for dry conditions. In over half the precipitation and seasonal conditions, the agreement is within 20%. The location within the Missouri river floodplain is similar between Labadie and Jefferson City. Though the orientation of the floodplain is WNW to ESE at Jefferson City, the distance to elevated terrain is similar to Labadie at 1 mile. Despite the slight difference in orientation of the floodplains, the Jefferson City airport surface weather station should adequately represent the magnitude of influence of the floodplain on wind speed and horizontal dispersion. The similarity of surface characteristics should also adequately represent the vertical dispersion experienced at Labadie. The combination of both surface characteristics and meteorological influences make Jefferson City the preferred choice for off-site representative surface weather data for Labadie. Until such time as one year of on-site weather information is collected and quality assured for Labadie, the best fit representative location will be used for SIP modeling exercises.

The Jefferson City airport surface NWS site data is preferable to represent the surface meteorological conditions at Ameren Labadie Energy Center due to similar surface characteristics and terrain-influenced meteorology.

Recommendation: The following meteorological data sets are recommended:

Facility of Interest	Upper Air Location	Surface Data Location
Ameren Labadie Energy Center	Lincoln, IL	Jefferson City, MO